Energy Policy Review

Brazil 2025

INTERNATIONAL ENERGY AGENCY

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Executive summary

Brazil has positioned itself as a leader in the global energy transition. Its vast renewable energy resources, strong biofuels sector and ambitious climate commitments offer distinct advantages in the low-carbon economy. The country has introduced a comprehensive National Energy Transition Policy (PNTE) aimed at achieving net zero greenhouse gas (GHG) emissions by 2050, supported by the Energy Transition Plan (PLANTE) and the Energy Transition Forum (FONTE). In 2024, the country also launched the Low-Carbon Hydrogen Law, the Brazilian Greenhouse Gas Emissions Trading System Law, the Fuel of the Future Law and the Energy Transition Acceleration Program, further boosting momentum for the energy transition. These initiatives seek to balance economic development with sustainability while ensuring energy security, social inclusion and technological advancement.

Brazil's energy transition is guided by long-term planning frameworks. These include the 30-year National Energy Plan (PNE) and the Ten-Year Energy Expansion Plan (PDE), which provide a structured roadmap for integrating clean technologies, expanding grid infrastructure and enhancing energy efficiency. However, Brazil would benefit from a more unified and overarching energy strategy that consolidates existing policies to ensure coherence, better co-ordination and investment certainty. Likewise, Brazil will need to re-evaluate its spending priorities and sources of funding across all energy areas to ensure that they properly align with the government's core objectives for the energy transition.

Brazil has prioritised achieving a people-centred clean energy transition. It has already made significant strides in improving energy access and affordability, notably through the Light for All Program (*Programa Luz para Todos*) and targeted subsidies for electricity and natural gas. Looking ahead, a key challenge for the government will be to design policy to ensure that the benefits of energy transitions are widespread

for all citizens and can be leveraged to accelerate economic opportunities and reduce inequalities. As part of this effort, the jobs potential from the energy transition could be considerable, but it is not fully understood in terms of the number of jobs, sectors and skills requirements. A comprehensive jobs planning and workforce mapping exercise would help maximise opportunities, building off successful local programmes. Brazil should also look to identify opportunities to expand clean cooking access to all families, including exploring the inclusion of electricity into clean cooking options.

A successful energy transition in Brazil will require massive amounts of economically viable investments across clean energy technologies and infrastructure. The government estimates that BRL 3.2 trillion (Brazilian real; EUR 0.5 trillion) will be required over the next decade for energy-related investments (including supporting infrastructure), from both public and private capital. Of this amount, 78% will be allocated to the oil and natural gas sector, 19% to electricity supply, and 3% to liquid biofuel supply. However, Brazil has a relatively high cost of capital, which can impede its investment potential. Funding from the Brazilian Development Bank, BNDES, was instrumental in supporting the strong growth in renewables the country has experienced over the past decade. A recently established investment platform and the Energy Transition Acceleration Program will further help bridge the gap to attract more private finance. However, to mobilise additional capital according to energy transition objectives, Brazil could also consider implementing a national investment fund directing a portion of government oil revenues to finance the energy transition and expand green finance mechanisms. The government has also taken the bold decision to establish a carbon market in Brazil, which will help direct investment into low-carbon areas. Revenues from the system can also be an important source of capital for energy transition investments as well as for offsetting the negative impacts on energy prices for low--income populations.

Brazil benefits from end-use sectors that already have high shares of bioenergy and electricity. While industry is the largest energy-consuming sector, transport is the largest emitting sector. Energy efficiency has the potential to bring considerable benefits for Brazil, from lowering energy bills to cutting emissions and managing energy demand growth. In industry, energy audits could help identify energy savings measures and support the implementation of energy efficiency measures. Ramping up energy performance standards for industrial equipment could likewise support more ambitious outcomes. Similarly, voluntary energy audits in buildings would also help identify low-cost energy-efficient solutions. The government should also ensure that energy efficiency and thermal comfort solutions are systematically considered in

social housing programmes to reduce energy costs. Meanwhile, though Brazil has enjoyed tremendous success with biofuels and flex-fuel vehicles, it also has a chance to expand the role of electric vehicles (EVs), including flex-fuel hybrids, to lower emissions and seize an important opportunity for domestic manufacturing. Brazil would also benefit from discrete policies to support demand for lower-emissions heavy-duty vehicles given a heavy reliance on fossil diesel in the freight sector.

Brazil is already endowed with a low-emissions and highly renewables-based power system. However, several important trends are creating challenges to the system that need to be addressed in the coming years. These include massive growth of wind and solar photovoltaic (PV) generation that has outpaced the growth of grids and flexibility solutions, more challenging dispatch scheduling of hydro generation based on the impacts of climate change, and an influx of distributed PV. Therefore, Brazil would benefit from a stronger holistic assessment of its electricity frameworks to ensure a system that is reflective of these structural shifts. Importantly, to support grid balancing and system stability, Brazil should incentivise all flexibility of existing resources, including hydropower, along with new solutions such as demand response and storage. Equally important will be ensuring a smooth assimilation of distributed PV resources into the system, including reform of the net metering scheme. Crucially, electricity prices need to be contained to support electrification, household affordability and industrial competitiveness. A reassessment of cost and subsidy allocations on retail tariffs should, therefore, be undertaken with an eye to creating a regulatory regime that ensures fair and accurate prices and avoids regressive effects on low-income households.

Brazil remains a major oil producer and exporter as well as a natural gas producer, led by state oil giant Petrobras. The upstream sector is a critical economic driver for the country, generating sizeable fiscal revenues that support the federal budget and social programmes. Based on the known resource base, Brazil's oil production is projected to peak in the coming decade, which will require increased investments in technology and innovation to enhance productivity, reduce costs and maintain the sector's competitiveness over the medium and long term. A balanced approach is essential to ensure economic stability while transitioning to a low-carbon economy. A key priority is reducing emissions from upstream activities by implementing carbon capture and storage (CCS), methane reduction strategies, and stricter flaring regulations to minimise environmental impacts. Additionally, it is important to maximise the value of oil and gas production for Brazil, including consideration of broader participation in upstream activities to increase efficiency and free up domestic capital for other priority areas that face more difficulty soliciting

private investment. The oil and gas sector can also be an important source of capital and know-how to bolster research and development (R&D) investments. The government could – in addition to establishing a national investment fund using oil and gas revenues for low-carbon investments – consider incentivising oil and gas companies to allocate a greater share of their investments to R&D in low-carbon technologies and clean energy innovation. Together, these actions would strengthen Brazil's position in the global energy transition.

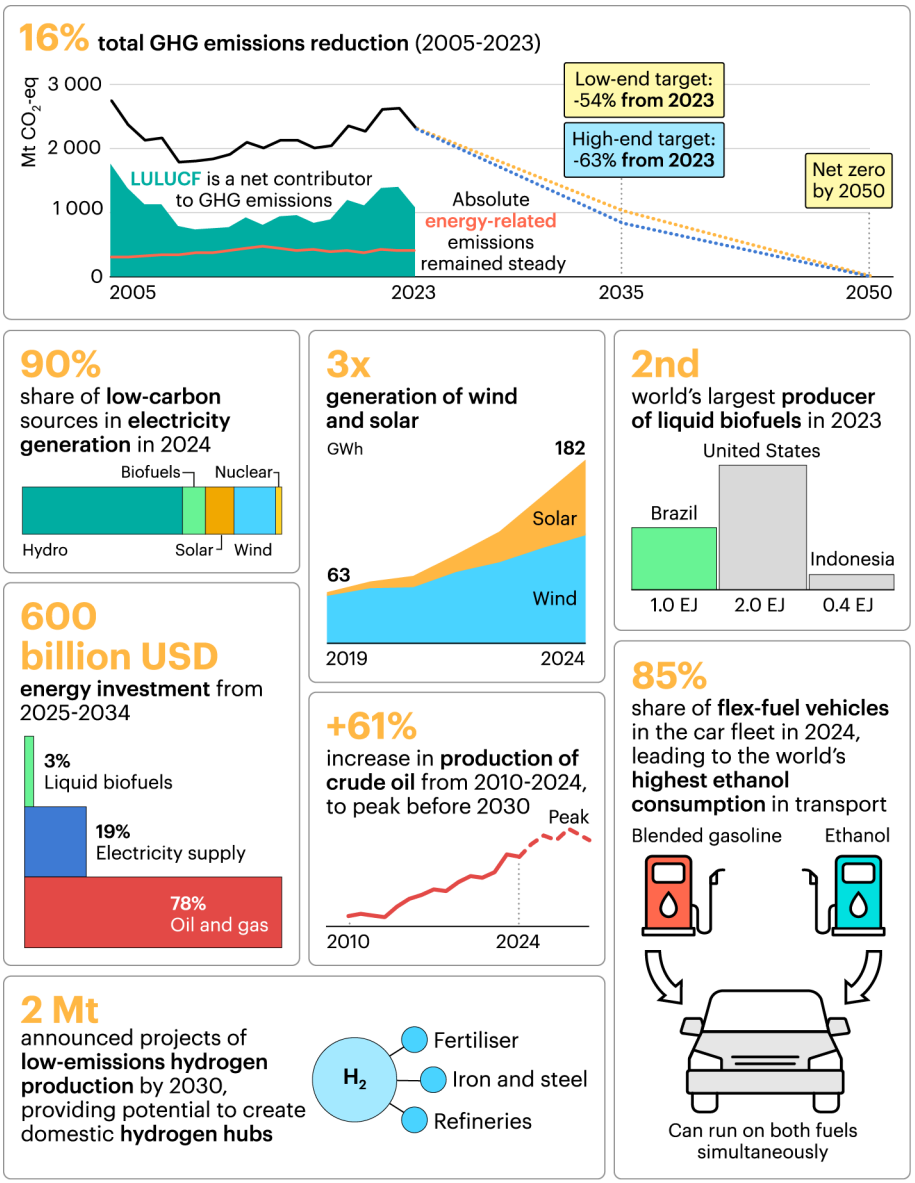
Oil and gas consumption also plays an important role in the Brazilian economy, highlighting the importance of security of supply and fair pricing. As a major oil producer, Brazil is a net exporter of crude oil but remains dependent on refined product imports, suggesting that additional efforts could be considered to ensure access to all fuels in a crisis situation. Brazil is a net importer of natural gas and has taken steps in recent years to diversify its gas imports through liquefied natural gas (LNG). However, prices for industrial consumers remain high, eroding competitiveness. The New Gas Market Reform passed in 2021 will go a long way to improve price discovery and shift pricing to more accurately reflect supply and demand fundamentals, but implementation of the law needs to be accelerated to realise the benefits. Brazil should also clarify the role of natural gas in the energy transition by developing a clear strategy that ensures its efficient use while supporting higher shares of renewables over time.

Biofuels have been an enormous success story for Brazil. Policies since the 1970s have significantly expanded both the production and consumption of ethanol and biodiesel. Today, the RenovaBio programme, which sets annual decarbonisation targets for fuels that incentivise biofuels blending, continues to drive sector growth. Moreover, the recently passed Fuel of the Future Law is a comprehensive piece of legislation that provides a demand pull for ethanol, biodiesel, biomethane, green diesel and sustainable aviation fuels (SAF) and sets regulatory frameworks for other sustainable fuels. The opportunity can be maximised by undertaking and disseminating detailed analysis on land-use impacts and land-use change from biofuels production across feedstocks, including through an ongoing assessment of RenovaBio. Brazil's expertise in first-generation biofuels can be further leveraged through the RenovaBio programme to develop advanced biorefineries that can produce advanced biofuels and SAF. Overall, the country's strong agricultural base provides ample feedstock for next-generation biofuels, reducing dependence on fossil fuels while enhancing energy security.

Another major opportunity lies in leveraging a highly renewables-based electricity sector to scale up low-emissions hydrogen. The Low-Carbon Hydrogen Strategy positions Brazil to be a leader in low-emissions hydrogen production, both for domestic use and potential exports, and its implementation should start in a timely fashion. Hydrogen can be used to decarbonise hard-to-abate sectors, such as steelmaking, fertilisers, shipping and aviation, not only helping reduce the fertiliser trade deficit but also creating new revenue streams through international trade. Demand creation and infrastructure development will be key market enablers and should be early focus areas for the government. Leveraging experience in the biofuels sector, an agri-industrial, cluster-based approach for both hydrogen and other sustainable fuels and products would support the development of localised markets through a measured infrastructure buildout that could subsequently be scaled up.

Over the past years, Brazil has strengthened its capabilities on energy data gathering and dissemination, a prerequisite to a successful energy transition. The effort has been spearheaded by the Energy Research Office (EPE), which also integrates the data into the preparation of 10-year energy plans as well as a 30-year plan that forecast the development of the energy sector over time. Building off these achievements, Brazil could look to develop a mid-term energy data strategy and further strengthen the institutional set-up for data collection in line with high policy ambitions in PLANTE. The collection of policy-relevant data will also need to evolve to keep up with a fast-changing energy landscape.

Overall, Brazil has a unique opportunity to become a global leader in clean energy sectors. Notably, its renewables-based electricity system and world-leading bioenergy sector offer rare competitive advantages that can be leveraged to build new industries, create millions of jobs and improve living standards for all citizens. The country is off to an excellent start, and policy actions over the past year have further positioned the country well to realise its immense opportunities. Success will require concerted efforts across the macroeconomic and energy landscape, including to mobilise finance, lower prices, increase efficiency and optimise resources. It will likewise require a balanced approach to oil and gas resource development. By aligning its energy transition with economic development, industrial transformation and social inclusion, Brazil can set a global benchmark for sustainable growth in the 21st century.



Sources: *Emissions*: IEA analysis based on SEEG – Greenhouse Gas Emissions and Removals Estimation System, Climate Observatory (accessed in May 2025). *Investment*: IEA analysis based on MME (2025), Ten-Year Energy Expansion Plan 2034 (accessed May 2025). *Flex-fuel vehicles*: IEA analysis based on EPE (2025), Analysis of the Biofuels Situation 2024 (accessed August 2025).

Policy recommendations for Brazil

Energy and climate policy landscape

1. Ensure that PLANTE serves as a coherent, overarching plan for the national energy transition that achieves a sustainable and balanced economic and social transformation for Brazil.
2. Review all government spending across energy sources to realign in support of PLANTE.

People-centred clean energy transitions

3. Introduce an integrated people-centred framework for the energy transition.
4. Implement whole-of-government energy transition workforce mapping and planning to ensure opportunities in local communities are optimised.
5. Integrate electricity into the portfolio of options for clean cooking access for families.

Investment and financing

6. Pursue the intended establishment of a carbon pricing instrument to orient investment while using revenues to mitigate adverse impacts on low-income groups and maintain competitiveness.
7. Establish a national investment fund to direct a fixed share of the government oil revenues to finance the energy transition, including plans to move up the value chain in new industries.

End-use sectors

8. Implement mandatory energy audits for companies above a certain level of energy consumption to support the implementation of energy efficiency measures and energy management systems.
9. Promote a more ambitious approach on minimum energy performance standards for energy-related products with a high impact on industrial energy consumption and relevance for the energy transition.

10. Seize the opportunities for domestic manufacturing and expand the role of flex-fuel hybrids and electric vehicles in the transport sector.

11. Create stronger demand for less carbon-intensive heavy-duty vehicles.

12. Encourage building owners to pursue voluntary energy audits on existing buildings, starting with larger buildings.

13. Integrate energy efficiency and thermal comfort standards into social housing programmes.

Electricity

14. Undertake a comprehensive review of institutional, regulatory and market frameworks to ensure a secure, affordable and future-proof power system that recognises the contributions and capabilities of all actors in a diversified system.

15. Incentivise all forms of power system flexibility resources, including existing hydropower and demand-side response, to integrate large shares of wind and solar photovoltaics (PV) in a secure and efficient way.

16. Reform the electricity retail market to reflect correct and fair pricing of electricity and use of networks, and to jump-start demand response.

17. Reform the distributed PV net metering scheme to address increasing inequalities and serious risks for power system efficiency and stability.

Oil and gas

18. Consider more targeted and regionally sensitive upstream policies to incentivise broader participation in exploration and production, and to develop oil and gas in a balanced way for Brazilian society.

19. Incentivise oil and gas companies to allocate a higher percentage of their annual investments into research, development and demonstration (RD&D), more focused on low-carbon technologies.

20. Simplify the institutional framework to allow the operational stock requirement to address external vulnerabilities that come from import dependency for fuels.

21. Formalise a national emergency response plan for fuel supply crises.

22. Accelerate the implementation of natural gas market reforms to improve price discovery for consumers.

23. Clarify the role that natural gas is expected to play in the energy transition.

Sustainable fuels

24. Finalise an assessment of the RenovaBio programme and provide public information on the results, including on sustainability and land-use change implications.

25. Promote the development of advanced biorefineries, leveraging existing strengths in biofuels production and opportunities for the bioeconomy.

26. Scale up low-emissions hydrogen by stimulating domestic demand creation and export potential, while developing hydrogen hubs to optimise infrastructure needs.

27. Develop infrastructure around clusters that support localised market development of a range of sustainable fuels and products, and expand into low-carbon corridors.

Data and statistics

28. Develop a strategy to guide the evolution of the energy data system in the mid-term (five years).

29. Further strengthen the institutional set-up for the provision of official energy statistics.

30. Adapt the development of policy-relevant data to a rapidly evolving energy landscape.

General background

Political structure

Brazil is a federal republic with a presidential system, comprising 26 states and a federal district, each with its own government. The current President, Luis Inacio Lula da Silva, was elected for a four-year term in 2022 with the possibility of re-election. The President serves as both the head of state and the head of government. The legislative branch, known as the National Congress, is bicameral and includes the Senate and the Chamber of Deputies, which are responsible for lawmaking and government oversight. Additionally, the judiciary is independent, with the Supreme Federal Court acting as the highest court in the nation.

Population

The population of Brazil reached 211 million in 2023. From 2010 to 2022, when the previous Demographic Census was carried out, the country's population grew by 10.2%, resulting in an annual growth rate of 0.8%, the lowest ever observed since the start of the historical series in 1872. The fertility rate has decreased from 6.1 births per woman in the 1960s to 1.6 births per woman in 2022. The population has become relatively old in Brazil. From 1960 to 2012, the population aged 15-64 grew from 53% to 70% of the total population. In the same period, the average age increased from 16.9 to 28.2 years, reflecting the ageing of the population. Besides, the proportion of children under 14, which was 38% in 1980, fell to 20% in 2022.

Economy

Brazil is the largest economy in Latin America and ranks ninth globally. In 2023, its gross domestic product (GDP) reached USD 2.17 trillion. In the last 20 years, the annual average growth of GDP reached 2.9%. The country has a GDP per capita of approximately USD 10 000, positioning the country around 108th in global GDP per capita. In terms of income distribution, Brazil's Gini Index stood at 0.53 in 2021, the second-highest level of inequality among countries for which data were available that year. Additionally, Brazil's Human Development Index was 0.754 in 2021, placing it 87th globally.

Key economic indicators for Brazil, 2020-2023

	2020	2021	2022	2023
GDP growth (annual %)	-3.3	4.8	3.0	2.9
GDP per capita (current USD)	6 923	7 794	9 065	10 043
Public debt to GDP (%)	98.7	85	79.1	
FDI, net inflows (% of GDP)	2.6	2.8	3.8	
Inflation, consumer prices (annual %)	3.2	8.3	9.3	4.6
Central Bank rate	2.0	9.25	13.75	11.75

Note: FDI = foreign direct investment.

Sources: IEA analysis based on World Bank (2024), Inflation, consumer prices (annual %) - Brazil; Trading Economics (2024), Brazil Interest Rate.

Services are an important part of the economy, accounting for 58.9% of GDP, while industry and agriculture correspond, respectively, to 22.3% and 6.2%. In 2023, Brazil's GDP growth was driven by agriculture (15.1% annual growth), services (2.4%) and industry (1.6%). Since the 1990s, the share of industry in GDP has fallen

as Brazil has struggled with a deindustrialisation trend, which the government plans to turn around, including through the energy transition and the new industrial policy.

Brazil's total exports surged to USD 393 billion in 2023, a 2.6% increase from 2022, while total imports fell by 9% to USD 342 billion. The trade surplus recorded in 2023 was the highest in the entire historical series, totalling USD 51.5 billion, an almost fivefold increase on the previous year.

In general, Brazil is a primary goods exporting country, mainly from agriculture and the extractive sector. In 2022, the main products that contributed to a positive trade balance were, in order of importance: soy, crude oil, iron ore, bituminous minerals, corn, meat, sugar and soybean meal. Together they were responsible for USD 177 billion in foreign exchange income for the country.

Although Brazil's economic performance was relatively strong compared to the OECD average in 2023, with an annual growth rate of 2.9%, the country's economic growth has overall been below the OECD average since 2014, when Brazil faced political and economic constraints. Before 2014, the behaviour of the Brazilian economy was known as a "stop-and-go" economy, due to fluctuations in GDP. Except for the second half of the 2000s, when the economy grew consistently, fluctuations in GDP were common, reflecting a structural challenge in the country. GDP growth in 2024 is estimated at 2.1%, reflecting a small economic recovery from the services and industrial sectors.

Economic growth is expected to increase to 1.9% in 2024 and 2.1% in 2025, driven mainly by domestic demand. Investments are expected to improve as financial conditions ease and business confidence strengthens. Domestic consumption should remain strong, supported by rising payroll values and enhanced job creation policies.

Inflation, which averaged 4.6% in 2023, is expected to decrease to 4.0% in 2024 and 3.3% in 2025, converging toward the 3% target by 2025. However, temporary spikes in inflation could occur, such as those caused by agricultural sector events that might affect food and beverage prices. Brazil's currency is the Brazilian real, which is managed under the Central Bank of Brazil. The BRL exchange with the euro is EUR 1 = BRL 5.4. The exchange rate has devalued by 25% since 2018.

In summary, although Brazil is one of the world's largest economies, wealth is highly concentrated, and its development indicators lag significantly behind those of G7 countries, highlighting stark disparities in economic and social conditions.

Energy and climate policy landscape

Institutional framework

Under Brazilian law, the Ministry of Mines and Energy (MME) is the main government institution responsible for Brazil's national energy policy. Its functions include formulating and implementing energy policies in line with the government's guidelines and co-ordinating medium and long-term energy planning in support of energy security. Among the MME's main responsible bodies are the National Energy Policy Council (CNPE) and the Electricity Sector Monitoring Committee (CMSE), both chaired by the Minister of Mines and Energy. In addition, the MME has four secretariats, three federal authorities (regulatory agencies), three public companies and three "mixed economy companies".

The CNPE, composed of several ministries and chaired by the Minister for Mines and Energy, is an advisory body to the President of Brazil for the formulation of energy policies and guidelines. Depending on the issue, the President takes part in the forums of the CNPE. The CMSE is tasked with monitoring and evaluating the continuity and security of electricity supply throughout the national territory.

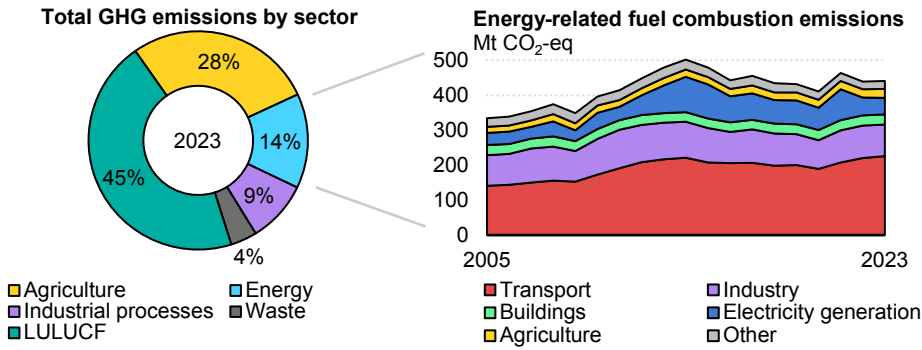
Apart from the CNPE and the CMSE, the key institutions responsible for energy planning, energy security, energy supply, energy markets and energy regulation are: the electricity regulator, the National Electric Energy Agency (ANEEL); the oil, gas and biofuels regulator, the National Agency of Petroleum, Gas and Biofuels; the data and statistics organisation, the Energy Research Office; and state oil companies Petróleo Brasileiro S.A (Petrobras) and the Brazilian Oil and Natural Gas Administration Company S.A.

Climate change

Greenhouse gas emissions

Brazil's GHG emissions profile is heavily influenced by its land-use and agricultural sectors. Historically, the majority of emissions have come from land-use change and deforestation, particularly in the Amazon rainforest, driven by agricultural expansion, cattle ranching and illegal logging. While there have been periods of progress in reducing deforestation through policies, especially from 2003 to 2012, recent years have seen renewed clearing in some areas. Agriculture is another major contributor to emissions, with methane from livestock use being the primary source of emissions. The next biggest emitters are, in order, energy, industrial processes and waste. These sectors highlight the close connection between Brazil's economic activities and its environmental challenges.

Total greenhouse gas emissions (2023) and energy-related GHG emissions by sector (2005-2023) in Brazil



Note: LULUCF = land use, land-use change and forestry.

Sources: IEA analysis based on IEA (2025), Greenhouse Gas Emissions from Energy; SEEG (2024), Total emissions (accessed April 2025).

The Brazilian energy sector is characterised by relatively low GHG emissions compared to global averages, largely due to its reliance on renewable energy sources. Hydropower, in particular, plays a crucial role in keeping power sector emissions low while biofuels in transport have successfully displaced large shares of

fossil fuels. However, even though the growth rate of renewables is considerably higher than the growth rate of fossil fuels, emissions from the energy sector are still expected to grow. This is happening as fossil fuel consumption grows in absolute terms and the economy continues to expand.

Nationally Determined Contribution

Brazil has updated its Nationally Determined Contribution (NDC) under the Paris Agreement, setting more ambitious targets for 2035. The NDC targets a reduction of net GHG emissions of 59% to 67% by 2035 from 2005 levels, which equates to absolute emissions of 850 million to 1.05 billion tonnes of CO_2-equivalent. It includes emissions from all sectors: energy, industry, agriculture, forestry and waste. This ambitious "banded target" reflects Brazil's commitment to climate neutrality by 2050. The NDC considers potential variations due to economic, international and technological factors, ensuring flexibility in implementation. Sectoral mitigation plans, due by 2025, will set specific emissions reduction goals for all economic sectors, supporting Brazil's alignment with the global 1.5 °C warming limit.

Brazil's climate targets for 2030

	Emissions (Mt CO_2-eq)	% change from 2005	Emissions (Mt CO_2-eq)	% change from 2005
	Low-end target		High-end target	
2035	1 050	-59%	850	-67%
2050	0	-100%	0	-100%

Note: Net emissions for the reference year 2005 of Brazil's second NDC are based on the emissions reported in the "National Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases not controlled by the Montreal Protocol" and not the Greenhouse Gas Emissions and Removals Estimation System.

Sources: UNFCCC (2024), Brazil's - NDC National determination to contribute and transform, SEEG (2024), Total emissions (accessed April 2025).

The NDC is part of Brazil's broader Climate Plan (*Plano Clima*), which integrates mitigation and adaptation measures with mechanisms such as sustainable finance platforms, tax reforms and a regulated carbon market. Efforts to combat deforestation

and restore forests are central elements, supported by initiatives like the Amazon Fund and the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon.

Mitigation

The National Policy on Climate Change commits Brazil to reducing GHG emissions and promotes sectoral mitigation and adaptation plans in areas like energy, transportation, agriculture and industry, aligning economic and social development with global climate goals through sustainable practices and low-carbon technologies. The National Policy on Climate Change focuses on reducing deforestation in the Amazon, expanding renewable energy, promoting biofuels and recycling, and fostering adaptation to climate impacts. Supported by instruments such as the National Climate Change Plan and the Climate Change Fund, it seeks to address climate challenges while contributing to sustainable development and global climate action.

The Climate Plan, under development since late 2023 by the Interministerial Committee on Climate Change and Green Growth with broad societal participation, will guide Brazil's climate policy until 2035. It focuses on two pillars: 1) the National Mitigation Strategy, aimed at reducing GHG emissions; and 2) the National Adaptation Strategy, designed to lower the vulnerability of cities and ecosystems to climate impacts, supported by sectoral plans. The plan emphasises a broader climate action strategy, including a socially just transition, implementation mechanisms, monitoring for transparency, and ensuring Brazil's readiness to address climate change and extreme weather events effectively.

The Brazilian president recently enacted a landmark bill that sets up a carbon pricing mechanism. It establishes the Brazilian Greenhouse Gas Emissions Trading System (SBCE), creating emissions limits and a trading system for emission certificates, thereby incentivising companies to adopt cleaner practices while exempting specific sectors like agribusiness. The bill also ensures the inclusion of indigenous communities and allocates funding for decarbonisation research. Additionally, it includes voluntary carbon credit trading, with a focus on maintaining the integrity of emissions offsetting, by ensuring that the credits represent real, measurable and verifiable reductions in GHG emissions. This legislation represents a crucial advancement in Brazil's commitment to sustainability and innovation in addressing climate change challenges.

Adaptation

The National Climate Change Adaptation Plan (PNA), established on 10 May 2016, is a federal initiative developed in collaboration with civil society, the private sector and state governments to reduce Brazil's vulnerability to climate change. It aims to manage and mitigate climate risks; capitalise on emerging opportunities; prevent losses and damages; and build tools to support the adaptation of natural, human, productive and infrastructure systems.

Regarding energy, the PNA emphasises the prioritisation of renewable energy within Brazil's energy sector, leveraging its extensive hydroelectric resources alongside solar, wind and biomass energy to maintain a low-carbon energy matrix. The PNA highlights the critical role of infrastructure resilience to climate impacts, addressing vulnerabilities in energy generation, transmission and distribution. It proposes actions such as fostering technological advancements, optimising planning tools to address climatic variability, and enhancing energy system integration to ensure sustainability and reliability. The strategy also stresses synergies between mitigation and adaptation efforts, aiming for energy security, environmental sustainability and economic feasibility.

Key energy policies and strategies

Brazil has two major, long-term plans to guide the country's energy planning by outlining strategic goals and actionable priorities for the development of the energy sector. The PNE 2050 (30-year National Energy Plan), drawn up by EPE based on guidelines from the Ministry of Mines and Energy, maps out various aspects of the sector's long-term evolution. The strategy is based on scenarios of changes in energy production and use, including through the energy transition. In a context of great unpredictability, the PNE seeks to explore future alternatives to improve the decision-making process in energy policies.

The PDE (Ten-Year Energy Expansion Plan) is a detailed document prepared by Brazilian Energy Research Office (EPE) in close collaboration with the Ministry of Mines and Energy. It outlines a ten-year forecast and planning framework for the development of Brazil's energy sector, covering supply, demand, infrastructure and policies. The PDE is based on the most important dimensions associated with energy planning: economic, strategic, social and environmental. It highlights energy policy decisions, integrating them with other policies adopted in the country, especially those linked to climate change and the energy transition.

However, Brazil does not have a single overarching energy policy document to define its energy goals and climate targets. Instead, it relies on a broad array of policies aimed at ensuring energy security, promoting sustainability and achieving universal access all while aligning with cross-cutting strategies from other ministries. Strategic frameworks such as the PNE and the PDE play central roles by laying out long-term scenarios and providing essential guidance for energy investments and planning, ensuring that resources are allocated efficiently to meet future energy demands.

In 2024, Brazil introduced key policies to accelerate its energy transition and align with climate commitments. Notably, the Energy Transition Policy, the Fuels of the Future Law and the Low-Carbon Hydrogen Framework, demonstrate a renewed focus on fostering a just and sustainable energy transition, aligned with the country's climate commitment. These initiatives, combined with a range of other energy and cross-sectoral policies, aim to optimise energy production and consumption while driving the country toward a low-carbon future and strengthening its global leadership in clean energy.

Moreover, in August 2024, the President initiated the development of a new Energy Transition Policy, including the creation of PLANTE and FONTE. At the request of the Minister of Mines and Energy, Alexandre Silveira, the IEA Energy Policy Review will play a crucial role in bridging gaps and connecting energy policies with cross-cutting strategies, providing essential support for the effective implementation of Brazil's PLANTE.

Key energy transition policies

National Energy Transition Policy

Brazil has officially launched its National Energy Transition Policy (PNTE), with the aim of guiding national efforts to transform the national energy matrix, contributing to the achievement of net GHG emissions neutrality in the country. This general framework, approved by the CNPE, will guide the development of the forthcoming Energy Transition Plan (PLANTE) and creates the Energy Transition Forum (FONTE) to inform this process, with input from stakeholders.

The PNTE prioritises collaboration and integration, bringing together government agencies, civil society and the private sector to guide its implementation. The policy is designed to align energy transition goals with broader national priorities, including

energy efficiency, climate change mitigation and adaptation, economic transformation, and strengthened production chains.

Key pillars of the PNTE include:

- Energy transformation: A shift towards a renewable energy matrix, reducing dependence on fossil fuels.
- Inclusive and just transition: Minimising negative impacts on communities and vulnerable groups while maximising opportunities for socio-economic development.
- Universal energy access: Ensuring reliable and affordable energy services for all citizens, addressing energy poverty.
- Climate change mitigation and adaptation: Aligning with Brazil's climate commitments, promoting measures to mitigate climate change and adapt to its impacts.

The PNTE's implementation will be supported by PLANTE, a long-term roadmap with specific actions, strategies and timelines. A permanent FONTE will facilitate dialogue and provide recommendations on the PNTE's implementation.

Governance and transparency are central to the PNTE's success, with monitoring mechanisms led by the CNPE and the National Secretary for Energy Transition and Planning. Transparency measures will be implemented to ensure public access to information.

Hydrogen legal framework

Law 14.948/2024 builds on Brazil's 2021 "National Hydrogen Plan" to analyse national laws and regulations and incorporate hydrogen as an energy vector and fuel, with a focus on low-emissions hydrogen. It establishes the National Low-Carbon Hydrogen Policy and provides clear definitions for "low-carbon hydrogen", "renewable hydrogen" and "green hydrogen".[1]

[1] The IEA does not use colours to refer to the different hydrogen production routes. However, when referring to specific policy announcements, programmes, regulations and projects where an authority uses colours (e.g. "green" hydrogen), or terms such as "clean" or "low-carbon" to define a hydrogen production route, the IEA has retained these categories.

Fuel of the Future (*Combustível do Futuro*) Law

The Brazilian President enacted the "Fuel of the Future" Law, introducing a series of initiatives to promote sustainable, low-carbon mobility and solidify Brazil's role as a leader in the global energy transition. The Law establishes national programmes for green diesel, sustainable aviation fuels and biomethane while also increasing the blending of ethanol in gasoline and biodiesel in diesel. Additionally, it creates a regulatory framework for CCS. These measures create opportunities that combine economic development with job creation and environmental sustainability, unlocking investments totalling BRL 260 billion (USD 43 billion).

Energy Transition Acceleration Programme (Programa de Aceleração da Transição Energética)

The Energy Transition Acceleration Programme (Paten) aims to advance sustainable development by promoting infrastructure projects, expanding renewable energy parks and fostering technological innovation with socio-environmental benefits. The Programme seeks to facilitate financing for sustainable projects, connect financial institutions with interested companies, enable private sector access to public financial resources, and support low-carbon energy generation and efficiency. A particular focus is on technologies that reduce GHG emissions, including waste-to-energy recovery solutions, in alignment with Brazil's climate commitments.

RenovaBio

The National Biofuels Policy (RenovaBio) was passed into law in 2017 as an integral part of Brazil's National Energy Policy and a contribution to the fulfilment of Brazil's commitments under the Paris Agreement. One of its objectives is to reduce the carbon intensity of the Brazilian transport mix by implementing a system of Decarbonisation Credits (CBIO), financial instruments that can be traded on the stock exchange, derived from the certification of the biofuel production process.

Energy programmes

Light for All Program (*Luz para Todos*)

The Light for All Program aims to provide electricity access to rural and remote populations, promoting social inclusion. It has connected millions of households over two decades and continues expanding to reach underserved communities.

Energy Efficiency Program

The Energy Efficiency Program, led by the National Electric Energy Agency (ANEEL), promotes efficient electricity use, reducing waste and optimising energy consumption across sectors. Focused on innovation and sustainability, it supports energy-efficient technologies and practices, benefiting consumers and enhancing the energy sector's efficiency and sustainability. Projects are selected based on their effectiveness and impact (for more details see the "End-use sectors" section).

Social Electricity Tariff

The Social Electricity Tariff is legally enshrined and provides discounted electricity rates to low-income households, with varying benefits based on consumption levels and additional support for indigenous and *quilombola*[2] families (see the "Electricity" section for more details).

Energies of the Amazon Program (*Programa Energias da Amazônia*)

The Energies of the Amazon Program, led by the MME, was established in August 2023. It aims to replace diesel power generation with renewable sources, such as solar, biomass and small hydroelectric plants, and ensure the quality and security of electricity supply for the more than 3.1 million people who live in isolated systems (cities and towns whose electricity is supplied by local generation facilities and do not have a connection to the national interconnected system). It is one of the

[2] *Quilombolas* are descendants of Afro-Brazilian people who formed communities after escaping slavery.

planks of the energy transition, contributing to improving people's lives and bringing development to the Amazon while at the same time contributing to reducing GHG emissions.

Cross-cutting plans

Ecological Transformation Plan and the Transformation Pact

Brazil, under the guidance of the Ministry of Finance, has embarked on an ambitious ecological transformation plan to become a leading hub of the green economy. The plan has three main goals: 1) employment and productivity; 2) sustainable development; and 3) social justice. This strategy, which envisions a new role for the Global South, includes the establishment of a regulated carbon market, the issuance of sustainable sovereign bonds and the implementation of a national sustainability-focused taxonomy. As Brazil prepares to host COP30, it is set to make significant strides in expanding hydroelectric infrastructure, integrating electrical systems, and enhancing the production of ethanol and next-generation biofuels.

In August 2024, the three branches of the Brazilian Republic established the Pact for Ecological Transformation among the three branches of the Brazilian state, committing to work harmoniously and co-operatively toward shared objectives. These include ecological sustainability, sustainable economic development, social justice, consideration of the rights of children and future generations, and resilience to extreme climate events. The Pact, fully aligned with the principles of the Ecological Transformation Plan, is organised into three main pillars: 1) territorial and land-use planning (Axis I); 2) energy transition (Axis II); and 3) sustainable development with social, environmental and climate justice (Axis III). The document outlines 26 measures and establishes a joint steering committee to oversee the implementation of each action.

New Industry Brazil (*Nova Indústria Brazil*)

New Industry Brazil is a strategic, long-term policy led by the Ministry of Industry, aiming to drive Brazil's sustainable development from the social, economic and environmental perspectives. The policy is built around mission-driven policies that focus on transformative change. Mission 5 on Bioeconomy and Energy Transition is

directly focused on transforming Brazil's energy landscape. It aims to reduce industrial CO_2 emissions by 30% per unit of output through the adoption of cleaner technologies, energy efficiency measures and renewable energy integration. It also seeks to expand the share of biofuels in transportation by 50%, capitalising on Brazil's agricultural strengths to decrease reliance on fossil fuels.

Brazilian Greenhouse Gas Emissions Trading System

Brazil's government in December 2024 passed a groundbreaking bill that regulates the carbon market and establishes the Brazilian Greenhouse Gas Emissions Trading System (SBCE). The legislation sets emissions limits and creates a trading system for emissions certificates to encourage less carbon-intensive corporate practices. It also includes provisions for indigenous community participation, funding for decarbonisation research and integrity in voluntary carbon credit trading.

Recommendations

1. Ensure that PLANTE serves as a coherent, overarching plan for the national energy transition that achieves a sustainable and balanced economic and social transformation for Brazil.

Brazil has made commendable progress in advancing the energy transition in line with its very ambitious climate change targets. This includes the National Energy Plan 2050 and the PDE 2034, developed by EPE in collaboration with the MME. Moreover, in 2024, the Brazilian government put in place a number of policies and strategies that give momentum to various elements of the energy transition, notably the Energy Transition Policy, the Fuel of the Future Law and the Low-Carbon Hydrogen Framework. In addition, the government launched PLANTE and FONTE as more comprehensive and consultative approaches to energy transition planning. Complementary to these policies are the Ecological Transformation Plan led by the Ministry of Finance and the *Nova Indústria* plan for reindustrialisation, including in clean energy sectors, led by the Ministry of Industry. Impressively in Brazil, cross-ministerial co-operation seems to work well. However, the energy transition would

benefit from a single, comprehensive document that consolidates all the various policies and strategies related to energy, climate, industrial growth, social inclusion and affordability (both current and future) to guide investments and sectoral development in a coherent, strategic way. This should include concrete action plans for sectors with a clear delineation of key bottlenecks, roles and responsibilities across government; intermediate milestones; and well designed and sustained monitoring mechanisms to track implementation. Such an overarching strategy should be guided with a view to achieving a balanced approach to oil and gas development and the energy transition.

2. Review all government spending across energy sources to realign in support of PLANTE.

As Brazil looks to capitalise on the enormous benefits the energy transition can bring, it will need to undertake a holistic rethink of its energy taxation and subsidy regime to ensure that the system's incentives and outcomes align with new economic and social priorities. As in most countries, the subsidy regime is a legacy of historic decisions that are often layered on top of one another, and an entrenched subsidy can be very challenging to undo. For instance, the electricity sector is subject to a number of subsidies and cross-subsidies that can undermine the efficient operation of the system and the sending of appropriate investment signals, potentially leading to inefficiencies in resource allocation. In addition, Brazil offers a number of fossil fuel fiscal support measures, on both the consumer and producer side. While these can help address affordability concerns for end users and support a productive upstream sector, the government should assess whether the current system is aligned with its future energy transition and net zero objectives, especially against the system of taxes and support mechanisms offered to clean energy technologies. Moreover, a thorough review can also help identify those areas that are crucial for the energy transition that may be underfunded, where investments can be considered a priority, such as energy efficiency. As such, a holistic reassessment of taxes and subsidies can help ensure a more rationalised, efficient and effective application of fiscal levers to best support the government's goals for the energy sector.

People-centred clean energy transitions

Brazil has made significant strides in improving energy access and affordability, notably through the successful implementation of the Light for All Program, alongside subsidies for electricity and gas. However, a key remaining challenge for the

government is designing new policies that ensure affordability in broader terms. This includes ensuring affordable access to clean energy products and protecting low-income households from potential setbacks. While past policies have, at times, led to distributional effects, such as rising electricity tariffs due to the expansion of distributed solar PV, this does not have to be the case. With well-designed policy measures and the phasing out of subsidies, Brazil can mitigate these impacts and promote a fair and inclusive clean energy transition.

Making progress on distributional benefits is also set to play a critical role in Brazil's energy transition, as is the case throughout the world. Historically, communities near large energy infrastructure projects, such as hydropower plants and wind farms, have often seen limited local benefits while bearing the social and environmental costs of these developments. Addressing energy inequality and incorporating the "social dimension of energy" are key pillars of PLANTE. However, specific governmental initiatives to promote local value creation and track the impacts of energy projects on affected communities are still limited.

In Brazil, the energy transition will require a significantly larger pool of trained professionals and technicians, as well as the future retraining of oil and gas workers due to the sector's anticipated long-term decline. Toward this end, Brazil has already implemented several initiatives to foster training and skills development in clean energy areas. The Qualifica-PAC programme promotes economic growth and social inclusion by providing targeted training for industrial electricians and metal structure assemblers, meeting the sector's growing workforce demands. The Social Fuel Certificate further supports regional development by incentivising biodiesel production from family farmers, fostering social equity. Additionally, the EnergIFE Program has retrained over 1 800 teachers and equipped more than 30 000 professionals with skills in renewable energy and energy efficiency, particularly in PV solar energy, positioning Brazil with a skilled workforce for its clean energy future. However, Brazil does not have dedicated programmes to reskill oil and gas sector workers in line with the expected gradual decline in oil and gas production in the 2030s.

Universalisation policies

Brazil's electricity access rate (around 99%) is higher than the Latin American average (96.6%). The access rate has increased dramatically over the past 30 years, from 87.5% in 1990 to 99% in 2022. This progress can be attributed to the country's National Programme for Universal Access to the Use of Electricity – Light for All,

launched in 2003 during the first administration of President Lula da Silva. The Light for All Program aims to provide electricity to rural populations and communities in remote regions of the Legal Amazon who do not have access to the public electricity distribution service. The Program was designed to ensure energy access as a vehicle for greater social inclusion and reduced inequalities in Brazil. Some of its results and goals include:

- energy to more than 3 million houses and 18 million people in 20 years
- since the programme started, job opportunities, household income and school activities in the evening each increased by at least 40%, and over 300 000 women started or resumed their studies
- in 2023, the objectives were exceeded by 24%, with 64 592 consumer units benefiting
- 39 000 people assisted in the first quarter of 2024 with an investment of BRL 228 million
- the goal for 2024 was to bring electricity to 75 723 families through the Growth Acceleration Program
- target: to benefit a further 500 000 families by 2026.

The Department of Universalisation and Social Policies for Electricity is responsible for co-ordinating, implementing and evaluating policies aimed at universal access to electricity and promoting social development and citizenship among electricity consumers. It supports the integration of public policies and guides programmes for the rational, safe and productive use of electricity in isolated and rural communities. Additionally, the Department monitors the performance of electricity supply in these areas and oversees studies and actions related to the energy transition and supply to isolated systems.

Energies of the Amazon

The Energies of the Amazon Program (*Energias da Amazônia*) is a key programme aimed at reducing diesel use in energy production by transitioning to renewable sources. It seeks to lower GHG emissions while ensuring reliable electricity for over 3.1 million people served by isolated systems. The renewable sources to replace diesel include solar (both with storage and without), biomass and small hydroelectric plants in isolated systems.

In 2022, 210 isolated systems were identified in the Amazon region, with 80% of diesel in electricity generation, followed by natural gas at 13% and biomass at 6%. As a result of actions to connect locations to the grid and reduce dependence on diesel, in 2024, the share of diesel reduced to 67% and 174 isolated systems were notified by utilities.

In 2024, two important Program initiatives were launched in an innovative approach to increase the participation of renewable sources: an auction for contracting new plants to meet forecasted demand for the next ten years and a public notice of proposals to replace diesel in plants already in operation, undertake energy efficiency actions or reduce losses, using Eletrobras' capital resources.

In the coming years the Amazon Energy Program's actions are expected to contribute to further reducing the share of diesel and increasing the reliability and safety of electricity services for isolated communities. The Program will be monitored and evaluated by goals and indicators to be defined by the CNPE.

Affordability

The Social Electricity Tariff was created by Law 10.438 of 26 April 2002. Through it, discounts are granted to consumers in the "Low-Income Residential Subclass". Consumers in this group benefit from an exemption from the cost of the Energy Development Account (CDE) and the cost of the Incentive Programme for Alternative Sources of Electricity. In addition to these exemptions, cumulative discounts are applied to the rest of the residential tariff, according to each household's level of consumption.

Families consuming up to 220 kilowatt-hours (kWh) per month are eligible for electricity discounts. However, the conditions vary for indigenous and *quilombola* families registered in the Unified Registry manged by the Ministry of Development and Social Assistance, Family and Fight against Hunger. The tables below illustrate the discount levels based on consumption for low-income households and indigenous and *quilombola* families.

Social Electricity Tariff for low-income households in Brazil in 2022

Monthly electricity consumption rate	Discount
0-30 kWh	65%
31-100 kWh	40%
101-220 kWh	10%
> 221 kWh	0%

Source: ANEEL (2022), Tarifa social (Social tariff).

Social Electricity Tariff for indigenous and *quilombola* families in Brazil in 2022

Monthly electricity consumption rate	Discount
0-50 kWh	100%
51-100 kWh	40%
101-220 kWh	10%
> 221 kWh	0%

Source: ANEEL (2022), Tarifa social (Social tariff).

The discounts under the Social Electricity Tariff are funded by the CDE. Distributors are reimbursed for all benefits granted. In addition to low-income residential discounts, the CDE also funds initiatives such as the universalisation of electricity services and the expenses of the Fuel Consumption Account, among others.

Clean cooking

More than 2.3 billion people in the world do not have access to clean energy sources for cooking. In Brazil, the number is approximately 14 million people, who mostly have to use firewood and charcoal for cooking. This means that, in addition to an energy issue, it also creates a public health challenge that disproportionately impacts women.

To address this issue, the federal government has already implemented or is planning to launch several initiatives, including the National Policy for Clean Energy in the Kitchen, Gas Aid and the Gas for All programmes. These three initiatives are primarily funded by the federal government, with expenses allocated in the federal budget. The funds are designed to provide benefits to eligible families, as outlined in law.

The National Policy for the Promotion of Clean Cooking

The Brazilian government is preparing to issue a decree to create the National Policy for Clean Energy in the Kitchen, which includes the launch of the Greener Kitchen Program. The Program's main objective is to eliminate the consumption of firewood in Brazilian kitchens, an important indicator of energy poverty.

The Sustainable Solidarity Kitchen

The Sustainable Solidarity Kitchen is part of the discussion of the National Policy for Promoting Clean Cooking, which aims to promote universal access throughout the country to clean technologies for cooking food, i.e. the use of clean energy sources for preparing food indoors. The initiative comes in the context of the G20 Energy Transitions Working Group, in synergy with the Global Alliance against Hunger and Poverty, which aims to reduce inequalities and contribute to global partnerships for sustainable development, advocating sustainable, inclusive and fair energy transitions.

The pilot initiative involves installing biodigesters in seven solidarity kitchens, strategically mapped throughout the country, as well as other equipment needed to guarantee a "clean cooking" process during the preparation of meals.

The **Gas Aid** (*Auxílio Gás*) programme, established in 2021, aims to reduce the financial burden of cooking gas prices on low-income families. It initially provided a benefit covering 50% of the national average price of a 13 kg liquefied petroleum gas

(LPG) cylinder, paid every two months. Since January 2023, the benefit has been expanded to cover the full cost of a cylinder, calculated by the National Agency of Petroleum, Gas and Biofuels. Eligible families include those registered in the Unified Registry with a per capita monthly income of up to half the minimum wage, including families receiving other government assistance programmes.

Although Gas Aid does not directly reduce the market price of cooking gas, it effectively lowers the financial burden on beneficiaries by providing targeted assistance, making energy access more affordable for the most economically disadvantaged populations in Brazil. The programme is set to be replaced by the Gas for All programme, announced by the MME in 2024.

Gas for All

The government has submitted a bill to the Chamber of Deputies for setting up Gas for All, a programme that will replace the Gas Aid programme. With a budget financed by the Social Fund from revenues obtained from oil production, the government will cover the purchase of LPG cylinders for needy families. The aim of Gas for All is to expand access to cooking gas, currently reaching 5.6 million people under the Gas Aid programme, to more than 20 million families by the end of 2027.

Public consultation

Brazil has made a broad commitment to open government principles of transparency, integrity, accountability and stakeholder participation. As a founding member of the Open Government Partnership, Brazil has implemented several participatory tools, including the "*Participa Mais Brasil*" (Participate More Brazil) platform and mechanisms for monitoring open government policies, such as the Access to Information Law and the Open Data Policy. However, the last OECD Open Government Review of Brazil (2022) underscores the need for a coherent federal open government strategy, which could align energy policies with broader democratic goals, strengthen citizen trust and protect civic space as an enabler for public participation.

Brazil has submitted some of its policies for public consultation to ensure transparency, stakeholder engagement and alignment. Some examples include consultations for the PDE 2034, which incorporates feedback on energy expansion priorities such as battery storage technologies, and PLANTE, where FONTE gathers stakeholder input. Public consultations have also informed the Guarantee of

Electroenergetic Supply in Isolated Systems, the Annual Resource Application Plan under the National Electricity Conservation Program (PROCEL) and the National Adaptation Strategy, for example.

Recommendations

3. Introduce an integrated people-centred framework for the energy transition.

Brazil's energy transition has the potential to bring significant economic opportunities for the country. However, an equitable distribution of the costs and benefits of the transition is not guaranteed. Brazil will, therefore, need to proactively enact policies and strategies to ensure that all segments of society benefit from the transition and to avoid disproportionate costs falling on lower income or marginalised populations. Programmes such as Light for All, Energies of the Amazon and the Social Electricity Tariff all help to support more equitable outcomes by expanding access and lowering prices. However, a more comprehensive approach to energy planning that addresses all elements of a people-centred transition – including jobs; social and economic development; equity, social inclusion and fairness; and citizen engagement – would be beneficial at this stage of the energy transition, where upcoming transformations of the energy system will be more significant. In this regard, the government should assess the distributional impacts of energy transition policies to ensure that fairness and equitable outcomes are embedded into policy design. For example, it is important that consumer fiscal support measures – such as net metering policies, EV purchase subsidies or renovation incentives – do not only benefit higher income households. Likewise, it should undertake co-ordinated engagement with local communities and citizens across regions to support broad stakeholder input from a wide cross-section of society. PLANTE has been designed as a comprehensive approach to energy planning, and the connection between various themes including employment, affordability and public participation in energy should be emphasised throughout its process. In addition to PLANTE, FONTE is another pillar of the energy transition that can be leveraged as a permanent and consultative instrument aimed at stimulating, expanding and democratising discussions on the energy transition across energy sector stakeholders.

4. Implement whole-of-government energy transition workforce mapping and planning to ensure opportunities in local communities are optimised.

Brazil, led by the MME, should develop a more comprehensive framework that incorporates governance, engagement and accountability for planning for the future energy workforce, improving upon the current uncoordinated approach, to guide the government's efforts over time. As the global shift to a 2050 net zero future evolves, it is important to develop a better understanding of the changing nature of the labour market and the variety of new skills and competencies the net zero economy will require.

An external study estimates that under Brazil's Ecological Transformation Plan, up to 1.4 million energy transition jobs will be created by 2030. Beyond this top-line forecast, additional information on the location or type of jobs is largely unknown, with the exception of a few notable cases. Therefore, the job creation potential should be carefully assessed, including for displacements and unintended effects on local communities. A very promising approach to prepare for clean energy jobs needs has been demonstrated by assessing the labour requirements resulting from an electricity transmission auction.

This information led to early action being taken to ensure that local communities along the transmission route were better able to access training programmes that could lead to employment in the electrical transmission sector. This is particularly important to ensure that benefits flow to local populations, who are increasingly expressing dissatisfaction and frustration with energy development where they feel they have not been adequately consulted and must bear the costs and negative impacts of unwanted activities and infrastructure without reaping any benefits. Regionally based training should be prioritised to ensure that social benefits and equity are advanced through the expansion of clean energy jobs, with special attention to regions with higher unemployment and lower educational attainment so that disadvantaged communities are given the support required. These actions would put into practice some of the Just and Inclusive Energy Transition Principles agreed upon in 2024 under Brazil's G20 Presidency.

A whole-of-government perspective on the clean energy workforce can maximise the impacts of new policies and programmes, such as the National Pact for More Women

in Energy and Mining. It can also leverage the existing flow of information from industry to government through the National Service for Industrial Training and expand on current efforts to train workers and educators in those fields. Brazil should likewise ensure that FONTE participants represent labour, industry, training and educational institutions, and youth to further contribute to improving jobs and skills-related energy transition planning. With other ministries advancing complementary initiatives, such as the New Industry Brazil policy and Ecological Transformation Plan, it is critical to have clear governance and accountability with targets and indicators of success.

Moreover, more concerted efforts to implement energy efficiency policies and programmes might lead to significant new job opportunities and a whole-of-government approach will ensure that education and training is put in place to bring youth, unemployed and underemployed workers to support the clean energy economy. In addition, through recent decrees and laws, Brazil has put in place some of the conditions for the creation and expansion of new industries, such as critical minerals processing; batteries; carbon capture, utilisation and storage (CCUS); and hydrogen. Efforts should be made to leverage, retrain and redeploy existing expertise to serve these new industries, where feasible. However, where expertise is not yet widely available, the government should support workforce training efforts (including through international partnerships) to ensure that skills shortages do not become an impediment to sector growth.

5. Integrate electricity into the portfolio of options for clean cooking access for families.

While access to clean cooking in Brazil is advancing, it remains a challenge, with 2024 data revealing that over 5 million people remain reliant on fuel sources such as coal, charcoal, kerosene and firewood for meal preparation.

It is well-known that this reduces air quality and leads to health problems, particularly impacting women and girls. Brazil has committed to ensuring clean cooking access for all under its signature Gas for All programme, which will primarily provide LPG to remote households. However, the programme is still not fully funded, and implementation is not completely underway.

The MME should consider all approaches to achieving clean cooking access and should analyse the total costs of various options, including the proposed LPG-delivered programme versus electric cooking connected to the grid and in off-

grid, isolated systems. Such assessments should consider local grid capacities and connections to the national grid to co-ordinate planning across relevant institutions, programmes and infrastructure plans. The well-established Lights for All programme could be leveraged and offer choice to families with the provision of electric cooking service through existing grid access and the provision of efficient appliances (with a higher upfront cost but the potential for longer term savings). This could accelerate the timeline to achieve 100% penetration of clean cooking access, provide a reliable and lower carbon form of energy for cooking, and streamline the administration of separate programmes, all while providing a "single window" for families in need.

Recognising that electric cooking is not widespread in Brazil and may need to overcome hesitation and lack of familiarity, the government could run pilot programmes for electric cooking to seek feedback from community members and help increase buy-in for the new technology. Community members of the pilot projects could ultimately help promote the new approach, sharing their experiences and learning journey with others. This would also provide time for manufacturers to ramp up the production of appliances to meet the growing demand.

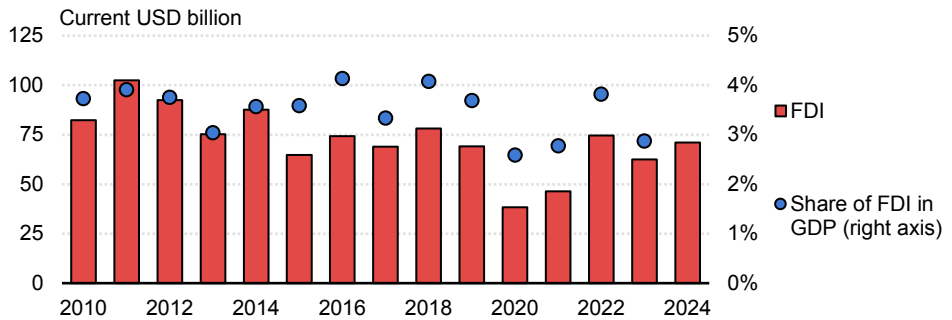
Some commentators predict that the proposed Gas for All programme will increase national LPG demand by up to 4%. In 2023, LPG accounted for 3.1% of Brazil's total energy supply (TES), dominated by the residential sector (78%, primarily for cooking). The design of the scheme and any procurement of the LPG will need to be carefully managed to avoid distortions in, and preferably promote, competition. This also increases the importance of the National Agency for Petroleum, Natural Gas and Biofuels' actions to ensure fuel demand growth is taken into account in overall energy supply forecasts and (together with the Competition Authority) to ensure that the supply and distribution market works efficiently so that the Brazilian government gets good value for money from this programme.

Investment and financing

Brazil has been effective at attracting international private capital, as well as growing a domestic financial ecosystem, which is very active in the energy sector. Brazil's continued attractiveness for investment is motivated by the abundance of natural resources and sectors, such as agriculture and mining. In 2024, Brazil's investment environment continued to be shaped by global economic challenges and domestic policy changes, such as the tax reform and the financial system reform to provide a more conducive business environment. The country remains by far the largest recipient of FDI in South America.

However, challenges remain, including business regulation, ranked 124th out of 190 in the World Bank's Ease of Doing Business ranking in the 2020 report, and high regulatory costs that deter potential investors. Brazil has a complex tax system, although it underwent a reform in 2024 to make it simpler and more transparent. Also, political and economic volatility have been significant factors affecting Brazil's investment environment. Inflation and fluctuating interest rates pose risks, with the country's benchmark interest rate reaching 10.8% in October 2024 to combat inflationary pressures (Agência Brasil).

Net inflows of foreign direct investment in Brazil, 2010-2024



IEA. CC BY 4.0.

Note: The share of FDI in GDP is not available for 2024.

Sources: IEA analysis based on World Bank (2025), Foreign direct investment, net inflows (BoP, current USD) – Brazil (accessed April 2025); World Bank (2025), Foreign direct investment, net inflows (% of GDP) – Brazil (accessed April 2025).

Investment needs

Infrastructure investment in Brazil has remained low over the past decades, resulting in substantial gaps across all sectors. To address these deficiencies, it is essential to not only increase public investment but also to enhance its effectiveness. Additionally, mobilising greater private sector resources will be critical. Strengthening strategic planning and ensuring it is consistently reflected in long-term budget allocations would improve the overall quality of infrastructure projects. Encouraging greater foreign participation in public procurement could boost competition and deliver better value for public funds. At the same time, improving the governance of state-owned enterprises would contribute to higher quality infrastructure services. Reducing policy and judicial risks would help attract more private financing for infrastructure,

particularly for longer term investments, while ensuring balanced risk-sharing between public and private entities.

Despite this, the government has implemented important energy and industrial policies such as the Energy Transition Policy, the Hydrogen Framework, the Fuel of the Future Law, the New Industry Brazil policy and the Ecological Transformation Plan. Under Brazil's energy transition, new industrial policies and infrastructure development goals will require substantial investment over the coming decades. The energy sector alone is projected to need a significant increase in both public and private financing to meet Brazil's climate commitments under the Paris Agreement. This includes investments in renewable energy projects, grid infrastructure and energy efficiency programmes. BNDES is currently developing an investment platform to optimise capital allocation for projects aligned with energy transition policies.

Domestic financing

Brazil's domestic financial markets are becoming increasingly sophisticated, with notable growth in environmental, social and governance-related regulations and sustainable finance products. The country's pension funds and commercial banks are expanding their involvement in green investments, with pension assets growing steadily since 2020. Brazil has introduced new frameworks aimed at boosting pension fund allocations to infrastructure projects, including raising investment ceilings for alternative asset classes.

BNDES is the primary financial institution for fostering investments across various economic sectors in Brazil. It plays a vital role in providing long-term funding and shareholding options to both large-scale and small enterprises, as well as individuals and public agencies. This inclusive approach ensures greater access to credit, which contributes to the overall advancement of the economy, spurring job creation and income generation. By supporting projects that align with Brazil's economic and social development goals, BNDES plays a key role in shaping the nation's financial landscape.

Over time, BNDES has adapted its strategy, particularly in the renewable energy sector. Initially it was a central figure in financing solar and wind energy projects through low-cost, long-term debt. However, as the industry matured and commercial banks gained more expertise in financing such projects, the role of BNDES shifted. By 2017, the bank had introduced a strategy to gradually align its concessional

financing with market-based rates. This transition coincided with the growing popularity of capital markets, particularly bonds, as a means of financing renewable energy projects. As a result, BNDES has moved towards a more catalytic role, stimulating private investment rather than directly funding projects.

Green financing

Brazil's green finance sector has grown significantly due to fiscal incentives and regulatory developments, such as the issuance of the first green bond in 2015 and the establishment of Green Bond Guidelines in 2016. The promotion of tax-exempt infrastructure debentures and innovative financial tools like the BNDES Renewable Energy line, the Climate Fund, and Green FIDC have supported renewable energy and sustainability projects by making capital more accessible and flexible for investors.

In addition, Brazil is working on creating a national taxonomy for sustainable finance to provide a unified framework for categorising sustainable economic activities. BNDES continues to be a central player in driving sustainable finance through initiatives like the Climate Fund, which supports diverse projects ranging from the energy transition to urban development, and RenovaBio, which enhances the efficiency of the biofuel sector. These efforts align with Brazil's broader environmental goals, positioning BNDES as a key catalyst for sustainable development.

Financing from carbon market revenues

Although Law 15.042/2024, which establishes the SBCE, lays the foundations for the regulated carbon market in Brazil, the specific destination of the revenues generated by this system has not yet been defined in detail. The law stipulates that part of the funds should be earmarked for sustainable production activities, social protection, cultural valorisation, and territorial and environmental management, especially in indigenous areas and traditional communities, in accordance with the relevant national policies. Specific regulations on the allocation and use of these revenues are pending and should be established through decrees or future normative acts during the process of regulating the Law.

Financing from the oil and gas sector

The Research, Development and Innovation Clause in Brazil's oil and gas industry mandates that concessionaires and production-sharing contract holders allocate a

portion of their revenue to innovation and technological advancement. This investment, regulated by the National Agency of Petroleum, Natural Gas and Biofuels, ensures a continuous stream of funding for research initiatives, infrastructure development and workforce training. By linking mandatory financial contributions to gross production revenue, the clause fosters research partnerships between industry players, universities and technology-driven companies, enhancing Brazil's scientific and industrial capacity. These investments not only strengthen the country's energy sector but also play a crucial role in increasing industry competitiveness and driving technological advancements, particularly in low-carbon technologies and operational efficiency. However, there is no obligation to direct these resources toward low-carbon infrastructure projects or to use them as a mechanism to reduce the cost of capital for such investments.

Recommendations

6. Pursue the intended establishment of a carbon pricing instrument to orient investment while using revenues to mitigate adverse impacts on low-income groups and maintain competitiveness.

Brazil has taken a highly ambitious step forward in tackling climate change with the SBCE. The market-driven approach will support the adoption of emissions reduction measures by large industrial emitters over time. In parallel, a voluntary market issues carbon credits, providing extra revenues to carbon mitigation and adaptation projects. The next step for Brazil will be to follow through with the implementation and establishment of the carbon pricing instrument. Work is well underway in this regard and should be supported in the coming years to ensure a successful and timely launch of the pilot scheme as planned in 2030. As part of this effort, Brazil should ensure that its carbon pricing system is compatible with the rules of other emissions trading systems (ETS) through international partnerships in this area. It will also allow Brazil to link with other ETS, both regionally (e.g. Chile) and internationally (e.g. European Union). Keeping the door open for linking with other ETS could protect Brazilian industry from carbon leakage and minimise its exposure to carbon border adjustment mechanisms applied by other countries. This would also be helpful for Article 6 co-operation under the Paris Agreement, which could be advanced under Brazil's COP30 Presidency. The implementation of an ETS can raise important revenues for the government, but it can also negatively affect low-income households. Ensuring carbon pricing does not bring unintended effects requires its development

be coupled with in-depth studies of energy price effects on those households along with the creation of programmes to mitigate those effects (including through rebates or combined with existing social tariff policies). The government should consider earmarking some ETS revenues to minimise these effects. Likewise, carbon pricing can also spur further emissions reductions in other sectors.

7. Establish a national investment fund to direct a fixed share of government oil revenues to finance the energy transition, including plans to move up the value chain in new industries.

The Brazilian government recognises the tremendous economic opportunities that the energy transition can bring for the country, from the development of new industries to expanding energy access and improving living standards. However, sizeable investments of both public and private capital will be required to realise the benefits. Toward this end, the government has an important resource in the form of considerable revenues from the oil and gas sector. Though oil revenues are a critical source of funding for the general federal budget and to finance social programmes (the Social Fund), the government should also consider establishing a national investment fund that directly transfers a fixed share of oil and gas tax or production-sharing revenues to finance the energy transition. This amount should be a share substantial enough to meaningfully support the transition yet measured enough to avoid compromising other essential public expenditures. Notably, the revenues can finance investments that help Brazil move up the value chain in new industries in which it has competitive advantages, such as green fertilisers, green steel and critical minerals. These investments should prioritise infrastructure development, lowering capital costs and offering green credit lines at reduced interest rates. Several other oil and gas exporting countries are successfully deploying this strategy, including Saudi Arabia and the United Arab Emirates. Therefore, as Brazil prepares to embark on an ambitious energy transition based on recent strategies and plans, it is a good time for the government to reconsider the establishment of such a fund. This would also strengthen the narrative of a balanced approach that bridges the important role of oil for economic growth while also advancing the energy transition and helping to gradually reduce the country's reliance on oil exports.

End-use sectors

This section provides an overview of main energy consumption and CO_2 emissions drivers in end-use sectors (industry, transport and buildings), as well as current perspectives and policy orientations for sectoral clean energy transitions. Energy efficiency improvement is a central decarbonisation lever, but other important orientations – including fuel switching and related adoption incentives, as well as domestic manufacturing of clean energy technologies – are also detailed.

In 2022, total energy consumption in Brazil was 9.6 exajoules (EJ), slightly up from 8.9 EJ in 2019. The industry sector accounts for the largest share of energy demand (42%), followed by the transport sector (39%) and buildings (19%). The transport sector is the largest emitting sector, accounting for 54% of domestic emissions.

The current PDE indicates a reduction in national energy consumption of 7% by 2034. The target is particularly ambitious for Brazilian standards, as the reduction envisaged is equal to the annual energy use of large industries like steel and cement. Brazil has a range of energy efficiency policies in place to boost energy efficiency across all sectors, including minimum energy performance standards (MEPS) and a Labelling Program (PBE), both fundamental tools to enhance energy performance, notably in the buildings sector (see the dedicated sub-section below).

Financial incentives for economic actors (including electricity companies and other project holders) and households are also available through the Energy Efficiency Program, which funds residential sector energy efficiency improvements and projects fostering the development and adoption of energy-efficient technologies. In addition, the long-standing PROCEL funds strategic energy efficiency projects as well as training programmes, equipment installation and upgrade, and demand-side management initiatives for electricity in the buildings and industry sectors. Both

programmes are financed by electricity providers, which are required to dedicate a percentage of their yearly net operating income to energy efficiency projects.

The CT-Energia Fund has specifically funded research, development and innovation programmes and projects in the energy sector for the past 25 years, seeking to establish links across existing corporate R&D on energy efficiency and innovation solutions and eventually to support domestic competitiveness.

Beyond energy efficiency policies, the New Industry Brazil policy seeks to reinforce or establish domestic industrial value chains, with a strong focus on clean energy technologies. Developed in collaboration with the private sector, New Industry Brazil presents a comprehensive framework to modernise Brazil's industrial base while advancing sustainability and low-carbon economic growth.

Around BRL 300 billion (USD 50 billion) have been made available by 2026 to improve industrial energy efficiency and support domestic manufacturing of low-carbon energy technologies.

The policy is structured around six key missions, with a strong focus on efficiency and emissions reductions. Key initiatives include:

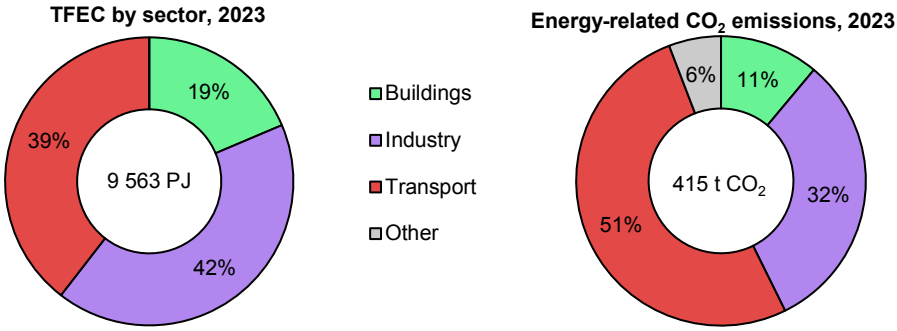
- Sustainable Infrastructure, Sanitation, Housing and Mobility: This mission aims to modernise productive value chains, reduce urban travel times and boost the domestic production of components for sustainable public transportation systems.
- Digital Transformation of Industry: This policy targets the digitalisation of 90% of Brazilian industries, alongside a threefold increase in domestic production of innovative technologies. Strategic priorities include the development of Industry 4.0 capabilities and the expansion of semiconductor manufacturing.
- Bioeconomy, Decarbonisation and Energy Transition: Efforts in this area include a 30% reduction in industrial carbon emissions, an expanded role for biofuels in Brazil's energy mix and initiatives to sustainably leverage the country's rich biodiversity.

In addition to these missions, the policy emphasises:

- tax incentives: providing financial relief to stimulate industrial innovation and competitiveness

- government procurement: leveraging public sector demand to drive domestic production and innovation
- strategic investments: prioritising sectors such as the bioeconomy, decarbonisation and clean energy
- modern financial instruments: encouraging the use of capital markets and other financial tools to support industrial growth.

Total final energy consumption and energy-related emissions by sector in Brazil, 2023



Notes: TFEC = total final energy consumption. Emissions from buildings, industry and transport include those from electricity and heat generation used in these sectors.
Source: IEA (2025), World Energy Balances.

Industry

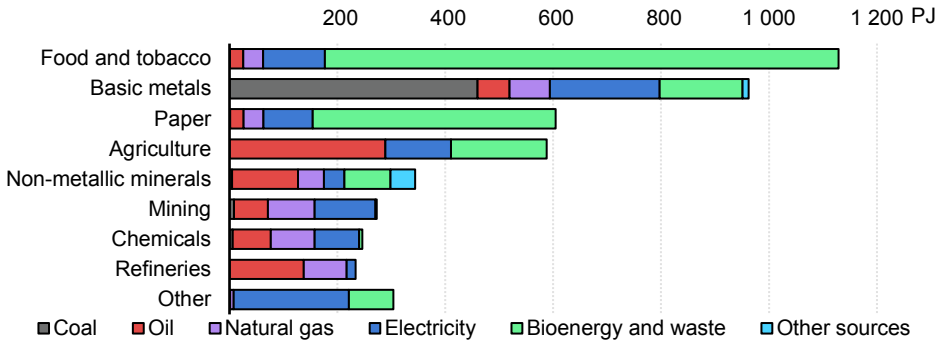
Energy consumption and emissions

The industrial sector represents almost 40% of Brazil's final electricity consumption. The bulk of the sector's energy use comes from food and tobacco and basic metals industries. Basic metals is the only subsector where coal consumption remains significant and accounts for nearly half of energy use.

Energy consumption in the industry sector has grown by around 20% since 2010, with temporary dips registered during the 2015-16 economic recession and

Covid 19-related economic crisis. Total energy-related CO_2 emissions in the industry sector reached 127 Mt CO_2 in 2023, almost a 20% reduction over a decade.

Energy use in industry by subsector in Brazil, 2023



Note: PJ = petajoule.
Source: IEA (2025), Energy End-uses and Efficiency Indicators.

Despite their high energy consumption levels, Brazilian industries stand out for their use of bioenergy, which accounted for 48% of the sector's energy use in 2023. In some sectors, bioenergy use is much higher, for example up to 84% in the food and tobacco subsectors and 74% in the paper industry subsector.

In the steel sector, the use of biomass resources like vegetal charcoal significantly reduces the carbon footprint compared to the traditional coal-based blast furnaces widely used globally. Primary solid biofuels overall account for 88% of bioenergy in industry, followed by charcoal at 8%. The two most important solid biofuels in industry are fuelwood (41%) and bagasse (33%). The food and tobacco sector relies almost exclusively on bagasse, with a total share of 86% in bioenergy.

Brazil's domestic power generation, which largely comes from hydropower and other low-carbon sources, offers further energy efficiency and emissions reduction opportunities through the electrification of industrial processes.

Policies

Several policies have been introduced across the industrial sector since 2020 with the aim of boosting industrial energy productivity. In 2016, the Brasil Mais Produtivo Program was introduced to increase the productivity of industrial small and medium-sized enterprises (SMEs), with a focus on efficiency. The Program, which was restructured in 2023, involves technical support, access to free training and the identification of energy saving opportunities, alongside measures to promote digitalisation of energy use.

In 2020, a pilot project was implemented to test the methodology of energy efficiency learning networks in the industrial sector. Named RedEE Industrias, the initiative provided technical support to promote capacity building in industry professionals and the adoption of efficient technologies and energy management systems. Based on this and other sectoral experiences, a proposal for a national learning network is being developed. In 2021, the Transformative Investment Program for Industrial Energy Efficiency (PotencializEE) was introduced as a partnership between the MME and Germany's GIZ, funded by the Mitigation Action Facility. PotencializEE aims to promote energy efficiency in industry by providing financial and technical support to identify energy efficiency opportunities in industrial facilities through investment in more efficient technologies and energy conservation actions, as well as to implement innovative financial mechanisms to support the implementation of energy-efficient projects.

Electric industrial motor systems, which account for a significant portion of industrial electricity use, are also subject to a range of efficiency policies in Brazil. Three-phase electric motors (<250 volts) manufactured or sold in Brazil have been subject to the Brazilian Labelling Program since the Program's inception in 1984, as well as to MEPS (for motors up to 500 horsepower) since 2001. In 2002, Brazil issued its first MEPS for industrial motors, IR1 efficiency class, similar to IE1. In 2017, the government enacted a new directive establishing the IR3 (IE3) efficiency class and included commercialised repaired motors that came into force in 2019.

Most recently, the 2024-2026 Action Plan for Reindustrialization (New Industry Brazil) seeks to strengthen domestic industrial value chains, with a strong focus on clean energy technologies. The Plan aims to further increase the use of bioenergy in the industry sector, reducing industry sector emissions intensity by 30%; digitally transforming 90% of Brazilian industrial companies; and tripling the domestic

production of “new technology segments,” which highlights renewable energy technologies, CCUS, biodiesel, low-emissions hydrogen, semiconductors and storage technologies.

Fuel switching provides additional decarbonisation opportunities. Brazil’s 2023-2025 National Hydrogen Programme, which aims to boost the country’s low-emissions hydrogen production and to establish low-emissions hydrogen hubs by 2035, also seeks to service hard-to-abate industrial sectors such as steel, for which Brazil ranks as the ninth-largest producer in the world. In 2024, the law established Brazil’s Low-Carbon Hydrogen Development Program and put in place tax incentives for low-emissions hydrogen purchasers from 2028 to 2032.

Recommendations

8. Implement mandatory energy audits for companies above a certain level of energy consumption to support the implementation of energy efficiency measures and energy management systems.

Industry accounts for the largest share (42%) of energy demand in Brazil and 40% of Brazil’s electricity consumption. However, energy consumption in the industry sector has remained steady since 2010, suggesting there is room to improve energy efficiency. Although several measures can contribute to energy efficiency (*Brasil Mais Produtivo*, RedEE Industrias and PotencializEE), likely more results could be realised by lending a stronger impetus to the energy efficiency first principle for industrial decarbonisation. In this regard, one option for Brazil to consider is periodic, mandatory energy audits for large, energy-intensive industries above a certain level of annual energy consumption (as set by the government according to which companies can realistically undertake these steps easily), based on relevant international standards (e.g. ISO 50002). The audit follow-up should result in an action plan, identifying measures for implementation and key performance indicators, including, if feasible, the non-energy benefits triggered by the implementation of the recommended measures, aiming for continuous improvement. The government could also consider the option of implementing voluntary energy audits below the mandatory threshold, especially as mandatory audits begin to show results in terms of energy and cost savings.

Notably, for many energy efficiency measures with short payback periods, upfront costs can easily and quickly be recovered through cost savings, resulting in overall financial benefits for companies. Still, financing for energy efficiency measures, especially by SMEs, can present challenges. While Brazil has made strong progress in mobilising investments in renewable energy and grid expansion, less progress has been made on energy efficiency, where sizeable investment gaps remain. To help narrow this gap, Brazil could consider support for energy efficiency investments in SMEs by exploring the development of on-lending facilities that can channel international public funds (concessional funding, if available) to local banks to support low- and lower middle-income households and SMEs to invest in energy efficiency solutions. In addition, BNDES could expand the scope of the Brazil Climate and Ecological Transformation Investment Platform (BIP) by lowering minimum investment size requirements to finance energy efficiency investments in SMEs. At present, there could be a risk that outsized investments are channelled primarily to large companies that typically do not face barriers to accessing capital. Likewise, BIP investments for smaller, decentralised projects could also be explored through possible aggregation of projects to a scale that can be marketed through BIP. This can bring considerable economic and social development benefits for local communities.

9. Promote a more ambitious approach on minimum energy performance standards for energy-related equipment with a high impact on industrial energy consumption and relevance for the energy transition.

Minimum energy performance standards are a key factor in enabling energy efficiency in energy-related equipment, in particular for industrial products like motors, compressors, distribution transformers, pumps and boilers. For example, motors account for a significant portion of industrial electricity use. Because electric motors have very long lifetimes, their replacement rate is very slow, and a lack of ambition can result in lock-in situations, with untapped energy savings spanning decades. Against this background, Brazil could pursue a gradual approach, combining a measured increase of MEPS to IE4 motors in tandem with fiscal and/or financial incentives, alongside other measures and existing programmes that can facilitate uptake, such as results of energy audits showcasing the potential benefits of more efficient motors.

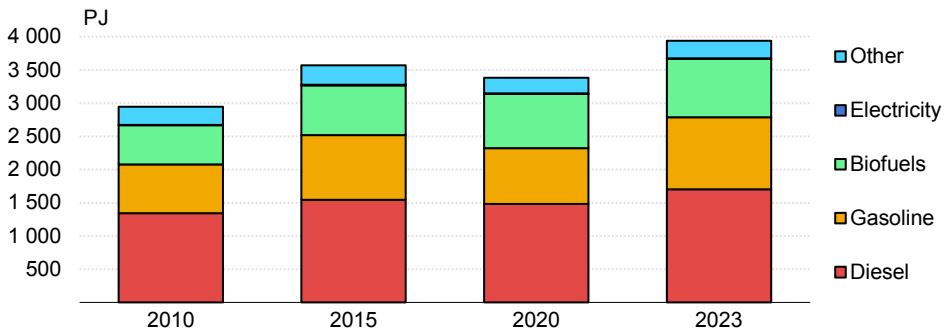
Transport

Energy consumption and emissions

The transport sector is Brazil's second-largest energy-consuming sector, accounting for 39% of final energy consumption (evenly divided among passenger and freight transport) and 51% of energy-related CO_2 emissions in 2023, mostly from road transport, which represented 94% of the sector's emissions. Oil accounted for 75% of energy consumption in the sector. However, biofuels are widely used and account for more than a fifth of transport energy use, a share that has remained constant since 2010.

A 50% increase in light-duty vehicle and passenger car fleets pushed transport sector energy consumption up by around 34% from 2010 to 2023, which led to a 33% increase in CO_2 emissions over the period.

Transport sector energy consumption in Brazil, 2010-2023



IEA. CC BY 4.0.

Note: Electricity is not visible on this scale and represented 0.2% of the consumption in 2023.
Source: IEA (2025), World Energy Balances.

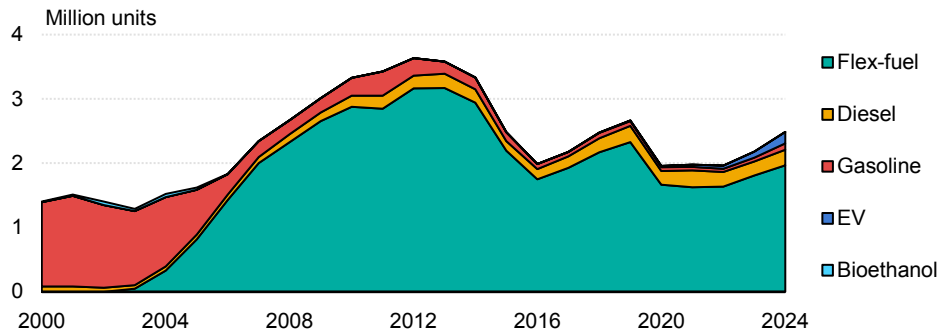
In 2024, Brazil had a car fleet of 45 million vehicles – by far the greatest number of any country in South America. In 2024, 61% of passenger kilometres driven were in light road vehicles, with a further 31% in road-based public transport. Around 85% of Brazil's car fleet consists of fuel-flex vehicles, which gives fuel consumers the option to switch between gasoline and ethanol. This allows almost the entire light-duty

vehicle fleet to use pure ethanol and the remainder to use E27 (27% anhydrous ethanol blended with gasoline), a unique context that presents more differentiated decarbonisation pathways than in other jurisdictions.

Interplay between biofuels and electric vehicles

Brazil's unique position as a global leader in biofuel production and use, particularly ethanol, poses interesting trade-offs and complementarities between EVs and ethanol-powered vehicles as pathways to sustainable mobility. While EVs offer a promising avenue for decarbonisation and gains in efficiency, the well-established ethanol infrastructure and its low-carbon footprint create a strong case for its continued use. Additionally, freight transport, which is dominated by road-based logistics, presents specific challenges and opportunities for emissions reductions and efficiency improvements.

Cars and light-duty vehicle registrations in Brazil, 2000-2024



Source: IEA analysis based on Anfavea (2024), Brazilian automotive industry yearbook (accessed June 2025).

Electric transport still played a minor role in Brazil in 2023. The penetration of EVs is less than 0.5% of the total vehicle fleet, while Brazil remains a global leader in flex-fuel car production and adoption (79% of light-duty vehicles sales in 2024 were flex-fuel models), including in flex-fuel plug-in hybrids equipped with both biofuel and battery systems. This hybrid vehicle appears to be an excellent solution for Brazil, as it combines the country's ethanol potential with its low-carbon electricity mix. However, electric car sales saw a significant increase in 2023, following a worldwide trend,

making Brazil one of the leading global markets in terms of annual growth. National EV sales reached around 7% of total sales in 2024, from just 0.4% in 2019. Policy incentives supporting domestic EV production – such as Mover (see below) – are increasingly attracting FDI, notably from Chinese manufacturers.

Policies

Fuel switching

The Brazil Fuel Program (*Combustível Brasil*) aims to ensure the supply of fuels, biofuels and other petroleum derivatives through strategic actions and measures. Brazil has made significant strides in the development and use of ethanol and biodiesel and, in the process, has accumulated significant experience with public policies for developing new markets. Brazil's biofuels success is mainly rooted in blending mandate policies, which have driven demand for ethanol and biodiesel while reducing reliance on fossil fuels. The National Ethanol Program (Proálcool), launched in 1975, introduced mandatory blending of ethanol with gasoline, starting with a 15-20% mix and evolving to higher percentages over time. Proálcool also contemplated the development of vehicles powered exclusively by hydrous ethanol. These vehicles dominated sales in the mid-1980s and the consumption of hydrous ethanol surpassed the consumption of gasoline (with a 20% anhydrous ethanol blend) by the end of that decade. The fleet of ethanol-powered vehicles grew faster than ethanol production, leading to supply shortages and higher maintenance costs for the subsidy policy. As a result, this technology was abandoned in the 1990s.

Similarly, the National Program for the Production and Usage of Biodiesel (PNPB), established in 2005, mandated incremental increases in biodiesel blending. These policies created a stable market for biofuels, encouraging investment in production capacity and supply chains. Today, decisions regarding blending percentages are periodically reviewed by the CNPE, which considers energy security, environmental benefits and economic impacts in setting mandates.

The introduction of flex-fuel vehicles in 2003 provided a significant, new boost to ethanol demand. Supported by tax incentives, flex-fuel vehicles allowed vehicles to run on any mix of ethanol and gasoline, giving consumers flexibility and revitalising the ethanol market, which had faced a downturn. This technology enables consumers to choose between ethanol and gasoline interchangeably. Ethanol contains approximately 67% of the energy content of gasoline. Therefore, mixing anhydrous

ethanol with gasoline, although improving combustion, reduces the energy content of the fuel. Therefore, ethanol contains approximately 70% of the energy content of E22 gasoline and 72% of the energy content of E27 gasoline. Since E22 gasoline is the reference fuel for vehicle certifications, it is conventionally said that if ethanol costs up to 70% of the price of gasoline, its use is more cost-competitive for the consumer. This technological innovation complemented the mandatory blending policies, cementing ethanol's role in Brazil's energy mix. Together, these measures positioned the country as a global leader in biofuels, combining energy security with economic and environmental benefits. As such, between 2000 and 2022, specific consumption (tonnes of oil equivalent per kilometre driven) of Brazil's car fleet declined by 5%.

These efforts align with the country's more recent and broader commitments to decarbonisation, as reflected in international agreements such as Brazil's NDC and domestic legislation such as the RenovaBio Policy. The Fuel of the Future Law targets an increase in the ethanol blend rate to a range between 22% and 35%, and the biodiesel blend rate to a range of 13-25% by 2030. It also aims to decrease aircraft operator emissions on domestic flights by 1%, increasing every year and having SAF meet 10% of the sector's emissions reduction target by 2037.

Additionally, the National Hydrogen Plan seeks to analyse and adapt existing laws and regulations to facilitate the adoption of hydrogen as a key energy vector and fuel.

Fuel economy standards and fleet electrification

The Green Mobility and Innovation Program (Mover), established in 2023, seeks to boost the domestic manufacture and sale of EVs and other low-carbon options through tax incentives and a dedicated National Fund for Industrial Development for domestic EV production, as well as the production of logistics solutions. In 2024, Brazilian authorities restored and subsequently increased import taxes for EVs to encourage domestic production.

Mover was introduced following the phase-out of the Rota 2030 programme (2018-22) and its predecessor Inovar Auto (2013-17). Rota 2030 set up an EV sales target (30% of new car sales by 2030) and was the first programme to mandate the labelling of all new light- and heavy-duty vehicles using the National Vehicle Labelling System, as well as a fuel economy standard placed on manufacturers to increase fleet fuel economy of new vehicles by 11% by 2022. Mandatory labelling remains in place today, though Mover did not re-establish specific new fuel economy standards. Annual investments associated with the Mover Program are expected to reach

between BRL 300 million and BRL 500 million per year[3]. In Rota 2030, the average investment was BRL 200 million annually.

In addition to passenger and freight road transport, Brazil has introduced a range of programmes to improve the uptake of public transport and non-road transport. These include the 2023 National Railway Plan aimed at doubling rail's modal share; the 2024 Urban Mobility Program, which provides support for urban public transport systems and urban mobility enhancement; BR do Mar, a 2022 government programme to promote coastal shipping; and Pro Trilhos, a government programme to modernise the country's railway infrastructure.

Recommendations

10. Seize the opportunities for domestic manufacturing and expand the role of flex-fuel hybrids and electric vehicles in the transport sector.

Notwithstanding Brazil's highly impressive penetration of biofuels in its road transport fuel mix, fossil fuel consumption and emissions from the sector remain relatively high compared to other sectors. Biofuels expansion has resulted in Brazil positioning itself as a world leader in production, and the sector will remain a cornerstone of the country's energy transition, with a perspective to expand especially in heavy-duty and non-road segments that are harder to decarbonise with electrification. EVs, in contrast, have seen more lacklustre uptake. However, projected transport sector energy consumption growth combined with decarbonisation objectives mean that Brazil should also increase focus on expanding the role of EVs toward a net zero trajectory, also benefiting from the low-emissions factor of its power mix. Brazil has a unique competitive opportunity to leverage its tremendous success in the production of flex-fuel vehicles to produce hybrid flex-fuel vehicles that can run on ethanol/gasoline combinations or electricity. Nonetheless, efforts should extend beyond this segment, with complementary policies that support EV adoption while maintaining a strategic focus on biofuels, a comparative advantage for the country.

[3] The BRL exchange with the euro is EUR 1 = BRL 5.4.

Demand support mechanisms (e.g. tax credits or targets for government/public/company fleets) can be structured in a way to avoid subsidising premium market segments and exacerbating social inequalities, such as by establishing a price threshold for qualified vehicles and applying income-based eligibility for purchases (as France currently does). Equally important will be due consideration to expanding charging infrastructure in the country once demand for EVs picks up. Stronger domestic demand for EVs should help support investment in domestic manufacturing that over time can limit the call on imported cars. Notably, Brazil is already attracting considerable investments from EV manufacturers, presenting an important opportunity for domestic manufacturing and potentially an opportunity to become an exporter of EVs.

11. Create stronger demand for less carbon-intensive heavy-duty vehicles.

Despite Brazil's global leadership in biofuels, heavy-duty vehicles, particularly trucks, still overwhelmingly rely on fossil diesel. Trucks accounted for over 70% of freight transport in 2023, and despite some investment in rail infrastructure, trucks are still expected to transport more than 65% of Brazilian freight by 2034. Modal shifts from road to rail for freight transport would be the most efficient decarbonisation pathway, but hefty upfront costs and lengthy time horizons to build rail networks throughout the country likely mean that trucks will remain an important transport option for freight for the foreseeable future. However, to reach net zero targets, Brazil will need to consider options to gradually increase the uptake of less carbon-intensive trucks in the coming years.

Brazil has made progress in the adoption of technologies to improve the energy efficiency of trucks and increase the penetration of biodiesel, but it could profit from technological progress and additional opportunities in electrification and the adoption of compressed natural gas, LNG or biogas. While policies such as Mover, the Brazilian Vehicle Labelling Program and the Vehicle Air Pollution Control Program L-8 provide incentives for energy efficiency and the decarbonisation of heavy-duty vehicles, there are no specific policies or programmes to accelerate investment in the required fuelling and distribution infrastructure to create demand for less carbon-intensive heavy-duty vehicles.

The IEA recommends the adoption of mandatory fuel efficiency standards and increased application of labelling as effective tools to deliver fuel efficiency improvements. These are especially relevant for energy-intensive transport modes,

such as trucks. The standards and labels should be regularly reviewed and updated to foster the retirement of older, high-emissions vehicles in a technology-neutral and cost-effective way. They can be implemented gradually to prevent sudden and high costs for consumers and to protect social equity. The standards and labels can also stimulate technological innovation.

Brazil would also benefit from a programme that promotes the development of sustainable corridors and industrial hubs with relevant charging/fuel infrastructure to accelerate the adoption of less carbon-intensive heavy-duty vehicles, e.g. in agri-industrial businesses producing biogas from agricultural residues or industrial clusters producing and consuming electricity and hydrogen. Brazil has already some established sustainable fuel corridors at the regional level. A Brazilian state might serve as a laboratory to test policies and incentives that could be replicated in other parts of Brazil through the co-ordination of federal and state programmes in co-operation with the private sector. This could include accelerated implementation of planned regulatory frameworks from the Fuel of the Future Law, taking advantage of available opportunities for biomethane for use in trucks running on natural gas in agro-industrial clusters.

In the longer term, Brazil also has a sectoral decarbonisation opportunity from renewable diesel or hydrotreated vegetable oil, which can be used as a drop-in fuel in heavy-duty road vehicles as well as in the maritime transport sector, using the same infrastructure as fossil diesel.

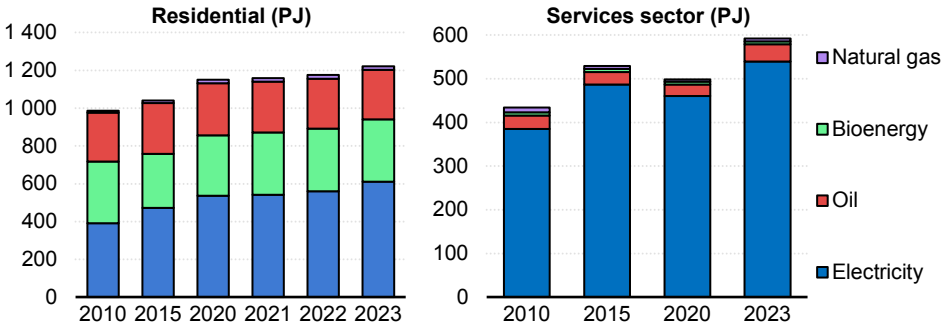
Buildings

Energy consumption and emissions

In 2023, buildings consumed 319 terawatt hours (TWh), which represents 55% of the country's electricity. That said, buildings represent less than a fifth of Brazil's TFEC and were responsible for 11% of its energy-related CO_2 emissions in 2023. These relatively low emissions levels are due to high electrification rates (62% of the buildings sector's energy consumption) and Brazil's low-emissions power mix. Bioenergy and oil products, respectively, cover 18% and 20% of the sector's energy use.

The buildings sector's TFEC increased by 29% from 2010 to 2023, which was largely covered by additional electricity supply. Electricity demand for cooling is also projected to triple by mid-century.

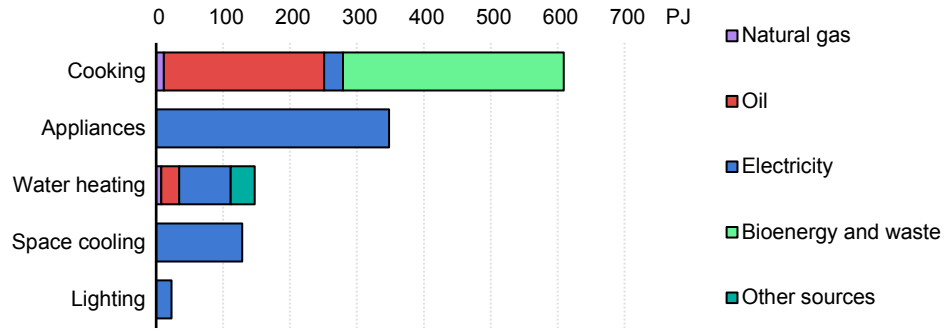
Buildings sector energy consumption in Brazil, 2010-2023



Source: IEA (2025), World Energy Balances.

Residential sector energy demand, which represents twice that of the non-residential sector, is driven by cooking needs (more than half of energy use). In 2023, cooking needs were met by bioenergy (54%) and oil (39%). Higher access to clean cooking and electrification could reduce the traditional use of biomass.

Energy end use in residential buildings by fuel in Brazil, 2023



Source: IEA (2025), Energy End-uses and Efficiency Indicators.

Policies

A wide range of policies in Brazil is aimed at improving the efficiency of building envelopes, and of the equipment and appliances used within them. These policies can be broadly classified as: regulation, information or financial incentives.

Brazil's PBE Edifica initiative provides a framework and methodology for building energy labelling. The National Label of Energy Conservation (ENCE) provides users of assessed buildings with information on the efficiency of the building envelope, with a rating from A to E for buildings and individual systems within them. The label also includes information on any onsite renewable generation present. PBE Edifica aims to promote sustainable building practices and reduce energy consumption in residential, commercial and public buildings. Building labels are mandatory for public buildings, and currently voluntary in the residential and non-residential sectors. A new initiative, launched in 2020, aims to establish a mandatory programme in the residential, non-residential and public sectors. In 2022, almost 5 000 buildings had labels issued, with residential buildings with independent apartments being the most common. A further regulation also includes the concept of nearly zero energy buildings and positive energy buildings. Nearly zero energy buildings are defined as those that supply at least 50% of the total annual primary energy demand with onsite renewable energy production, whereas positive energy buildings achieve annual renewable energy production equal to or above the total annual primary energy consumption.

The PBE also sets the general framework for energy efficiency labelling for equipment and appliances used within buildings. As of 2017, the programme covered 38 product categories including lamps, air conditioners, fans, water heaters, televisions, renewable energy systems and equipment, computers, ovens, electric motors, pumps, and distribution transformers. The PROCEL Energy Seal programme stimulates the production and marketing of energy efficiency products by endorsing the most efficient appliance in each category.

There are comparatively few standards for energy performance of buildings in place in Brazil, though recent amendments have improved coverage. The regulation ABNT NBR 15.775 sets requirements for the thermal performance of building fabric and is mandatory for all new residential buildings, though enforcement is variable. The standard was updated in 2024 to become more stringent. Under a separate 2014 regulation, new federal public buildings and those renovated with federal funds must

have an ENCE rating of A. There are currently no national regulations in place to improve the energy efficiency of existing residential or non-public, non-residential buildings through retrofit.

MEPS for a range of appliances have been in place since the 2001 Energy Efficiency Law, with coverage and stringency gradually increasing since. Brazil has recently revised its MEPS for air conditioners (2022), refrigerators (2023) and a range of other products.

Financial incentives for energy-efficient buildings remains relatively limited in Brazil. Under the "*Casa Azul + CAIXA*" green building certification system, developers of social and community housing can access funding sources via the Residential Lease Fund and Social Development Fund to assist in the design and construction of green buildings. The certification system specifies criteria for building design and construction, such as the use of energy-efficient equipment and installation of motion sensors and timers; requirements for building energy code compliance; and the installation of onsite renewable energy, among other criteria. In addition, the "My House, My Life Programme" (*Minha Casa Minha Vida*, MCMV) subsidises and facilitates the purchase of a house or apartment for low-income families. Incentives to install solar energy also allow surplus energy generated in MCMV homes to be sold to public bodies if the resident is a beneficiary of a federal, state or municipal social or housing programme.

Recommendations

12. Encourage building owners to pursue voluntary energy audits on existing buildings, starting with larger buildings.

Given that the majority of the existing buildings stock will be operational by 2050, it is important to pursue a strategy to progressively fill information gaps related to energy performance and efficiency. Within this endeavour, voluntary, targeted energy audits could be a first measure to help address the inefficiencies of the existing building stock across different typologies and climatic zones while having the potential for establishing a data-driven foundation for future retrofit policies, facilitating the prioritisation of interventions with the lowest life cycle costs. Moreover, a voluntary approach mitigates resistance from the real estate sector, allowing building owners

and property managers to assess the financial viability of retrofits without immediate regulatory impositions. The focus on larger buildings also helps ensure that those undertaking audits have the financial means to do so. Close co-operation with state governments will be essential for effective implementation, including capacity building for auditors at the local level. Voluntary programmes can also support the expansion of capacity within the buildings sector, including the development of skills and service providers, toward broader application of audits down the road. Audits can also help identify cost-effective, energy-efficient air conditioning solutions for buildings to help address the rapid expansion of cooling demand expected from the buildings sector in the coming years.

13. Integrate energy efficiency and thermal comfort standards into social housing programmes.

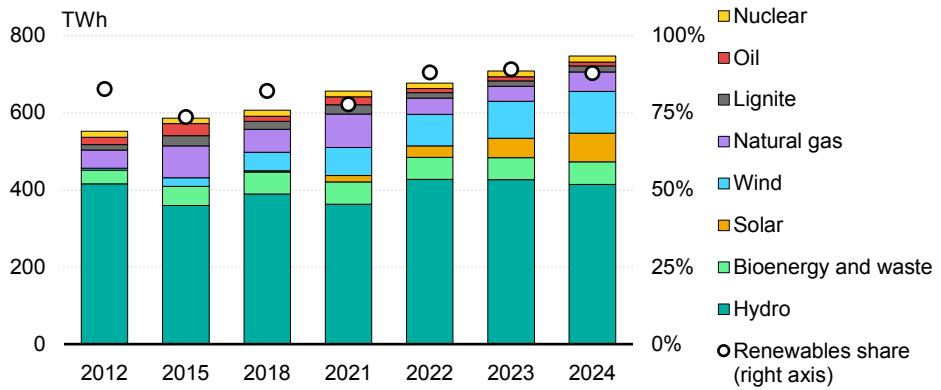
Energy efficiency and thermal comfort criteria are key aspects to integrate into social housing programmes, such as MCMV, to enhance resilience, affordability and sustainability. Such criteria should consider specific socio-economic and infrastructural contexts in Brazil. From a policy perspective, integrating clear energy efficiency requirements, such as passive cooling strategies, within MCMV will maximise the impact of solar PV deployment, reducing unnecessary energy consumption. By establishing clear efficiency requirements before implementing distributed generation, the government can enhance social housing resilience, improve indoor thermal comfort and optimise public investment. Additionally, linking funding allocation to projects that meet both efficiency and renewable energy criteria will ensure a holistic approach to sustainable, low-income housing, fostering long-term affordability and climate resilience.

Electricity

Electricity demand in Brazil has been increasing over the last decade. Several factors have contributed to this. The most important ones are growth in population, the economy and electricity access, as well as the impact of high temperatures that lead to more intense use of air conditioning on hot days.

Brazil's electricity generation is mostly produced from renewable sources, particularly hydroelectric power, which dominates the mix. Electricity generation increased by more than 46% over the period 2010-24, with a consistently high share of renewables. In 2024, renewables accounted for 89% of electricity generation. Of this, hydropower had the largest share (64%), followed by wind (17%), solar PV (11%) and bioenergy (8%). Natural gas is the main fossil fuel used for electricity generation, at around 7% in 2024.

Electricity generation by source in Brazil, 2012-2024



Sources: IEA (2025), World Energy Balances; IEA (2025), Electricity 2025 (for 2024).

Looking ahead, according to the IEA Electricity 2025 report, Brazil's electricity market is expected to see significant additional growth in renewable energy from 2024 onwards, with solar and wind leading the way. Wind power generation is expected to increase by an average of 9.1% annually through 2027. Solar PV is the fastest-growing source, with a projected average annual growth of 23.5% from 2025 to 2027. In contrast, hydropower, while remaining the largest renewable source, shows only minimal growth during this period, and fossil fuel sources continue their steady decline.

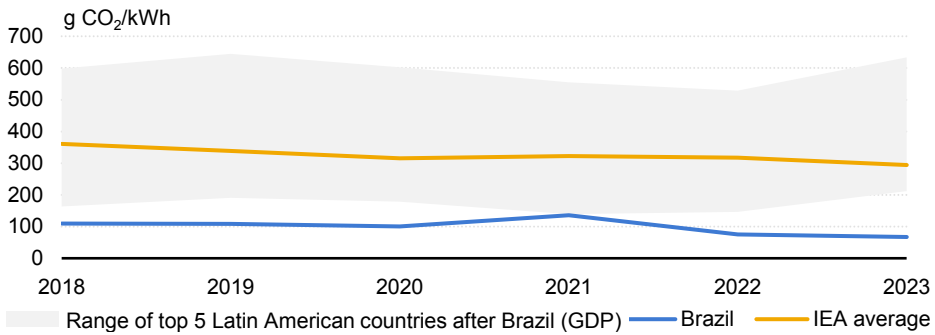
These trends underscore Brazil's accelerated integration of further renewable energy sources, whose share in the total electricity generated will be, depending on hydrological conditions, around 90% in 2027, compared to 89% and 78% in 2024 and 2017, respectively.

Eletrobras is Brazil's largest utility and a key player in its power sector, responsible for about 29% of the country's total power generation capacity and 47% of its high-voltage transmission lines (77 000 km). It operates a diverse portfolio, providing over 20% of the country's total electricity, with 97% coming from clean energy sources. In power transmission, it accounts for almost 40% of the national total. Privatised in 2022, Eletrobras shifted from a mixed ownership, with the federal government retaining control, to private sector control, with the government retaining a golden share. In the past, Electrobras supported the implementation of Light for All, the government's flagship programme, to close the remaining electricity access gap of about 1%.

Decarbonisation outlook

Brazil's power sector ranks among the least carbon-intensive in the world, at 74 g CO_2/kWh in 2022, well below the IEA average (323 g CO_2/kWh). Historically, the value has remained steady, below 100 g CO_2/kWh, except between 2012 and 2019 and in 2021, when natural gas generation increased due to years of drier weather. In light of the planned expansion of generation capacity options, emissions intensity is projected, according to the IEA, to fall on average by 14.4% annually over the 2025-27 period, as the power sector progresses with its decarbonisation trend, while enhancing energy security.

Carbon intensity of the power sector across selected Latin American countries and the IEA average, 2018-2023



Note: 2023 data for the IEA average carbon intensity is provisional.
Source: IEA (2024), Emissions Factors 2024.

Scenarios, system planning

Brazil's energy planning is anchored by the PDE, which provides a comprehensive ten-year outlook on the energy sector, offering an integrated perspective on the expansion of the electricity sector.

Ten-Year Energy Expansion Plan 2034

The PDE 2034 was published in April 2025 and is includes the following projections of which have been made available on EPE's web page:

- **Electricity generation:**
  - Electricity generation is projected to reach 1 045.3 TWh, growing at 3.3% per year.
- **Renewable energy:**
  - Renewable sources will comprise 49% of the total energy matrix.
  - Electricity generation from renewable sources will reach an 86.1% share.
  - Significant growth in solar and wind energy, with capacity additions of 13 147 megawatts (MW) and 15 504 MW, respectively.

- **Energy diversification:**
  - Natural gas share in the electricity mix increases from 11% to 14%.
  - Reduction in oil and derivatives share from 35% to 30%.
- **Per capita metrics:**
  - Energy per capita increases from 1.45 tonnes of oil equivalent in 2024 to 1.72 tonnes of oil equivalent in in 2034.
  - Electricity per capita grows from 3 475 kWh to 4 568 kWh.
- **Self-production and distributed generation:**
  - The share in the electricity generation rises from 15% to 17%, driven by biomass and solar sources.
- **Investment outlook:**
  - Estimated investments reach BRL 3.2 trillion, with 78% allocated to oil and natural gas.
  - Renewable energy and distributed generation account for significant shares in the expansion plan.

These trends provide valuable guidance to policy makers and market stakeholders in energy planning and capital allocation. One of the key outcomes of the PDE is its support to the MME in defining auctions for energy generation and transmission.

Electricity capacity auctions

Auctions to expand electricity generation capacity were introduced as part of electricity sector reforms in 2004. These auctions are competitive bidding processes through which new generation projects are contracted to meet the projected growth in energy demand.

The auctions are organised by ANEEL to contract the purchase of electricity, with the support of the Electricity Trading Chamber (CCEE) and EPE. The aims of the electricity purchase auctions are to:

- contract energy at the lowest possible price
- attract investors to build new plants to expand generation
- retain existing generation.

Transmission system planning

The MME is legally responsible for planning the expansion of the transmission system. As such, with the support of EPE, the MME issues the "Electricity Transmission Grant Plan", which determines which transmission projects should be tendered or authorised. New transmission line concessions are awarded through competitive bidding processes managed by ANEEL.

Brazil has a centralised planning for the National Interconnected System. The cycle between the identification of a project's necessity and its completion typically ranges from five to seven years.

Expanding Brazil's transmission network, especially regional interconnections between the renewables-rich north/northeast and high-demand southeast/central-west regions of the country is a government priority. Recent auctions include the Northeast Bipole I (5 gigawatts [GW] of export capacity from the northeast to increase total capacity to 25 GW) and Northeast Bipole II (3 GW export capacity to increase total capacity to 28 GW).

In Brazil, electricity transmission auctions are bidding processes conducted by ANEEL to grant private companies the right to build, operate and maintain new transmission lines and substations. During the auction, participants submit bids for the Annual Permitted Revenue, and the winner is the one that offers the lowest amount for the provision of the service. After the award, the winning company is responsible for building and operating the facilities for the period stipulated in the concession contract. Future transmission needs will also be shaped by growing loads from new industries (e.g. data centres, low-emissions hydrogen production). By 2035, data centre demand is projected to grow to 12.5 GW (mainly in the states of São Paulo, Rio Grande do Sul and Ceará). Meanwhile, according to the MME, electrolytic hydrogen has potential demand of 46.8 GW by 2038, with a heavy concentration of projects in certain areas of the network. In response, EPE has initiated studies to assess transmission infrastructure needs to meet new, concentrated demand.

In addition to expanding the transmission network, the government estimates an investment of BRL 39 billion will be required to replace and modernise existing infrastructure, including implementing advanced digital technologies. However, concerns are growing over the financial burden of these combined investments in expansions and upgrades, as they contribute to rising tariffs.

Electricity market

Market models

In Brazil, the electricity market is structured around two main models: the Captive Market and the Free Energy Market (FEM). These models differ significantly in terms of their contracting mechanisms, flexibility and cost structures.

In the Captive Market, which primarily serves small consumers, energy supply and transmission are exclusively managed by the local energy distributor, with energy provided according to the distributor's designated service area. ANEEL is the authority responsible for setting, regulating and defining tariffs, which are predetermined for each concessionaire's area of operation. These tariffs, along with any adjustments, are fixed for a 12-month period and cover various costs, including investments, operations, maintenance and energy procurement, making it difficult to predict future expenses. Consumers cannot choose alternative suppliers. Adjustments, such as the annual tariff review or the application of tariff flags, are implemented to address unforeseen events like economic crises or droughts. However, there is some flexibility, as charges are proportional to actual consumption, allowing reduced costs during lower usage periods.

In the FEM, consumers have greater control, contracting energy directly with generators or trading companies. They can select from various sources, such as hydro, wind, solar or thermal energy, offering cost optimisation of up to 40%. Nonetheless, distribution and transmission tariffs remain regulated and consistent with the Captive Market. In the FEM, on the other hand, there is freedom of negotiation and better commercialisation conditions. In practice, free customers can negotiate commercial conditions, which allows flexibility in pricing, quantity of energy contracted, supply period and payment, among others.

As part of the FEM, consumers have two options: 1) become a direct agent of the CCEE; or 2) work through a trader, which can be a retailer or wholesaler, in the "retail energy market". In the wholesale model, or option (1), the consumer takes on the responsibility of fulfilling the CCEE's obligations directly. This requires the contracting company to associate itself with the CCEE, assume the role of an agent, and comply with responsibilities such as ensuring commercial adequacy and providing financial guarantees.

The retail energy market, or option (2), in Brazil works as an intermediary model in which energy traders act as mediators between generators and consumers, simplifying access to the FEM for smaller companies that do not have the expertise or sufficient volume to negotiate directly with generators. In this model, the trading company manages energy contracts, optimising costs, adjusting contracted volumes, and offering personalised services such as consumption analysis and purchasing strategies. This approach allows smaller consumers to take advantage of the benefits of the FEM, such as savings and flexibility, without facing the technical and regulatory complexity associated with direct negotiations.

Pricing and tariffs

In the Captive Market, where utility companies operate, electricity prices are set by ANEEL, which develops tariff calculation methodologies for all segments of the electricity sector (generation, transmission, distribution and commercialisation), taking into account factors such as generation, transmission and distribution infrastructure, as well as economic factors to encourage tariff moderation and market signalling.

In Brazil, tariff flags (or *bandeiras tarifárias*) are a system ANEEL introduced to signal the cost of electricity generation, reflecting changes in the operational costs of Brazil's electricity system. They are designed to provide consumers with real-time information on the state of electricity generation and allow for adjustments to the tariffs based on different conditions, particularly during periods of higher generation costs. The colours of the flags (green, yellow or red) indicate how much electricity will cost depending on generation conditions. In 2024, ANEEL changed the tariff flags, from green to yellow and red, and consequently revised electricity prices because of the severe drought that took place in the country.

In contrast, the FEM allows companies to negotiate energy supply conditions, leading to prices that are volatile and dependent on factors such as the energy source, market conditions and specific metrics. The main pricing metric is the Settlement Price of Differences (PLD), used to define short-term energy prices. Calculated weekly by the CCEE, the PLD balances supply and demand costs.

The PLD is determined through a complex process considering factors like hydrological conditions (hydroelectric reservoir levels), energy demand, the availability of other generation sources and operational costs. It reflects the difference between generated and consumed energy, helping to identify deficits and balance

costs. Despite periodic fluctuations, the PLD is the key reference for negotiations in the FEM, offering predictability for contracts and on-demand energy procurement.

There is currently a debate in Brazil on whether the FEM should be expanded and allow smaller users to participate. Proponents argue that expanding access could foster more competition and lower costs for a broader range of consumers. However, expanding the FEM raises concerns about higher tariffs for consumers in the Captive Market, as a smaller customer base must cover the fixed costs of the system. Critics argue that this could lead to inefficiencies and increased financial burdens for low-income households. Additionally, price volatility in the FEM exposes consumers to risks, particularly during periods of supply shortages or high demand. The government is actively looking into how to address this issue and promote better integration of both markets.

Market design and modernisation

The FEM presents opportunities for tailored energy strategies, emphasising cost reduction and operational flexibility. Companies must carefully manage multiple contracts and leverage market intelligence to choose the best timing and conditions for energy purchases. This includes monitoring market dynamics, supply-demand balance and hydrological factors. Specialised consultancy is invaluable in maximising savings and securing favourable terms, aligning energy strategies with corporate needs.

The Bill of Law 414/2021 has been under discussion in Congress for an unusually long period of time. It advocates for the modernisation of Brazil's electricity sector by opening up the FEM and promoting competition, seeking increased transparency, and efficiency. This initiative proposes a market design that separates distribution, transmission and commercial activities to eliminate barriers and increase market participation. It supports clearer pricing mechanisms, such as the "tariff of wire", and fosters flexibility for consumers to choose suppliers and contract renewable energy sources. The integration of advanced technologies, like smart grids and energy storage, complements these efforts, while regulatory enhancements by ANEEL ensure a balanced and competitive environment.

While this Bill is still under discussion in Congress, the MME has issued Ordinance 50/2022, which enabled high-voltage consumers to access the FEM. Beginning in January 2024, customers in group A (including SMEs such as supermarkets, bakeries, pharmacies, retail chains and hotels) began migrating to the

FEM. This transition allows consumers to select their energy suppliers and negotiate customised contracts, boosting competition within the sector. In 2024, the number of consumers in the FEM expanded by approximately 50%, highlighting the importance of power sector reform and market design that accurately anticipates and accommodates evolving electricity demand trends in the coming years.

EPE is also following progress on the study, "Short-Pricing for Electric Energy: An Analysis of the Brazilian Market". Initiated in June 2023, the study is being conducted by the consulting company PSR, with financial support from the World Bank Group and the oversight of the CCEE. The initiative's main objective is to assess and propose enhancements to the short-term price formation mechanisms in the Brazilian electricity market, with a focus on promoting greater economic efficiency, optimising resource allocation and strengthening price signals to market agents.

Cross-border interconnections and trade

Brazil, the largest electricity market in South America, has developed integration projects with Argentina, Uruguay and the Bolivarian Republic of Venezuela, as well as a binational hydropower station with Paraguay – Itaipu Binational. Except for the Itaipu project, power trade with other countries is ad hoc, without long-term contracts, largely due to differences in commercial and regulatory issues.

In addition to the above, the construction of two binational hydroelectric projects is being planned: 1) the Garabi-Panambi complex on the Uruguay River, bordering Brazil and Argentina; and 2) a project with the Plurinational State of Bolivia on the Madeira River.

Brazil has historically been a net importer of electricity, with net imports slowly declining over the years. As of 2022, around 2% of the electricity supply was covered by cross-border interconnections. Almost all the country's electricity imports are sourced from the Itaipu project.

A challenge to greater regional integration of Brazil's energy market is the current commercial model, which has been in place since 2004. This model relies on trading electricity certificates, which are essentially guarantees of power supply. The system is centralised, rigidly planned and optimised for domestic use. For Brazil to effectively integrate with neighbouring countries' energy markets, it would be necessary to align regulations and create market rules that are transparent and flexible enough to allow for easier cross-border trade.

However, despite these limitations, regional electrical integration has a promising and immediate opportunity for progress through binational hydroelectric projects.

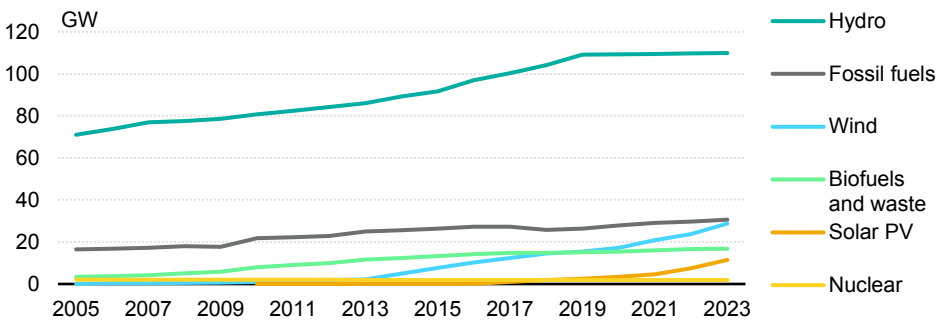
Brazil is part of two key regional electricity integration initiatives: SIESUR (South American Electrical Interconnection System) and ARCONORTE (Northern Region Electrical Interconnection System). These initiatives aim to enhance electricity trade and improve the reliability of power supply across South America. SIESUR seeks to foster cross-border electricity exchange and promote regional energy security by integrating Brazil with Argentina, Paraguay and Uruguay. ARCONORTE, on the other hand, focuses on the northern regions, linking Brazil with countries like Colombia and Venezuela. Both systems enable Brazil to participate in a broader regional electricity network, allowing for better resource sharing, cost savings and support during peak demand or power shortages.

Renewables

Installed capacity

Renewable energy has long been central to Brazil's electricity generation, and its role will continue to gain importance in the coming decades. The installed capacity of the power sector has closely mirrored its generation profile over the 2005-23 period.

Electricity capacity by source in Brazil, 2005-2023

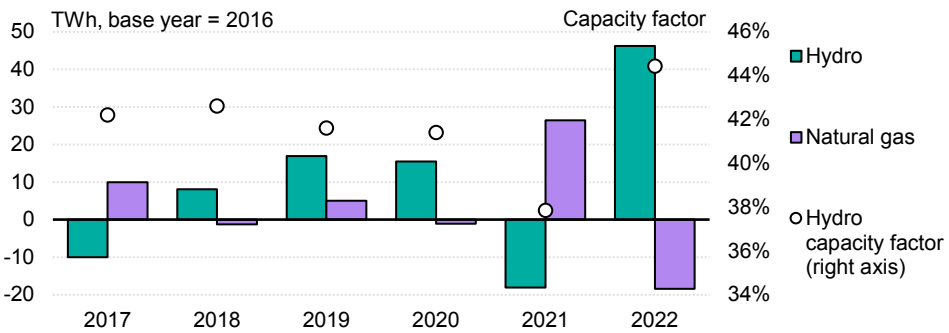


Source: IEA analysis based on EPE (2025), National Energy Balance (accessed April 2025).

Hydro-dominated system

However, differences between installed capacity and actual generation often occur due to weather conditions, especially variations in water availability. For instance, during dry seasons, hydropower output declines sharply, reducing the share of renewables in the electricity mix. In these periods, natural gas generation becomes a critical source to service demand. This reliance on hydropower makes Brazil's system particularly vulnerable to climate change, emphasising the need to diversify with complementary renewable sources like wind, solar and biomass, which is already happening.

Annual changes in electricity generation from hydro and natural gas and hydro capacity factor in Brazil, 2017-2022



Sources: IEA (2025), World Energy Balances; Ministry of Mines and Energy (2024), Historical Series and Matrices (accessed January 2025).

Wind and solar incentives

Brazil has made significant strides in diversifying its electricity mix with non-hydro renewables, driven by proactive policies and incentives. The Incentive Program for Alternative Sources of Energy, initiated in the early 2000s, laid the groundwork for the adoption of wind, solar and biomass energy. The Program combined mechanisms such as price guarantees, long-term contracts, discounted grid usage fees and preferential financing to stimulate early investments. Additionally, the introduction of energy auctions transformed the renewable energy landscape, creating a competitive market that has steadily expanded the share of renewables in Brazil's energy mix

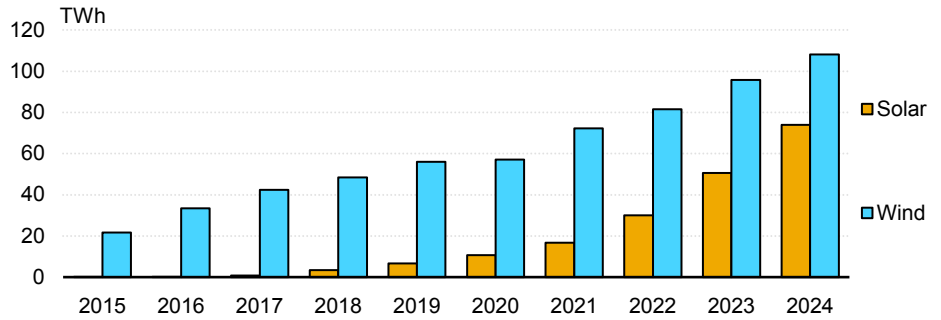
over the past two decades. The auctions include specific targets for wind, solar, biomass and small-scale hydro. Renewable energy projects can also qualify for low-interest loans through public banks, such as BNDES, and benefit from certain tax exemptions (such as import duties on equipment and some transmission fees). Indeed, BNDES has played a crucial role in financing the expansion of renewable energy in Brazil, contributing USD 36.4 billion between 2004 and 2023 to lead the way in this sector.

Meanwhile, distributed generation from solar, wind and biomass enjoys net metering benefits, which are legally enshrined and due to expire in 2029. These benefits have significantly boosted the deployment of PV projects. In fact, according to EPE, the installed capacity from distributed generation grew from 0.2 GW in 2017 to 20.6 GW in 2024.

Critics of net metering policies, which have allowed distributed PV system owners to offset their electricity bills by injecting surplus power into the grid at retail rates, argue this system unfairly shifts grid maintenance and operation costs onto non-solar consumers, which tend to be lower income households. Distribution companies claim that PV users still rely on the grid but do not pay their fair share for infrastructure and services, creating a financial imbalance.

To address this, Brazil enacted Law 14.300/2022, introducing a gradual transition to a new compensation starting in 2029. This model imposes charges on distributed PV users to cover grid usage and service costs while maintaining reasonable returns for system owners. So the Law maintained the primary characteristics and procedures of the existing model but introduced a progressive charge from 2023 to 2028 for new installations to cover distribution costs. An exception applies to systems exceeding 500 kilowatts (kW) for remote compensation, for which charges are more substantial and immediate. Subsequently, after 2028, the compensation for all systems installed from 2023 onward will be determined based on a cost-benefit analysis. This assessment will encompass the effects of decentralised power plants on costs related to generation, transmission, distribution and power losses. Hence, this new compensation framework can be classified as a net-billing scheme, as the net exported electricity is generally valued lower than the retail rate.

Wind and solar electricity generation in Brazil, 2015-2024



Sources: IEA (2025), World Energy Balances; IEA (2025), Electricity 2025 (2024 data).

Nonetheless, solar and wind projects also face some challenges. For solar, the lack of a standardised regulatory framework for environmental licensing creates a patchwork of guidelines across municipalities and states, compounded by the absence of regulation establishing baseline criteria for classifying project sizes and minimum licensing requirements. In contrast, wind farms benefit from federal regulations that set a baseline framework for local licensing procedures, but also face local acceptance challenges (mainly related to noise, conflicting land use and unfavourable terms for local landowners).

Brazil also has tremendous untapped potential for offshore wind along its coast. However, offshore wind struggles from a cost perspective against alternatives, including onshore wind and solar PV. Additional work is needed to assess offshore wind resources and costs, along with greater clarity on large-scale demand, to jump-start an offshore industry. However, Bill 576 of 2021, which regulates the generation of renewable electricity by offshore wind turbines, was signed into law in the beginning of 2025.

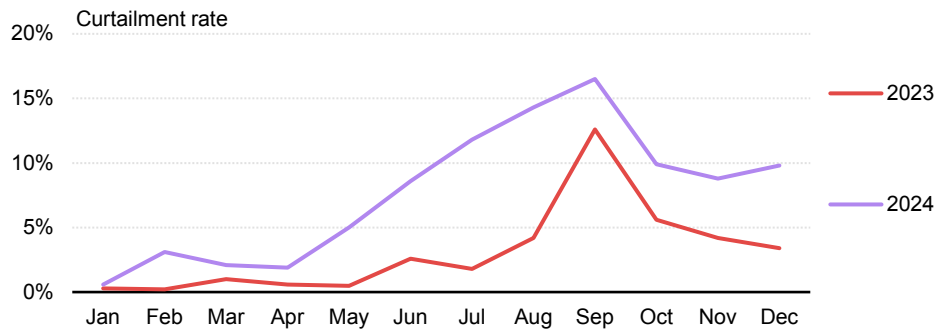
System integration, flexibility and security of supply

As the penetration of variable renewable energy (VRE) sources such as wind and solar increases, new challenges have emerged in system planning and operation. These sources, while abundant, are variable with weather conditions and require greater grid flexibility to manage fluctuations in supply. These challenges are

compounded by changes in other renewable sources, such as hydropower, whose capacity factor has declined from over 50% to around 40% in recent years, with 2021 being a notable outlier due to a severe drought. This decline has increased dependence on thermal generation, particularly natural gas, which, while reliable, raises costs and carbon emissions.

Moreover, the rapid growth of renewables often outpaces grid capacity and has contributed to curtailments, highlighting the need for improved regulation, infrastructure and system integration. On this aspect, it is worth noting that Brazil's renewable energy generation, particularly in the northeast (wind) and north (solar), is not always aligned with the demand centres in the southeast and central-west regions. As a result, grid bottlenecks occur, limiting the amount of renewable energy that can be transported to where it is needed.

Solar PV and wind curtailment rates in Brazil by month, 2023 and 2024



Source: IEA based on Operador Nacional do Sistema (2024), Data Sets (accessed April 2025).

The regulatory framework for handling curtailments classifies them into three types: 1) external unavailability due to issues in facilities outside the plant, typically in the transmission system; 2) electrical reliability requirements related to equipment reliability in external facilities; and 3) energy constraints due to the inability to allocate energy generation to the load. However, compensation for lost energy generation is only granted in cases of external unavailability.

To address these issues, Brazil has prioritised investments in transmission, among other measures. ANEEL held two transmission auctions in 2024 awarding projects totalling 7 250 km of new lines and 19 200 megavolt-amperes of transformer capacity, with an estimated investment of USD 4 billion. These projects aim to alleviate bottlenecks, reduce curtailments and enhance system reliability. Moreover, efforts have been made to address the mismatch between the shorter planning time and construction cycle for renewables projects (two to four years) relative to transmission projects (five to seven years), such as undertaking assessments across broader geographical regions and efforts to identify connection needs before actual requests come in.

EPE has been incorporating flexibility as a key dimension in expansion planning since 2018, through several studies and technical notes. These assessments aim to establish foundational concepts distinguishing flexibility from capacity, develop methodologies for assessing flexibility needs and resources, and create standardised definitions to support stakeholder dialogue. Additionally, they support energy expansion planning by ensuring that generation sources meet system requirements. The studies also contribute to the integration of renewable energy sources into the transmission network, particularly in regions rich in wind and solar potential, by guiding investments in infrastructure that improve adaptability and maintain system reliability.

Also, Brazil has put in place other market mechanisms such as the Capacity Contracting Model (*Modelo de Contratação por Capacidade*). The Capacity Contracting Model was introduced to ensure that there is enough generation capacity available to meet peak demand and provide system reliability, without depending solely on energy consumption from distributors. This model allows contracting reserve capacity not only from thermoelectric plants, but also from the expansion of hydroelectric plants. Additionally, the auction process ensures stricter performance requirements for the projects, which helps prevent future cost overruns and ensures that the plants are able to meet their obligations when needed.

Additionally, energy storage systems are expected to play a pivotal role in providing grid stability and supporting peak demand, though there is no defined regulatory framework for energy storage remuneration. Brazil's hydro-dominated electricity system has sizeable amounts of hydro storage capacity, especially from projects built before 2000. After 2000, most projects were built as run-of-river projects, with significantly less storage potential. As such, since then, storage capacity has not kept pace with demand growth, a trend that is expected to persist. Therefore, optimising

the use of existing hydro reservoirs for storage potential (including large, run-of-river facilities) will take on increasing importance, both for seasonal/inter-year stocks and providing daily/hourly flexibility. Conflicting demands for water from other uses exacerbate this challenge.

Beyond hydro storage, battery storage is also poised to play a greater role. The MME plans to hold its first dedicated energy storage auction in 2025, focusing on contracting battery systems to balance the variability of wind and solar power while reducing reliance on carbon-intensive backups. This initiative seeks to attract major manufacturers, promote domestic adoption of storage technologies and ensure system integration without significantly increasing energy costs for consumers.

Moreover, demand response can also play an important role in balancing system needs by reducing consumption at times of tight supply. Brazil has made notable progress in demand-response programmes for the electricity sector, but it is still in the early stages compared to more developed markets. ANEEL has authorised the system operator to carry out a pilot project on demand response. These initial efforts aim to understand the potential of demand-side management in balancing supply and demand, especially during peak periods or when hydropower production is low. In addition, a voluntary demand-response programme was established in 2021, which allows large consumers to earn compensation for reducing their load during critical periods for the grid. The first demand-response auction was held in 2024, which further integrated this measure into grid-balancing tools. In addition, EPE published a technical note, "Demand Response: Concepts, Regulatory Aspects and Energy Planning", which provides conceptualisation of demand-response programmes in Brazil, presents international benchmarks and outlines methodologies for integrating demand response into energy planning. The agency has also progressively increased the role of demand response in its long-term scenarios and plans.

Lastly, regional integration with neighbouring countries presents a strategic opportunity to enhance energy security and share resources. By pooling renewable generation across borders, Brazil can better manage supply-demand imbalances and mitigate the impacts of climatic events like droughts.

Nuclear

Brazil's nuclear energy programme began in the 1950s with the establishment of the National Nuclear Energy Commission to oversee R&D in the field. The construction of Brazil's first nuclear power plant, Angra 1, started in the 1970s with technology and equipment from the United States. It became operational in 1985. The subsequent plant, Angra 2, was completed in partnership with Germany and began generating power in 2001. Both plants are located in Angra dos Reis, Rio de Janeiro, and together contribute to the country's electricity mix (2% of generation in 2024), providing stable, carbon-free electricity. Angra 1 has an installed capacity of 640 MW, while Angra 2 has 1 350 MW, bringing the total nuclear capacity to 1 990 MW. Together, these plants account for approximately 1% of Brazil's total installed electricity capacity. However, the development of Brazil's nuclear programme faced delays and challenges, including financial constraints, political instability and public opposition, which slowed its expansion.

Angra 3, envisioned as the third plant in the Angra complex, has been under development for decades, facing multiple interruptions due to funding and regulatory issues. Construction initially began in the 1980s but was halted and only resumed sporadically. Currently, the Brazilian government and Eletronuclear are discussing the completion of Angra 3, with expectations to add 1 405 MW of capacity to the grid, bolstering the country's generation adequacy. The project aligns with Brazil's efforts to diversify its energy matrix and reduce GHG emissions. Future perspectives for Angra 3 also involve potential integration with advanced nuclear technologies and international partnerships to ensure its completion and efficient operation. When operational, Angra 3 is expected to reinforce the role of nuclear energy as a reliable complement to Brazil's growing renewable energy sector, especially during periods of hydropower variability.

The Angra 3 reactor is the only nuclear expansion envisioned under the 2034 PDE, while the 2050 PNE assesses the potential for new nuclear reactors, including small modular reactors. However, Brazil is not self-sufficient in large-scale uranium enrichment, so part of the enriched material used in nuclear power plants like Angra 1 and 2 needs to be imported from France, the Russian Federation and the United States.

Recommendations

14. Undertake a comprehensive review of institutional, regulatory and market frameworks to ensure a secure, affordable and future-proof power system that recognises the contributions and capabilities of all actors in a diversified system.

The Brazilian power system has been undergoing a shift from a centralised power system based almost solely on hydropower to a diversified power system, including impressive amounts of wind and solar as well some thermal plants. This diversification is recognised for decreasing the vulnerability of power supply in dry years and as a means of meeting increasing electricity demand (which is projected to expand further in the coming years). However, as diversification increases, the need to recognise the contributions and capabilities of different actors also grows, and appropriate remuneration needs to follow suit. This transition is key in maintaining cost-efficiency, system stability and security of supply. A comprehensive review of frameworks involves a common approach and long-term strategy from key central players including EPE, ANEEL and the National Electric System Operator (ONS), and could include developing new markets for system services.

There is a need for a comprehensive review of market frameworks and a long-term strategy to revisit, for example, how hydropower is used and remunerated to make full use of the resource's dispatchability as well as its storage capacity in dams. Inverter-based resources also have capabilities, notably in reactive power management, that could be explored further. In combination with storage this could also be expanded to fast frequency response. Demand response from resources such as battery backup systems in data centres or flexible hydrogen production can also be valuable contributors, especially in a system with occasional surplus. With the increasing complexity of a diversified system that features significant and growing amounts of distributed generation and changing demand patterns, there may also be a need to evolve the role of distribution utilities into a distribution system operator or introduce a role of a balancing responsible party. Developing a role of distribution system operator or similar entity could also be applied to isolated systems.

15. Incentivise all forms of power system flexibility resources, including existing hydropower and demand-side response, to integrate large shares of wind and solar PV in a secure and efficient way.

Brazil's power mix is undergoing a massive change, with variable renewables expanding very rapidly. According to IEA forecasts, solar PV and wind could ramp up to almost 40% of total electricity generation by 2030. While Brazil has an effective grid planning and procurement system, constructing and operating new lines takes at least seven years. There is an urgent need to take concrete steps that enable and increase all forms of flexibility to address increasing curtailment issues, exploit new VRE generation in an effective and efficient way, and keep security risks under control.

The recent capacity auction, which includes provisions on flexibility, is a very good step in the right direction of integrating flexibility into the energy planning process. Brazil could consider issuing flexibility auctions in the near future as a means to remunerate flexibility, including demand-side response and existing hydropower assets. Several of them are already operating in a different way than in the past, producing less energy and providing more flexibility to accommodate wind and solar, but do not get remunerated under current market rules.

16. Reform the electricity retail market to reflect correct and fair pricing of electricity and use of networks, and to jump-start demand response.

Given the current development of the Brazilian power system, two aspects of the retail market become pronounced: 1) the potential flexibility of end users is inhibited; and 2) the risk for unfair pricing increases. Correct electricity price signals are key to creating incentives for both industry and smaller consumers to use electricity surplus as well as alleviating adequacy issues. The changes in the physical power sector, including both the general shifts in generation sources and specifically the increase in behind-the-meter PV, warrant changes in the electricity market and tariff models. Currently, a large volume of subsidies and cross-subsidies end up on end-user tariffs in the captive market. Enacting results from a study currently underway on short-term electricity pricing reform options aimed at increasing economic efficiency, optimising resource allocation and strengthening price signals would be a good place to start.

Ongoing sandbox testing for new regulatory models is highly commendable and will result in valuable experience and knowledge. Results from these should swiftly be implemented in a thorough overhaul of the tariff models, addressing correct cost allocation and incentivising consumers to make choices that also bring value to the power system, recognising that small consumers too can be a powerful resource in potential scarcity situations. Tariffs should, for example, promote self-consumption of PV generation and reflect a correct allocation of costs. This could include a separation of tariffs for electricity and network utilisation. To create fair and correct pricing, it is also necessary to thoroughly review the subsidy schemes imposed on electricity tariffs.

17. Reform the distributed PV net metering scheme to address increasing inequalities and serious risks for power system efficiency and stability.

Reform of the net metering framework is needed to avoid increasing inequalities in cost burden allocation and exposing the entire power system to unintended economic inefficiencies and stability risks. As in many other countries, distributed solar PV can play a major role in the clean energy transition in Brazil, but it needs to be managed carefully to avoid unintended impacts. The current net metering scheme is too generous and the phase-out plan is too slow (2029), triggering massive deployment of distributed solar PV. The IEA forecasts that with current regulations, rooftop solar PV would double to around 70 GW by 2030. If left uncontrolled, such a trend would have severe negative repercussions on the entire power system – both from an economic and technical/security point of view.

As a part of distribution company costs are paid on an energy basis, with shrinking demand due to distributed generation, fewer customers (including those who cannot afford installing a rooftop PV) pay for all the others. In some cases, prosumers also avoid paying taxes. *De facto*, this situation corresponds to “rooftop solar taxing the poorer” and increasing cross-subsidies favouring higher income parts of society. A non-controlled rooftop solar PV deployment also exposes the entire power system to curtailment and stability risks. The Brazilian system is rapidly moving towards increasing curtailment driven by insufficient demand and excess solar power at certain times and days. Curtailed sources – including other renewables such as wind or hydropower – are not compensated, leading to increasing uncertainty for new investors. Furthermore, it exposes the system to steeper ramp-up and ramp-down

balancing curves, which cannot be controlled by distribution companies or the system operator, ultimately potentially triggering system stability and security risks in the event of a fault.

While the phase-out is set in law, the Brazilian government should push for a rapid reform of net metering design, aligning it to international best practice. As already indicated by the IEA in 2019, this includes progressively moving towards hourly balanced net metering, with prosumers contributing to fixed costs of distribution companies in an equitable way. Moreover, the government should foster the deployment of behind-the-meter batteries for new rooftop installations to better align PV production with electricity demand (e.g. from cooling in the evening or at night) and reduce imbalances on local and national power systems. Batteries could be incentivised by the introduction of time-of-use tariffs, which would remunerate excess solar PV power according to the value provided to the power system, by mandates or a combination of both. Finally, the government should strive for full digitalisation of exchange meters, allowing system operators control in the case of a fault or emergency.

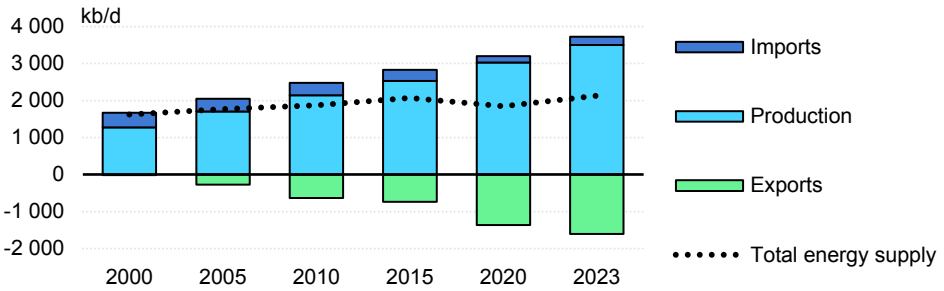
Fuels

Oil and gas upstream sector

Role in economy

The upstream oil and gas sector is a cornerstone of Brazil's economy, generating significant fiscal revenues through royalties, taxes and profit-sharing agreements. Revenues from production-sharing contracts also support social programmes. These funds are essential for public services and infrastructure, particularly in oil-producing states like Rio de Janeiro and Espírito Santo. Beyond fiscal contributions, the sector stimulates job creation and economic activity across various industries, including logistics, engineering and equipment manufacturing, while bolstering Brazil's trade balance by reducing energy import dependency and driving export revenues.

Crude oil balance and trade in Brazil, 2000-2023



Note: kb/d = thousand barrels per day.
Source: IEA (2025), Oil Information.

Local content policies have also played a pivotal role in shaping the sector, especially following the discovery of deepwater pre-salt reserves in the mid-2000s. These policies initially required operators to meet domestic content targets, fostering a robust supply chain and supporting industries like shipbuilding, oilfield services and engineering. Over time, these rules have been adjusted to balance market competitiveness with local industry development, encouraging innovation and strategic growth while reducing compliance burdens.

Additionally, revenues from pre-salt production are channelled into the Pre-Salt Social Fund (*Fundo Social do Pré-Sal*), which supports education, health and social development programmes. While not a formal just transition mechanism, these investments enhance socio-economic resilience and human capital across the country. Brazil's growing focus on social inclusion and workforce training reflects a broader effort to ensure that communities and workers are equipped to adapt to the energy transition, paving the way for sustainable development in the evolving energy economy.

Exploration and production regulatory framework

Exploration and production activities in Brazil are governed by a robust regulatory framework. The National Agency for Petroleum, Natural Gas and Biofuels oversees and regulates the sector, managing licensing rounds and enforcing compliance with technical and environmental standards.

The upstream sector operates under two distinct systems: the concession regime and the production-sharing regime. Under the concession regime, typically applied in conventional exploration areas, companies have ownership of the oil and gas they produce in exchange for financial contributions, such as royalties and taxes. Conversely, the production-sharing regime is designed for strategic areas like the pre-salt basins. Under this system, the government retains ownership of the extracted resources and companies are compensated with a pre-defined share of the production. This dual framework provides flexibility to tailor contract terms to the characteristics and strategic importance of different exploration areas.

Environmental licensing, a crucial aspect of oil operations in Brazil, is overseen by federal and state agencies, including the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) for offshore projects. Companies are required to conduct environmental impact assessments and implement mitigation

measures to minimise risks to ecosystems. Emergency response plans for potential oil spills are also mandated as required by Brazilian environmental legislation and the National Contingency Plan.

Resolution No. 8 from the CNPE sets strategic guidelines to decarbonise oil and natural gas exploration and production. It promotes the adoption of advanced technologies, efficient practices, and the reduction of routine flaring and methane emissions. The Resolution also emphasises transparency in emissions reporting and mandates studies to assess decarbonisation pathways and impacts within 180 days, aligning with global climate commitments.

Recent measures have been proposed to streamline licensing processes while enhancing environmental safeguards. These include initiatives to stricter monitoring of methane emissions and flaring during production. These efforts aim to align the oil and gas sector with Brazil's sustainability goals while potentially strengthening its position as an attractive destination for international investment.

Industry structure

Petrobras, the state-controlled oil company, remains the dominant player in Brazil's upstream sector, particularly in pre-salt exploration and production. The company is responsible for a significant portion of national output and continues to pioneer technological advancements in ultra-deepwater exploration. Petrobras[4] recently announced its 2025-2029 Business Plan and its 2050 Strategic Plan. The 2025-2029 Business Plan outlines a USD 111 billion investment, with USD 77 billion allocated to exploration and production; USD 20 billion to refining, transportation and marketing; USD 3 billion to corporate expenses; and USD 11 billion to gas and low-carbon energy. However, it does not provide details of the specific allocation for low-carbon energy. Petrobras aims to sustain its role in Brazil's energy supply and economic development, increasing output from 4.3 EJ in 2022 to 6.8 EJ by 2050, maintaining a 31% share of the country's primary energy supply.

[4] Petrobras is a mixed-capital company controlled by the Brazilian federal government, which directly holds 50.26% of its common shares. Through entities such as BNDES, the government maintains an indirect interest of 18.48% in preferred shares and 7.94% of the total share capital. The corporate governance structure includes a General Shareholders' Meeting, a Fiscal Council, a Board of Directors with committees, and an Executive Board led by a president and eight officers.

At the same time, international oil companies are playing an increasingly prominent role in Brazil's upstream activities, bringing capital investment and technical expertise. These collaborations have led to greater efficiency and innovation in developing complex offshore projects, reinforcing Brazil's position as a global leader in oil and gas production.

Finaly, Brazil has signed on to the OPEC+ Charter of Cooperation, but this agreement does not subject the country to production quotas.

Reserves

Brazil's oil reserves have grown significantly in recent years, driven by advancements in exploration and production within the pre-salt basins. In 2023, the country saw a 7.0% increase in proven oil reserves (1P) compared to the previous year, with proven and probable reserves (2P) rising by 3.8% and total reserves (3P) increasing by 2.3%. Petrobras alone added 1.5 billion barrels of oil equivalent (boe) to its reserves, mainly through discoveries in the Búzios, Tupi and Atapu fields in the Santos Basin. These additions brought Petrobras' total proven reserves to 10.9 billion boe, ensuring over 12 years of production at current levels. The pre-salt basins are projected to dominate Brazil's oil output, contributing to 76% of national production by 2034. However, most of this growth will rely on existing resources, highlighting the need for continued investment in exploration to sustain production levels beyond 2030, when oil output is expected to peak at 5.3 million barrels (mb/d) per day.

To mitigate the natural decline of mature fields and sustain long-term production, Brazil would need to expand exploratory efforts, particularly in the pre-salt, while also advancing frontier areas such as the Equatorial Margin. The CNPE Resolution 17 (June 2017) established a comprehensive Oil and Natural Gas Exploration and Production Policy, providing a framework to support continuous exploratory activities. This policy includes a multi-year plan for the supply of exploration areas and emphasises measures such as basin attractiveness studies, regulatory simplification, strategic incentives and greater predictability in environmental licensing processes to promote exploration in frontier regions. These actions aim to balance efforts between optimising production from mature assets, like the declining post-salt offshore fields in the Campos Basin, and pursuing new reserves.

In the Campos Basin, many post-salt fields that were pivotal to Brazil's oil production until the early 2000s are now experiencing declines due to reservoir depletion and reduced investment in recovery techniques.

Oil exploration in the Equatorial Margin

The exploration of Brazil's Equatorial Margin, which extends from the Northeast to the North of the country, particularly in the deep offshore area of Amapa State has become one of the most complex and debated topics in the energy sector. While the area may present vast economic opportunities, including job creation, investment and energy security, environmental concerns have sparked debate. The MME and the Presidency have prioritised the acceleration of Petrobras' drilling efforts in the region, and are trying to make the project viable, which depends on relevant environmental licensing.

The decision has faced pushback from environmental entities, including the Ministry of Environment and the environmental regulatory agency, IBAMA, which previously denied Petrobras' drilling licence. IBAMA cited the need for further environmental impact assessments and compliance measures. The oil company's efforts to address these concerns include plans to establish an emergency response base near the FZA-M-59 block to enhance preparedness. Despite these efforts, tensions persist within the government, highlighting the challenges of reconciling economic development with environmental protection. IBAMA is currently reviewing an addendum to the request presented by Petrobras that opens the door for a licence to be granted. The broader context includes Brazil's leadership in global climate discussions, exemplified by its G20 Presidency, where it has argued for continued investment in fossil fuels for emerging economies. With Brazil's pre-salt oil reserves declining and peak production anticipated by 2030, the Amazon's Equatorial Margin is seen by the Ministry of Mines and Energy as vital to sustaining energy security and supporting economic development. However, the timing and scope of these activities remains contentious.

Greenhouse gas abatement

Reducing GHG emissions in Brazil's oil and gas sector is a key priority aligned with the country's international climate commitments and energy transition goals. Several measures, both regulatory and operational, have been implemented to address emissions from exploration, production and associated activities. Brazil's oil and gas sector has an average emissions intensity well below the global average.

Methane, with a much higher global warming potential than CO_2, is a focus of Brazil's climate policies. As part of the Global Methane Pledge adopted at COP26, Brazil committed to work together with other participants to collectively reduce methane

emissions by at least 30% below 2020 levels by 2030. Oil and gas companies are currently subject to permitting requirements as well as flaring restrictions. The National Energy Policy Council recently published a resolution to promote the decarbonisation of oil and gas operations, including the mitigation of methane emissions as an objective of Brazil's National Energy Policy, and tasked the National Agency of Petroleum, Natural Gas and Biofuels to take measures to limit fugitive methane emissions during oil and gas exploration and development. The Energy Planning Office recently published a technical note on methane emissions from natural gas supply showing that many methane abatement options are cost-effective. These initiatives are positive steps towards mitigating the environmental impact of methane emissions from oil and gas operations.

Brazil has made significant advancements in deploying CCUS technologies in the oil and gas sector, particularly in pre-salt regions with high CO_2 concentrations in reservoirs. Initiatives such as carbon reinjection into wells have been successfully implemented in fields like the Lula Field, where extracted CO_2 is stored in deep geological formations. Petrobras leads many of these projects, which are supported by R&D programmes funded through oil royalties. These projects not only mitigate emissions but also enhance oil recovery.

To minimise carbon intensity during oil and gas production, Brazil has adopted measures to reduce flaring and improve energy efficiency. Associated natural gas from oil production is increasingly used rather than wasted, reflecting global best practices. Advanced technologies in offshore operations optimise production processes, further reducing emissions.

Recommendations

18. Consider more targeted upstream policies to incentivise broader participation in exploration and production, and to develop oil and gas in a balanced way for Brazilian society.

There is a need for substantial investments in the energy transition, but also in other sectors in the Brazilian economy. Overall energy policy design should take this into consideration and make policies that increase the efficiency in the Brazilian economy while addressing distributional needs to reduce inequalities. Notably, the economic

activity and the tax proceeds from oil and gas activities can contribute to broader economic prosperity from the energy transition. This requires a robust oil and gas sector that operates with maximum efficiency while also considering the role of the upstream sector in supporting regional economic development. In this regard, higher levels of FDI might be a source for increased upstream investment capacity. By increasing efficiency in the oil and gas sector and securing further economically viable development of oil and gas resources, current and future proceeds can be an important funding source for the energy transition. In particular, opening up space for more foreign oil companies in the upstream sector for exploration and field development could reduce the need for subsidies and tax incentives that might have distortive effects in the economy. Increased FDI can also make more domestic investment capacity available for other purposes while still maintaining the considerable ripple effects oil and gas provides into the Brazilian economy (including jobs, research, new technology and revenues). The participation of a broader set of companies in the exploration and development of new fields can also result in increased innovation and financial capacity to develop new areas.

19. Incentivise oil and gas companies to allocate a higher percentage of their annual investments into RD&D, more focused on low-carbon technologies.

Brazil faces the complex challenge of balancing its economic reliance on the oil and gas sector with the urgent need to transition towards a cleaner, more sustainable energy future. The oil and gas industry plays a crucial role in the Brazilian economy, generating significant revenue and employment. These resources are fundamental to financing the energy transition that will eventually reshape the energy landscape. The oil and gas sector thus has an important role to play in the Brazilian energy transition context. Brazil will need to pursue a strategic and balanced approach that leverages the sector's existing strengths while simultaneously driving innovation and investment in decarbonisation and clean technologies.

One option would be to incentivise oil and gas companies to allocate a percentage of their annual investments (e.g. up to 3%) to RD&D by offering corresponding tax deductions. These tax deductions would be contingent on RD&D relevant for both oil and gas activities (e.g. 50%) and low-carbon technology measures (e.g. 50%). This incentive-based approach recognises the importance of fostering a collaborative environment where oil and gas companies are encouraged, rather than compelled, to

participate in the energy transition. Tax deductions offer a tangible benefit, motivating companies to invest in innovation that aligns with national decarbonisation goals while also supporting their core business activities. Companies could choose the level of RD&D investment that best suits their individual circumstances, fostering a more dynamic and responsive innovation ecosystem. This incentive structure would still guide RD&D towards crucial areas such as CCUS, advanced biofuels and hydrogen production, but allows companies greater flexibility in how they pursue these goals. It also recognises that oil and gas companies possess valuable expertise and resources that can be effectively leveraged through positive incentives rather than strict mandates. This approach is more likely to foster a long-term, sustainable partnership between the oil and gas sector and the broader energy transition effort.

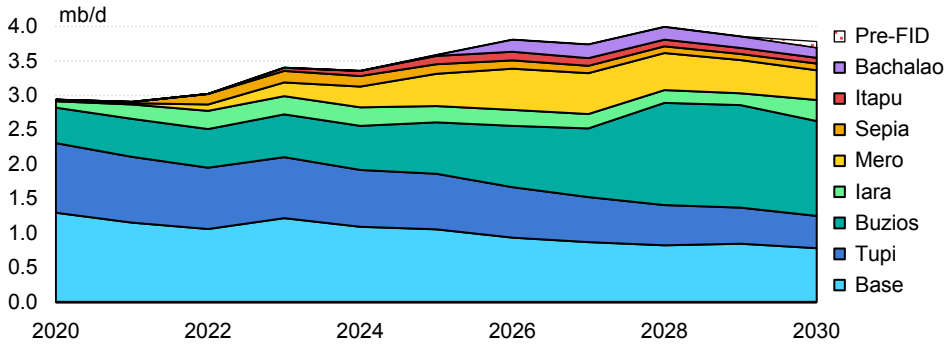
Oil market

Crude oil production outlook

Brazil is both a major producer and consumer of oil, playing a critical role in the global energy landscape. The country's oil sector is one of the most dynamic industries in its economy, underpinned by extensive exploration and production activities, especially in deep water, led by Petrobras, Brazil's state-controlled oil giant. A key driver of Brazil's production growth is the prolific pre-salt layer, located deep beneath the Atlantic seabed, which has positioned the nation as a global leader in offshore oil production. Additionally, the Brazilian Equatorial Margin presents new exploration possibilities, albeit with environmental and regulatory hurdles to overcome.

Brazil's oil production is expected to peak in the coming decade, with pre-salt reserves continuing to drive the majority of output. As fields in the Santos and Campos Basins mature, sustaining production levels will require advancing exploration efforts into new areas, such as the Equatorial Margin in the north as well as continued CO_2 injection for enhanced oil recovery, infill wells and well interventions. This highlights the need for ongoing investments in technology and innovation to maintain competitiveness and energy security. At the same time, the country faces challenges in balancing production growth with its long-term commitments to sustainability and decarbonisation.

Oil production by oil field, historical (2020-2024) and projections (2025-2030) in Brazil

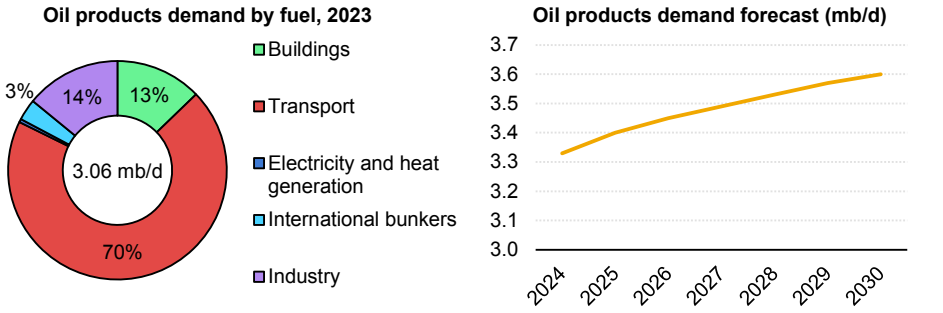


Source: IEA (2025), Oil 2025.

Oil products supply and demand

Oil products are among the most important sources of energy demand in Brazil, representing 42% of total final consumption, playing critical roles especially in transport and industry. Diesel dominates oil products demand (46% in 2022), followed by gasoline (23%), with smaller shares allocated to jet fuel, LPG and other fuels. Oil products demand has seen steady growth over time, reflecting the increasing reliance on these fuels to meet Brazil's energy needs.

Oil products demand by fuel (2023) and forecast (2024-2030) in Brazil

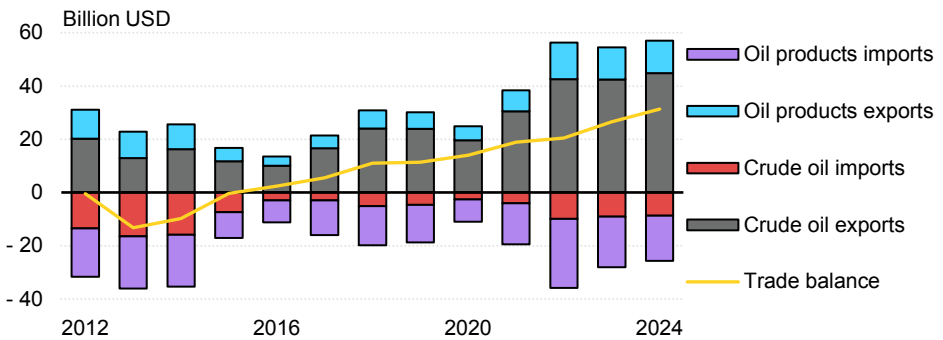


Sources: IEA (2025), Oil Information; IEA (2025), Oil 2025.

Oil trade

After years of a negative balance, Brazil achieved a positive trade balance in oil and products starting in 2016. The main driver of this shift was the growth of domestic crude production and the consequent reduction in import dependence, which increased the trade surplus to USD 11.4 billion in 2019. In 2023, the oil and products trade balance reached a record USD 21 billion, driven by higher domestic crude production and elevated prices compared to recent years. In 2024, international crude oil sales totalled USD 44.8 billion, making it the largest contributor to Brazil's trade balance, accounting for 13.3% of the country's total exports. However, though Brazil has a sizeable trade surplus for crude, it remains a net importer of oil products.

Evolution of crude and oil products trade balance in Brazil, 2012-2024



Source: IEA analysis based on Brazilian Oil Institute (2023) Sector Observatory (accessed June 2025).

Downstream sector

In 2023, domestic production accounted for approximately 94% of Brazil's crude oil supply, with imports covering the remaining 6%, according to EPE. Of the total crude supply, 56% was refined domestically while 44% was exported. Petroleum products primarily serve energy purposes, with 92% of final consumption being energy-related, of which 72% is used in the transport sector.

Brazil's supply chain is supported by a robust infrastructure comprising 18 refineries with a combined capacity of 2.3 mb/d and one shale processing unit (Paraná Xisto), which processes 6.1 thousand tonnes per day. The downstream sector has

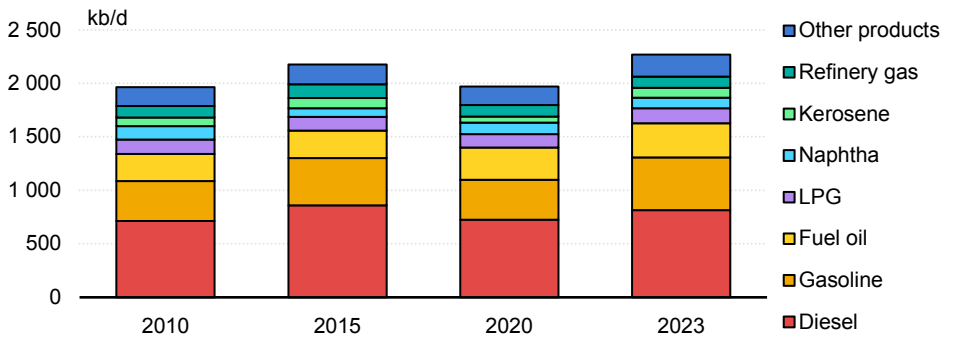
historically been dominated by Petrobras, which held a near-monopoly for a long period. Today, it still remains by far the dominant player, with a 78% of market share.

The transportation infrastructure for oil and oil products includes pipelines, terminals, highways and railways. In 2023, Brazil operated 67 marine terminals and 60 land terminals, with a total of 2 425 storage tanks. The pipeline network spans approximately 20 400 kilometres, supporting the transfer of oil, natural gas, ethanol and derivatives.

Brazil's refining sector is undergoing significant modernisation, driven by substantial investments aimed at enhancing operational and energy efficiency. Petrobras, through its RefTOP programme, has allocated USD 776 million to improve the performance of its refining assets, focusing on high value-added, low-carbon products. Additionally, the company plans to invest USD 11.5 billion in projects that include onshore and offshore wind, CCUS, hydrogen R&D, and the expansion of biorefining initiatives.

In Brazil, the Abreu e Lima Refinery (RNEST) Train 1 is operational, with a proposed modernisation project set to expand capacity from 115 kb/d to 130 kb/d by late 2024. The long-stalled Train 2 addition, which had been on hold since 2015, is now progressing and expected to come online by 2028. This expansion aligns with Brazil's stricter air pollution control programme for on-road heavy-duty and utility vehicles, transforming existing refineries and improving diesel quality. These refineries will combine with a growing biofuels sector to cut Brazil's domestic diesel and gasoline import requirements by nearly 250 kb/d by 2030.

Oil products refinery output by fuel in Brazil, 2010-2023



Source: IEA (2025), Oil Information.

Despite projections in the PDE 2034 indicating increased supply and demand for petroleum products in Brazil over the next decade, significant advancements are planned to decarbonise refineries and petroleum logistics infrastructure. Investments focus on reducing GHG emissions in refining, with companies adopting specific emissions reduction targets. Prominent low-carbon alternatives being studied include the use of low-carbon electricity, low-emissions hydrogen, and biogas or biomethane in refining processes.

Oil emergency policy

While Brazil is a significant crude oil exporter, its refining capacity is insufficient to meet domestic demand for petroleum products, necessitating imports of products such as LPG, naphtha, gasoline, jet fuel and diesel. The government's risk assessment highlights reliability of infrastructure and port bottlenecks, oil worker strikes, and extreme weather events as key local risk factors for oil (products) supply.

The Petroleum Law reinforces the government's role in guaranteeing the supply of petroleum and its derivatives nationwide. The law empowers the federal government, in collaboration with the National Agency for Petroleum, Natural Gas and Biofuels (ANP), to allocate public funds and oversee the development of strategic reserves for emergencies. Additionally, the National Fuel Stock System (SINEC) requires industry agents to maintain emergency fuel stocks based on consumption and production forecasts, ensuring readiness to address potential disruptions.

SINEC was established in 1991 in response to the global oil supply crisis triggered by the Gulf War. It consists of two main components: 1) strategic reserves to secure the supply of crude oil and ethanol for fuel use; and 2) operational fuel stocks, designed to maintain the regular supply of petroleum derivatives. The President of the Republic is required to submit an Annual Strategic Fuel Stock Plan to the National Congress as part of the Budget Guidelines Bill. This plan must include: SINEC's objectives; SINEC's priorities; and financial resource projections for maintaining the strategic reserves.

In 2002, SINEC produced its first report, which recommended to the CNPE that Brazil should not establish strategic reserves for crude oil, LPG, gasoline A, diesel A, jet fuel (QAV) or fuel oil. Since then, the MME has focused on proposing policies to ensure the availability and quality of fuel supplies without the need for strategic reserves, considering Brazil's growing oil production. Until today, Brazil's status as a net exporter of crude oil remains the primary rationale for Brazil not to establish strategic

oil reserves. The last SINEC annual report (for 2023), published in October 2024, reconfirmed this assessment, highlighting that some net-exporting IEA countries (Canada) do not have strategic oil reserves.

A permanent working group (GTP/SINEC), created in 2013 in the wake of localised shortages of petroleum products, annually assesses and identifies necessary actions for the effective functioning of SINEC. This includes evaluating every year the need for strategic reserves of crude oil and ethanol for fuel purposes, as well as operational fuel stocks. So far, despite noting Brazil's growing reliance on imported liquid fuels and infrastructure bottlenecks at ports, the GTP/SINEC's continued assessment is that Brazil does not require any strategic stocks. To address local shortages, however, the regulator, ANP, issued resolutions mandating the establishment of regional operational stocks for diesel, gasoline, jet fuel and LPG.

Since 2022, the ANP requires daily reporting of fuel stocks by a range of regulated entities, including fuel distributors, refiners, biodiesel producers and terminal operators. This resolution allows the ANP to monitor fuel availability, enabling pre-emptive action in case of supply risks. The data cover nearly 1 800 installations across Brazil, consolidating information on national fuel inventories.

Recommendations

20. Simplify the institutional framework to allow the operational stock requirement to address external vulnerabilities from import dependency for fuels.

Brazil has already taken important steps to bolster its energy security through an operational stock system regulated by the ANP and by diversifying fuel sources through biofuels. However, the Brazilian market is long on crude oil and short on most refined products. For some oil products critical to the Brazilian economy (especially diesel), the import dependence is significant (>20%) and is exposed to geopolitical risks. The current Law on Strategic Stocks is limited to the government's direct ownership of crude oil and ethanol, and the creation of a government-owned stockholding would come at considerable fiscal cost. However, a mechanism to reflect the strategic risk around the import dependency of refined products should be explored given the high levels of import dependency.

The pragmatic implementation by the ANP of the Law on Operating Stocks via a requirement on fuel producers and distributors has been targeted at managing the risk of disruption of domestic logistics/supply chains. Some 100 companies produce and distribute fuels that are subject to the holding obligation, with levels of required stockholding related to the length of domestic supply chains. Obligations are at a level equivalent to three to ten days of a company's inland sales, depending on the fuel and the state in which sales were made. The government believes the level is approximately equivalent to 40 days of imports.

It would be a pragmatic option to simplify the institutional set-up to combine SINEC's and the ANP's responsibilities and adjust the stock system to also take account of import dependency for refined products and the risk of international disruptions. While maintaining stocks can be seen as adding costs to the fuel chain, a cost ultimately borne by consumers, it is crucial to recognise the strategic importance of holding emergency stocks. This principle is akin to insurance – a necessary measure to safeguard against potential supply disruptions. Therefore, a robust and comprehensive study evaluating risks will need to be carried out, but ensuring the security of supply of diesel is particularly important given the constraints in Brazil's infrastructure, especially for consumption centres that are distant from coastal importing facilities.

21. Formalise a national emergency response plan for fuel supply crises.

The plan should set out a range of measures from which the government can select to support industry supply logistics, prioritise supplies to essential services and reduce overall demand.

The Brazilian government has made good progress in developing processes for managing fuel supply emergencies. The IEA welcomes the 2023 adoption of a Crisis Protocol for energy emergencies, which allows the co-ordination of government action across different ministries and other state agencies, and the role of the ANP in monitoring the fuel market and the supply alert mechanism. The framework facilitated the sharing of situational awareness and the adoption of time-limited measures during the floods in 2024 for flexibility in biofuel blending rates and prioritisation of fuels for municipal emergency services. However, there is a lack of a national emergency plan covering other options for response measures and contingency plans, such as demand reduction.

Similarly, the IEA applauds the institution of a monthly meeting of power stakeholders to consider status of the system, risk identification and ensure the sharing of information. The set-up was used as a governance forum to manage the impacts of the 2022 drought to implement ad hoc response measures, such as a time-limited regulation on the operation of select hydro plants.

Formalising a process of risk assessment and a National Emergency Plan with suites of measures across fuels and sectors, including those for demand reduction or rationing, would facilitate a timely response to any future crises. This National Emergency Plan should be kept under review to reflect the evolution of the energy market (e.g. growth of biofuels and other low-carbon fuels).

Natural gas market

Brazil's natural gas sector has been undergoing transformative reforms since 2019 under the New Gas Market (*Novo Mercado de Gás*) programme, which aims to increase competition, reduce costs and attract private investment. Key measures include unbundling pipeline ownership, enabling non-discriminatory third-party access and enhancing transparency in pricing. These reforms are expected to create a more dynamic and efficient gas market while reducing Petrobras' historical dominance.

Natural gas is a cornerstone of Brazil's energy transition strategy, considered to be a bridging fuel, contributing to the stability of the power system in the short and medium terms while renewable sources expand and low-emissions hydrogen supply chains are developed. Infrastructure expansion, including new LNG terminals and pipeline networks, is improving access to natural gas in underserved regions. Additionally, the integration of biomethane into the natural gas grid is being explored, further supporting Brazil's decarbonisation objectives.

Brazil's natural gas market is evolving as a critical component of the country's energy strategy. The Brazilian government has been working to reduce information asymmetries throughout the natural gas value chain to support reforms aimed at improving price signals in the market. Under these efforts, the "Gas to Employ Program" was launched to increase domestic supply, reduce reinjection rates, and address market challenges such as high infrastructure costs and limited competition. The Program also integrates natural gas into the broader national energy transition, aiming to leverage synergies with low-carbon technologies like biogas, biomethane and hydrogen. Efforts to achieve these goals have led to strategic regulatory

advancements, such as the 2024 decree that established the Integrated National Plan for Natural Gas and Biomethane Infrastructures. These actions underscore the government's commitment to enhancing the economic and social returns of natural gas production in Brazil.

As a key outcome, Decree No. 12,153/2024 established the National Natural Gas and Biomethane Infrastructure Plan to integrate strategies for expanding supply, demand and infrastructure. EPE, with participation from the ANP, is responsible for developing the Plan, incorporating contributions from public consultations and market data. These initiatives aim to create a more transparent and efficient market, leveraging stakeholder input and infrastructure planning to optimise natural gas and biomethane development in Brazil.

Brazilian production and infrastructure for natural gas are poised for significant growth. In 2023, domestic gas accounted for over 78% of total gas supply, contributing 8.4% to the country's TES. Gross natural gas output is forecasted to reach 315 million cubic metres per day (or 115 bcm/yr) by 2034, with the pre-salt areas accounting for about 80% of this production. Net production is expected to increase by 158% from 2023 levels by the end of the decade. Alongside production growth, Brazil is expanding its natural gas transmission infrastructure to reduce reliance on imports, particularly from Bolivia, whose supply capacity has been declining due to limited investments. Natural gas storage, long overlooked, is now gaining attention in Brazil's new gas market as a flexible solution for thermal power generation, pipeline balancing and reducing gas reinjection. Unlike seasonal demand patterns, natural gas demand in Brazil fluctuates based on the needs of thermal power plants, which are influenced by hydropower generation. With hydropower volatility increasing in recent years due to droughts and climate factors.[5] To encourage investment in storage infrastructure, the New Gas Law replaced the concession system with an authorisation regime, streamlining the approval process. Additionally, seven LNG regasification terminals are operational, enhancing the flexibility and reliability of the gas supply system.

The market for natural gas in Brazil is structured through various segments, with key players like Petrobras, Shell Brasil and TotalEnergies leading exploration and production. Transmission pipelines are managed by regional companies such as COMGAS and CEGAS, ensuring the resource's availability across the country. Notable regulatory measures include the liberalisation of the market through

[5] There is currently no operational underground storage facility in Brazil.

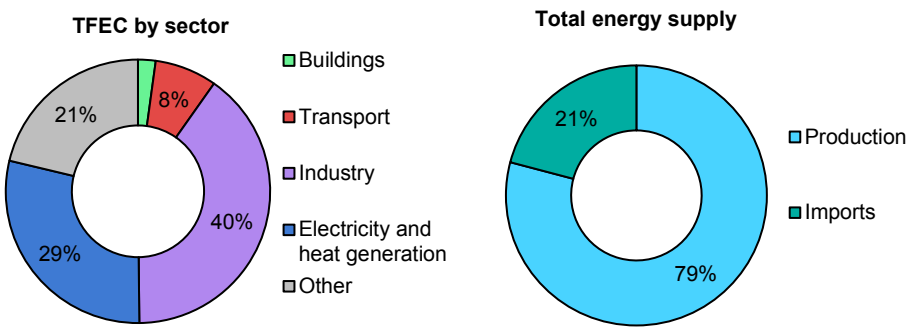
Petrobras' asset divestitures, enhancing competition, enabling third-party access and transparency in pricing mechanisms.

Strategic policies are driving affordability and accessibility of natural gas to end users. Additionally, investments in low-carbon technologies and the potential integration of biomethane into the natural gas network are shaping Brazil's transition to a more sustainable energy mix. These measures, coupled with significant economic impacts such as job creation and GDP growth, underscore natural gas's role in Brazil's energy landscape and socio-economic development. Indeed, natural gas plays a vital role in Brazil's energy system, especially in the industrial and residential sectors.

Natural gas can support energy security, particularly in scenarios that rely on a greater share of variable renewable energy sources in the electricity mix. Its lower GHG emissions relative to other fossil fuels, particularly combined with CCS, from existing facilities, such as bioethanol and biogas, make it an important transitional energy source – capable of enabling deeper renewables penetration while maintaining grid stability and supply reliability.

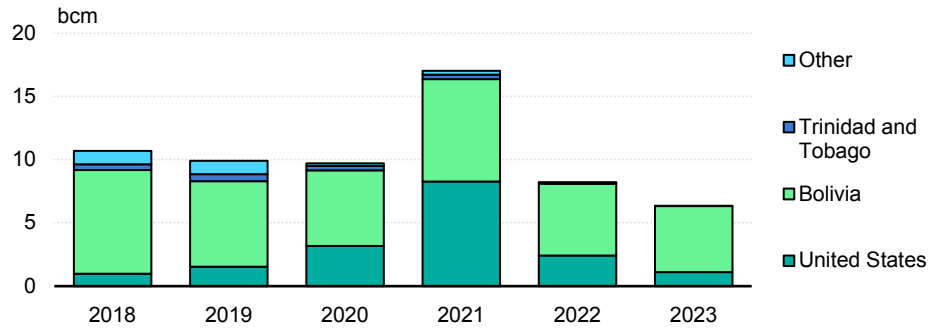
In addition, natural gas with CCS has the potential to decarbonise industries and low-emissions hydrogen production today, particularly by retrofitting existing steam methane reformers used for hydrogen production with CO_2 capture systems.

Natural gas total final energy consumption by sector and total energy supply by origin in Brazil, 2023



Source: IEA (2025), Natural Gas Information.

Natural gas imports by country in Brazil, 2018-2023



Source: IEA (2025), Natural Gas Information.

Recommendations

22. Accelerate the implementation of natural gas market reforms to improve price discovery for consumers.

Natural gas plays an important role in Brazil's energy system and is expected to continue to do so for the foreseeable future. Therefore, it is imperative that Brazil create an efficient gas market framework to support fair prices reflecting supply and demand fundamentals. Currently, Brazil faces relatively high natural gas prices for industrial users compared to many other countries, based on direct price contracts between sellers (usually Petrobras) and local system operators, often linked to oil prices. The 2021 New Gas Market Reform and the 2024 Decree No. 12.153/2024 lay the grounds for improved competition, flexibility and efficiency in the gas market. They are, therefore, steps in the right direction. Progress has already been seen in certain areas such as establishing an entry-exit transport system.

However, broader implementing regulations to realise the Law's vision have been slower to follow. For instance, regulatory frameworks are still needed to support infrastructure expansions, and more work is needed to break Petrobras' control over large segments of the market. Implementing effective third-party access to transmission and distribution pipeline systems and the development of traded hubs

will be crucial to ensure the success of market opening reforms. In addition, state oversight over local distribution companies requires more harmonisation across the federal and state levels to create uniform rules. Therefore, Brazil should place increased focus on expediting the issuance of regulatory frameworks to support the New Gas Market Law.

When implemented in full, the Law will create a more liberalised and competitive market that improves price discovery for consumers. In particular, the shift toward a hub-based model of pricing that more accurately reflects supply and demand conditions in Brazil can lead to more competitive prices for end users (as well as for producers). A more efficient market operation that supports better price discovery will also yield considerable competitiveness benefits for Brazil's industry sector, which is the largest gas-consuming sector in the country. It will likewise support the energy transition by bolstering the flexibility role of natural gas-fired generation in balancing a renewables-based power system and facilitating the introduction of low-emissions gases (such as biomethane and hydrogen) into the system down the road.

23. Clarify the role that natural gas is expected to play in the energy transition.

Brazil is blessed with an energy system that is already highly renewables-based. Nonetheless, natural gas plays an important role in the current energy system, both in industry and electricity, and is expected to continue to play a key role through the energy transition. Therefore, the foreseen future role of natural gas through the energy transition in the coming decades will determine the level of investment needed along the supply chain. A well-functioning and highly flexible natural gas system will be instrumental to Brazil's security of supply through the energy transition. Infrastructure investments can help support this outcome. Not only will Brazil need to see a wider buildout of domestic gas pipelines to improve connectivity throughout the country, it might also consider complementing its highly successful deployment of LNG import capacity with underground storage. However, the current energy transition strategy context appears to leave considerable uncertainty about the role that natural gas will play through the energy transition. In electricity, other flexibility options (hydro, batteries, etc.) might displace the need for natural gas as a balancing resource at some point in the future. Likewise, electrification, hydrogen and biomethane penetration could displace natural gas consumption in industry and transport. Therefore, a clarification from the government on the role that natural gas is expected to play would benefit sector development in line with government goals.

In this regard, the issuance of a Gas Transition Plan should be considered. The Plan should clearly outline the envisioned role for natural gas in each sector, timelines associated with transitions, policy and regulatory levers that will shift the role of natural gas, and infrastructure requirements needed to support the outcomes. It should likewise clarify the role of upstream natural gas production over time, both for domestic needs and possibly even for export.

An important component of the Gas Transition Plan should be a roadmap for biomethane. Brazil has demonstrated considerable success in building up domestic biogas production, supported by the RenovaBio programme and facilitated by a vast agricultural sector. Looking forward, the new Fuel of the Future Law will further promote both biogas and biomethane production, notably through the establishment of annual GHG emissions reduction targets for the natural gas sector. However, biogas still remains a tiny share of Brazil's energy supply, and production levels lag behind those of several other countries (e.g. the People's Republic of China [hereafter, "China"], Germany, the United States). Moreover, given Brazil's significant production potential for biogas (current levels are considered only a small fraction of total potential), efforts to upgrade biogas to produce biomethane, which can be directly transported through existing natural gas infrastructure and applied to all end-uses, would go a long way to support the country's long-term energy transition by decarbonising natural gas supply. To support an expanded role for biomethane in Brazil, the government should issue a detailed biomethane action plan that lays out key supporting policy measures, production milestones, and necessary investments and infrastructure needed to realise the goals. This will also help to align various actors in the value chain that currently appear to lack clarity on the plans of others. Notably, biomethane also presents an important industrial growth opportunity for the Brazilian economy.

Biofuels

Biofuels and waste accounted for 29% of Brazil's domestic energy production in 2023. Brazil was the second-largest liquid biofuels producer in 2023.

Brazil has made significant strides in the development and use of ethanol and biodiesel and in the process has accumulated significant experience with public policies for developing new markets. Starting with the Proálcool programme in 1975, blending mandates, tax breaks and price setting are just some of the strategies that underpinned the early commercial development of biofuels in Brazil, making their production more economically attractive and enabling their use in the transport sector.

As such, these policies were crucial not only for the supply side but especially for the consumption side, as they created robust demand for biodiesel and ethanol and encouraged the market to make the necessary investments.

Since the 1970s, public policies in the shape of mandate blends have ensured a stable and growing market for ethanol and biodiesel, driving investment in agriculture and in biofuel production facilities. These policy frameworks not only secured energy independence but also positioned Brazil as a global leader in biofuel production and usage.

Nowadays, in addition to the mandated blends, central to Brazil's biofuel strategy is RenovaBio, the country's National Biofuels Policy, which sets annual decarbonisation targets for fuel distributors. This policy incentivises the production and use of biofuels like ethanol, biodiesel and biomethane – through a market-based mechanism – promoting emissions reductions and reinforcing biofuels as a key part of Brazil's energy transition.

The regulator, the ANP, plays a fundamental role in RenovaBio, being responsible for the process of certifying the production and import of biofuels, for individualising national decarbonisation targets for fuel distributors and checking their compliance, and for the Decarbonisation Credits (CBIO) Platform, a computerised system developed with Serpro to guarantee the collateralisation of the CBIO. The results of the certifications are published on its website.

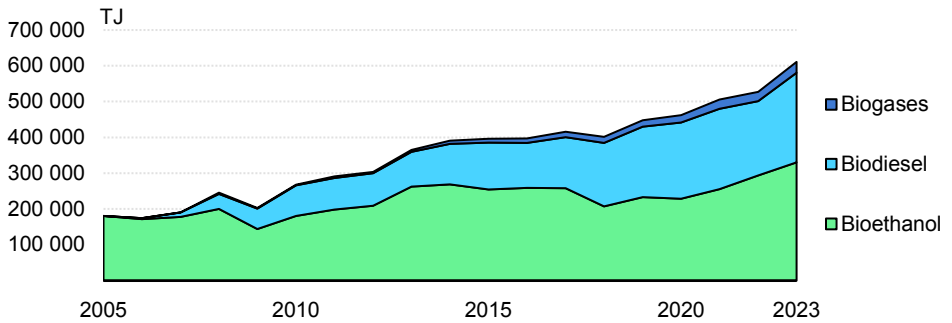
For biofuel producers to join RenovaBio and be entitled to CBIOs, they must meet three eligibility criteria:

1. all certified production must come from an area without deforestation after the date of enactment of the RenovaBio Law (26 December 2017)
2. the entire area must comply with the Forest Code, through regularisation of the Rural Environmental Registry
3. sugarcane and palm production areas must comply with the agroecological zoning of oil palm, as defined by Federal Decree No 7.172/2010.

While specific policy efforts for second-generation biofuels are not extensively detailed, Brazil's commitment to reducing GHG emissions and expanding its biofuels sector suggests potential for future development.

With RenovaBio and other policies as well as innovations like flex-fuel technology, Brazil has solidified its role as a global biofuels leader.

Domestic production of liquid and gaseous biofuels in Brazil, 2005-2023



Note: TJ = terajoule.
Source: IEA (2025), World Energy Balances.

The new Fuel of the Future Law, is expected to further strengthen biofuels' role in Brazil's transition to low-carbon mobility. It expands the market for renewable diesel (or hydrotreated vegetable oil), SAF and biomethane while enhancing technological innovation and supporting decarbonisation goals. The Law establishes regulatory frameworks for CCS and synthetic fuels, increasing predictability and fostering investment in these emerging technologies.

The Law increases the mandatory blend of ethanol into motor gasoline to a margin of 22-35% (previously 18-27.5%). It increases the mandatory biodiesel blend in diesel, currently (April 2025) at 14% (B14), to 15% (B15) by 2025 and 20% (B20) by 2030, driving domestic demand and boosting production. It also encourages the diversification of feedstocks beyond soybean oil, by supporting alternatives like residual biomass and other vegetable oils. The Law directs the alignment among the National Biofuels Policy (RenovaBio), the Mover Program, the Brazilian Vehicle Labelling Program and the Vehicle Air Pollution Control Program to ensure a transparent and unified policy to increase efficiency and decarbonise the transportation sector. Additionally, it reinforces sustainability certification under RenovaBio and fosters the development of other biofuels, such as green diesel and SAF.

Brazil has several policies and regulations that impact land use for biofuel production. For instance, RenovaBio grants CBIO credits only if biofuel production complies with specific land-use requirements, while the Agroecological Zoning for Sugarcane designates areas suitable for sugarcane cultivation. Additionally, the Forest Code provides broader regulation of land use across rural properties. However, Brazil lacks a single, comprehensive land-use policy specifically tailored to the biofuels sector. Instead, the country addresses the complex balance between agricultural expansion, environmental conservation and bioenergy production through a combination of existing laws, new initiatives and ongoing policy discussions.

Ethanol

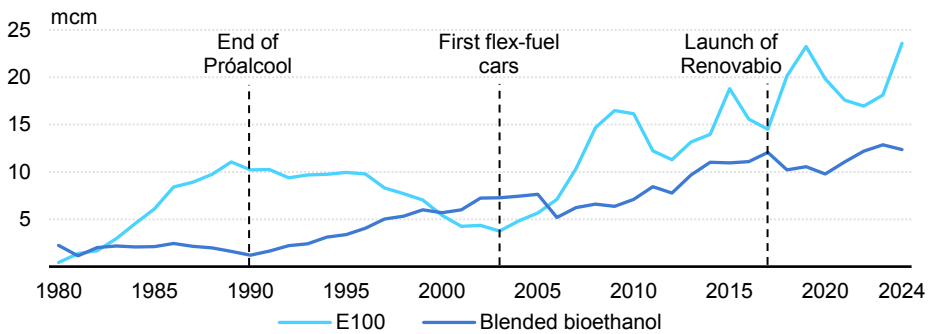
Brazil's ethanol sector stands as a cornerstone of its energy matrix and a global example in renewable energy leadership. Its development took off in the 1970s with the Proálcool Program, which aimed to reduce Brazil's dependence on imported oil by promoting bioethanol production from sugarcane. The Proálcool Program, in its first phase, promoted ethanol as an additive to gasoline, specifically anhydrous ethanol through a blending mandate. In its second phase, it promoted ethanol as an alternative to fossil fuels, using hydrated ethanol in dedicated engines. From that point onward, all gasoline sold in Brazil has included anhydrous ethanol and the exact blending ratio is determined by the CNPE based on market conditions; the mandated proportion has been set at 27.5% since 2015. Ethanol production has continued to expand, driven by both climate goals and energy security concerns.

The latest phase of policy support for bioethanol in Brazil focuses on reducing fossil fuel consumption to address environmental concerns, particularly climate change. In the early 2000s, tax incentives were introduced for ethanol-fuelled cars, which revitalised declining sales. In 2017, the government launched RenovaBio, a biofuels policy aligned with Brazil's commitments under the Paris Agreement and integrated into the broader national energy strategy. RenovaBio aims to provide predictability in the fuel market, a critical issue that had previously hindered ethanol sales due to volatile oil prices. Since its implementation, RenovaBio has contributed to the steady growth of the ethanol market.

In 2023, sugarcane biomass was the second-largest source of energy in TES in Brazil, after oil. Nearly 52% of all sugarcane harvested in 2024 was used for bioethanol, and 335 mills produced 29 billion litres of bioethanol. When also considering burning of the bioethanol by-product "bagasse", sugarcane additionally met 6% of electricity demand. The National Energy Research Office has indicated

that sugarcane production could be as much as 55% higher in 2050. Furthermore, it is important to highlight the rapid growth in corn ethanol production, which reached more than 8 billion litres in 2024 (20% of ethanol production). Ethanol consumption in the fuel market amounted to approximately 36.7 billion litres in 2024, with 13.3 billion litres of anhydrous ethanol (E27) and 23.4 billion litres of E100.

Sales of ethanol in Brazil and selected policy and technology milestones, 1980-2024



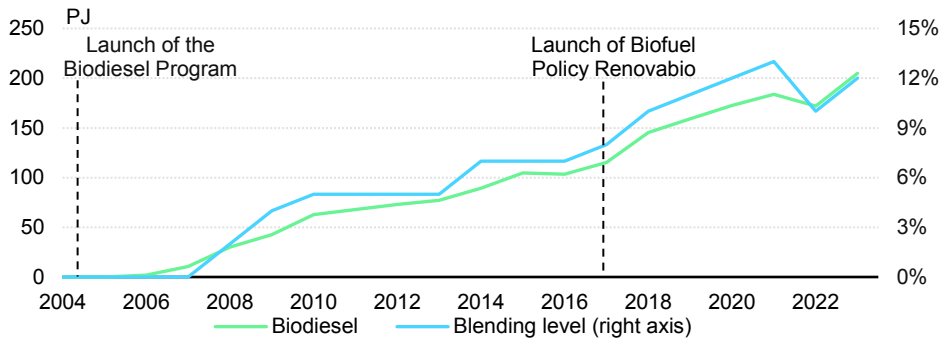
Source: IEA analysis based on EPE (2025), National Energy Balance (accessed June 2025).

Biodiesel

In 2004, the government launched the PNPB. The aim, in the initial stage, was to introduce biodiesel into the Brazilian energy matrix, with a focus on social inclusion and regional development.

After the institutionalisation of the PNPB in 2005, the biodiesel market grew significantly and continuously due to a combination of two factors: 1) the successive increase of the mandatory blend ratio of biodiesel in fossil diesel; and 2) the adoption of a system of public auctions. The following chart shows the influence of the mandatory blending in the biodiesel production.

Biodiesel consumption in transport and mandatory blending level (%) in Brazil, 2004-2023

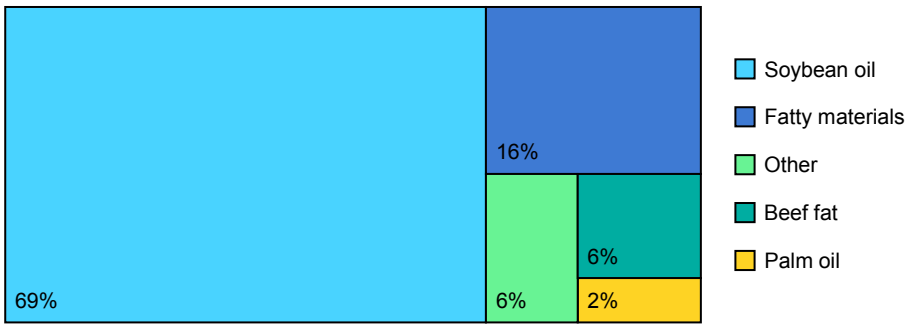


Source: IEA analysis based on EPE (2025), National Energy Balance (accessed June 2025).

In this context, increasing the mandatory blend aimed to create predictable demand, supporting the expansion and diversification of production capacity. Meanwhile, the ANP's auctions boosted competition for the product, ensuring balanced prices that benefit both suppliers and consumers. A relevant feature of the auctions was the role played by Petrobras, the state-owned oil giant, as the auctioneer intermediating transactions. By purchasing biodiesel through these auctions and distributing it nationwide, Petrobras played a significant role in the biodiesel supply chain.

Biodiesel production in Brazil, as envisioned by the PNPB, was initially intended to be diversified across various feedstocks. However, it was soybean oil production that enabled the CNPE to increase the mandatory blending rates and scale up biodiesel production. Historically, soybean oil has been the most significant feedstock for biodiesel. This prevalence is attributed to the well-established soybean industry, which provides a consistent and large-scale supply of oil suitable for biodiesel conversion. Additionally, the existing infrastructure and technological advancements in soybean processing have facilitated its use as a cost-effective and efficient feedstock for biodiesel production. Indeed, the country boasts a vast cultivated area for soybeans, approximately 21 million hectares, making it a readily available resource for biodiesel manufacturing. In 2023, it accounted for 70% of the total production, followed by other fatty materials at 16%.

Feedstock for biodiesel production, 2023



Source: IEA analysis based on EPE (2024), Análise de Conjuntura dos Biocombustíveis (accessed February 2025).

The National Green Diesel Program is one of the pillars of the Fuel of the Future Law. Under the proposal, the CNPE will establish, each year (from 2027 to 2037), the minimum mandatory share of green diesel in relation to petroleum derivatives. The definition of the percentage will have to take into account the specific conditions of supply of this biofuel.

Biogas and biomethane

The biogas sector in Brazil is rapidly emerging as a vital component of the country's renewable energy portfolio, driven by the need for sustainable waste management and decentralised energy production. According to EPE (2023), while biogas still represents a modest share in absolute terms, it has demonstrated remarkable growth in relative terms. Between 2011 and 2023, while TES grew on average by 1.1% per year, biogases in TES grew by 19.5% in the same period, raising its share from 0.03% in 2011 to 0.21% in 2022. From 2022 to 2023, biogas contributions to domestic energy supply rose from 26 PJ to 31 PJ.

In the biomethane sector, as of March 2025, the ANP had authorised 12 plants with a combined production capacity of 697 000 normal cubic metres (Nm^3) per day. Biogas's primary application in Brazil is electricity generation. In 2023, 86% of operational biogas plants used biogas for this purpose, consuming 57% of the total biogas produced. Compared to 2022, the percentage of plants equipped for electricity

generation using biogas remained unchanged, but their installed capacity for this purpose increased from 2.08 billion Nm³/year in 2022 to 2.35 billion Nm³/year in 2023. The most significant increase between 2022 and 2023 was observed in the number of plants converting biogas into biomethane, which rose from 20 in 2022 to 50 in 2023, with installed capacity reaching 37% of the biogas produced in the country in 2023.

In October 2024, the Fuel of the Future Law was enacted, creating the National Program for Decarbonization of Natural Gas Producers and Importers and Biomethane Promotion. This initiative aims to stimulate the research, production, commercialisation and use of biomethane and biogas in Brazil's energy matrix. The Law mandates the CNPE to set annual GHG emissions reduction targets for the natural gas sector to be met by producers and importers. The Program is set to begin in January 2026 with an initial target of 1%, which cannot exceed 10%.

In addition, the New Gas Law grants biomethane equal treatment to natural gas under ANP standards, and Decree No. 11,003/2022 established a federal strategy to encourage sustainable biogas and biomethane use while reducing methane emissions. Economic incentives have also supported sector growth, with biomethane's inclusion in RenovaBio, tax exemptions under the Special Incentive Regime for Infrastructure Projects and access to favourable credit lines, particularly through BNDES and the Climate Fund.

Complementing these measures, Decree No. 12,153/2024 created the National Integrated Natural Gas and Biomethane Infrastructure Plan, aiming to align supply, demand and infrastructure development. EPE has supported this agenda by conducting studies on low-carbon transportation corridors and publishing analyses on biomethane potential and production, reinforcing the government's commitment to expanding the role of biomethane in Brazil's energy transition.

Leveraging Brazil's extensive agricultural, livestock and urban waste resources, biogas production offers a clean and renewable energy solution while reducing methane emissions from organic waste. Supported by policies like the RenovaBio and recent incentives for low-carbon energy, biogas contributes to energy security, especially in rural and agro-industrial regions. As a versatile energy source, biogas can generate electricity, provide heating and be upgraded to biomethane for use in transportation, complementing Brazil's goal of diversifying its energy mix. With growing investments and advancements in technology, the biogas sector is

positioned to play a crucial role in Brazil's energy transition, fostering economic development, reducing emissions and promoting sustainable waste-to-energy practices.

Hydrogen

In 2023, Brazil produced about 500 kilotonnes of hydrogen, which was mainly used in refineries and to a lesser extent for ammonia production. Hydrogen was mostly produced by steam reforming of natural gas, accounting for about 6% of the country's total natural gas demand. Notably, Brazil imported nearly 30% of its natural gas consumption in 2022, underscoring how its current hydrogen demand further increases its dependence on natural gas imports. Looking forward, Brazil's abundance of relatively cheap renewable electricity, including hydropower, offers a strong comparative advantage in low-emissions hydrogen production, both for domestic decarbonisation and for export.

To co-ordinate its efforts to develop low-emissions hydrogen, the Brazilian government introduced the National Hydrogen Program (PNH2) guidelines in 2021. The PNH2 was formally established by the CNPE in 2022 and updated in 2023. It underscores the potential of low-emissions hydrogen to drive the energy transition and highlights the country's opportunity to become a key player in the global hydrogen market. The 2023-2025 Work Plan for the National Hydrogen Program is Brazil's first hydrogen strategy. Its goals include deploying pilot plants in several regions by 2025, positioning Brazil as one of the most competitive low-emissions hydrogen producers by 2030, and developing consolidated hydrogen hubs by 2035. The Program's priorities for 2023-25 focus on: defining a national legal and regulatory framework; promoting research, development and innovation to reduce costs; and improving access to financing.

A legal framework for low-emissions hydrogen has been established as part of the PNH2. In August 2024, the National Low-Carbon Hydrogen Policy Law was enacted, providing a clear definition of "low-carbon hydrogen" in Brazil. The Law classifies hydrogen as "low carbon" if its GHG emissions, determined through a life cycle analysis, are equal to or less than 7 kg CO_2-eq/kg H_2, around 30-40% lower than emissions of production from unabated natural gas, the most common production pathway today. The Law grants the ANP the authority to regulate, authorise and supervise activities within the low-emissions hydrogen value chain. It also introduces the Brazilian Hydrogen Certification System, the first of its kind in Latin America, and establishes the Special Incentive Regime for Low-Emissions Hydrogen Production

(Rehidro), a fiscal incentive for producers that meet the criteria for low-emissions hydrogen, in the form of an exemption from some taxes levied on a company's gross income.

In September 2024, Brazil approved a law establishing the Low-Carbon Hydrogen Development and Investment Program, which will allocate up to BRL 18.3 billion (USD 3 billion) in tax credits between 2028 and 2032 to support the production of low-emissions hydrogen and its derivatives. These credits will be distributed through a competitive process, so the level of support per unit of hydrogen is still unknown, with the cap set at the maximum cost difference between low-emissions hydrogen production and traditional fossil-based methods, while being inversely proportional to its GHG emissions.

Brazil is considering several technology pathways. While most announced low-emissions projects are based on electrolysis, one example of a project that is not based on electrolysis is a pilot project currently under construction in São Paulo, for reforming bioethanol into hydrogen. In addition, Petrobras has signed a memorandum of understanding with the state government of Espírito Santo and the Espírito Santo Federation of Industries (Findes) to study the potential of hydrogen production from natural gas reforming with CCUS in the region. Petrobras has also signed a memorandum of understanding with Japan's Mitsui to evaluate hydrogen production from biomethane with CCUS. Brazil is also actively exploring for natural (geological) hydrogen. Early investigations appear to show prospects, especially in the state of Rio de Janeiro.

If all announced projects as of September 2024 in Brazil are realised, annual electrolytic hydrogen production could reach more than 2 Mt H_2 by 2030. This would represent around 6% of the world's total announced electrolytic hydrogen production of 37 Mt H_2 by 2030. However, the status of Brazilian projects varies considerably, with only 0.3% in operation, under construction or having reached final investment decision, compared to 8% globally. Around 50% of Brazilian projects are at a very early stage, which is similar to the global average, while the remainder are undergoing feasibility studies.

If all announced electrolytic hydrogen projects in Brazil were to be realised, they would require an installed electrolyser capacity of almost 25 GW by 2030 – or 11 GW if projects in very early stages of development are excluded. Notably, 88% of these projects would be gigawatt scale, slightly exceeding the global average of around

80%. The largest operational electrolyser in Brazil today is 3 MW. A 5 MW electrolyser project for White Martins is under construction in Jacareí (São Paulo) for ammonia production.

Producing more than 2 million tonnes per annum of hydrogen (Mtpa H_2) by electrolysis by 2030 would also require a significant increase in electricity generation capacity, equivalent to almost 16% of Brazil's current electricity generation. While first smaller projects are planned in hydropower-rich regions, the largest projects are planned in regions with strong solar and wind potential. If Brazil's announced projects were to rely solely on dedicated electricity from wind and solar PV, the generation capacity from these sources would need to double within this decade just to meet the demand for hydrogen production. In addition, the high concentration of electrolyser projects at specific nodes of the transmission network (e.g. around Ceará) could pose additional challenges, given the long lead times required to expand power transmission infrastructure. To address this, EPE initiated prospective studies in 2024 to assess transmission infrastructure needs arising from hydrogen projects in critical areas.

Brazil's electricity matrix is already highly renewable, with around 90% of total electricity generation coming from renewable sources. Since hydroelectricity is the most important energy source, it has the potential to enhance the competitiveness of low-emissions hydrogen in the future. By enabling the efficient integration of electrolysers, it would allow the production of grid-connected hydrogen with relatively low emissions.

The average grid emission factor was about 75 g CO_2-eq/kWh in 2022, less than a fifth of the current global average of about 460 g CO_2-eq/kWh. The emissions associated with electrolytic hydrogen production depend on the upstream and midstream emissions of electricity generation. Most of the announced projects will use renewable electricity, often from dedicated sources. If hydrogen production were entirely based on directly connected renewables, it would have near-zero emissions, excluding embedded emissions from the power assets. However, if all announced projects were connected to the grid without purchasing guarantees of origin for their electricity, hydrogen production would have an emission intensity of 3.9 kg CO_2-eq/kg H_2, based on Brazil's current average grid emission factor. This would still comply with Brazil's threshold (<7 kg CO_2-eq/kg H_2) and with some international regulations, such as the US Clean Hydrogen Production Standard (<4 kg CO_2-eq/kg H_2). As Brazil continues to integrate variable renewable energy into its grid, the grid emission factor may decrease (depending on potential fluctuations in hydro generation), which could make hydrogen compliant with other regulations such

as the EU Taxonomy (<3 kg CO_2-eq/kg H_2) or Japan's Hydrogen Society Promotion Act (<3.4 kg CO_2-eq/kg H_2).

While Brazil is experiencing a surge in announced hydrogen production projects, most are still driven by the expectation of becoming a major exporter of low-emissions hydrogen with limited domestic demand, as is the case in most emerging markets, particularly in Latin America and Africa. More recently, however, Brazil has begun to explore the large potential of its domestic market, without specific demand targets or quotas in place yet.

Agriculture: Nitrogen-based fertilisers. Brazil is the world's fourth-largest consumer of fertilisers, and currently imports around 90% of its nitrogen-based fertiliser needs, which in 2021 amounted to almost 9 Mt of ammonia (whose production would need around 1.6 Mt H_2). Ammonia prices, which are used as a proxy for nitrogen-based fertiliser costs as it is the main raw material, fluctuate significantly with natural gas prices. Over the past five years, Brazil's trade deficit in nitrogen-based fertilisers has ranged from USD 2.5 billion to as much as USD 7.7 billion in 2022 – equivalent to 0.4% of the country's GDP in that year. This sharp increase was driven by a global spike in natural gas prices, highlighting Brazil's exposure to price volatility caused by market disruptions and short-term trends. In 2022, Brazil published its National Fertiliser Plan for 2050, which includes domestic production targets, such as 1.9 Mtpa of nitrogen (2.3 Mt NH_3-eq) by 2030, a 50% reduction of imports by 2040, and at least three low-emissions ammonia plants by 2050.

Refining. In 2023, Brazil's crude oil refining averaged 2.1 mb/d, with a hydrogen demand of 300 kt H_2, depending on throughput and the sulphur content of the crude oil. Petrobras is the country's largest hydrogen consumer. Brazil's PDE 2034 forecasts increased supply and demand for petroleum products while emphasising decarbonisation strategies for refineries, including the use of low-emissions hydrogen, as fossil-based hydrogen production today accounts for around 15% of GHG emissions in the country's refineries. As part of the Petrobras 2024-28 Strategic Plan, USD 0.3 billion has been allocated for hydrogen, CCUS and corporate venture capital projects. In October 2024, Petrobras took a final investment decision for a 2 MW electrolyser to blend hydrogen in gas turbines at the Vale do Açu power plant (Rio Grande do Norte), investing BRL 90 million (USD 15 million) to gain experience in electrolytic hydrogen production. Petrobras is also considering the feasibility of producing hydrogen from natural gas with CCUS at the Duque de Caxias (Reduc) refinery in Rio de Janeiro.

Steelmaking and hot briquetted iron (HBI) trade. Brazil holds about one-fifth of the world's iron ore reserves and in 2023 accounted for almost 20% of the world's iron

ore trade in monetary terms, exporting almost 400 Mt of iron ore – 65% of which went to China. Brazil is also the largest exporter of high-grade iron ore suitable for 100% H_2 direct reduced iron (DRI) processes, as opposed to lower grade ores for which alternative reduction methods are still being explored. Currently, iron ore reduction and steelmaking are typically co-located, but future shifts may see reduction move to regions rich in renewable energy and iron ore resources, such as Brazil, while steelmaking remains close to consuming markets. The shift from exporting raw iron ore to processed iron offers significant revenue opportunities, as iron fetches almost four times the price of iron ore today (400 USD/t vs. 105 USD/t), with near-zero emissions iron, such as 100%-H_2 DRI exported as HBI, expected to command even higher premiums. In 2023, Brazilian mining company Vale agreed to supply iron ore pellets to Stegra's 100%-H_2 DRI plant in Boden (Sweden) – one of the first of two such plants under construction worldwide – and partnered to explore the production of HBI in Brazil. In 2024, Vale partnered with Green Energy Park to evaluate the feasibility of HBI trading from the planned Green Energy Park hydrogen hub in Ceará. More recently, in early 2025, Vale and GreenIron signed an memorandum of understanding to evaluate the feasibility of a direct reduction facility in Brazil using low-emissions hydrogen and iron ore agglomerates and briquettes instead of pellets.

Available biogenic and unavoidable CO_2 sources for synthetic fuels and urea. Brazil's abundant biogenic CO_2 resources from bioethanol, biogas, and the pulp and paper industry combined with its bioenergy potential put the country in a unique position to significantly expand the production of low-emission fuels for aviation and shipping. Carbon-based fuels such as synthetic jet fuel, methanol for shipping and urea for fertilisers require CO_2 and, in the short term, the use of biogenic or unavoidable CO_2 emissions – such as from cement production (i.e. limestone calcination) – is more cost-effective than direct air capture. Brazil's largest biogenic CO_2 sources are pulp production, with over 50 Mtpa of CO_2, and bioethanol production, with almost 30 Mtpa of concentrated CO_2, which is cheaper to capture, although transport may be required due to more dispersed plant locations and a smaller scale. Cement production, as the world's seventh-largest producer, could contribute over 30 Mtpa of CO_2. With a CO_2 demand of around 25 Mtpa to meet 50% of current aviation needs with synthetic jet fuel, 100% of shipping needs with methanol and all of today's urea needs, Brazil has sufficient CO_2 resources and could use this surplus to produce and export hydrogen-based fuels and near-zero emissions urea, adding value over exporting hydrogen alone. Brazil, along with Chile, is the only Latin American country with a SAF policy, and it is supporting the adoption of SAF through RenovaBio and the ProBioQAV programme, which is part of the 2024 Fuel of the Future Law. The policy includes GHG reduction targets for aircraft operators on domestic flights of 1% by 2027 and up to 10% by 2037, through the use of SAF,

but could pave the way for the longer term where synthetic fuels could also be used as drop-in fuels at higher blends (up to 50% under today's ASME[6] standards).

Moving towards implementation: Creating the first hydrogen hubs. Hydrogen hubs are networks of hydrogen and hydrogen-based fuel producers, potential users and the infrastructure connecting them within a specific geographical area. These hubs serve as nodes for the development of larger networks and offer several benefits in the early stages of market development. These include creating economies of scale by aggregating supply and demand, fostering collaboration between co-located stakeholders, and reducing the need for extensive new hydrogen infrastructure. Brazil has already taken significant steps to start developing hydrogen hubs. In October 2024, the MME launched a public call for proposals for Brazilian low-carbon industrial hydrogen hubs, pre-selecting 12 projects for the next stages. The call aims to identify one or more projects to receive funding from the international Climate Investment Funds – Industry Decarbonisation, which can provide up to USD 250 million in concessional funding per country. In addition, in 2024, the government launched the Brazilian Investment Platform for Climate and Ecological Transformation, based on the G20 reference framework for country platforms, with BNDES as the secretariat. This platform focuses on engaging financial and non-financial stakeholders. Of the seven projects confirmed under the BIP, three are low-emissions hydrogen projects, representing a potential investment of more than USD 7 billion. These projects aim to establish the country's first large-scale plants for the production of ammonia for fertilisers and HBI.

Recommendations

24. Finalise an assessment of the RenovaBio programme and provide public information on the results, including on sustainability and land-use change implications.

Brazil has experienced unequivocal success with its biofuels programme. Over the decades since blending mandates were first put in place, biofuels production and consumption have steadily grown, and biofuels are now a central element in the impressively high share of renewables in Brazil's overall energy mix. Leveraging this

[6] American Society of Mechanical Engineers.

success, biofuels are poised for continued strong growth in the coming years. In fact, the IEA forecasts 40% growth in biofuels demand from 2023 to 2030 (up by 15 billion litres to 51 billion litres), the largest of any country in the world, propelled by rising fuel demand and ambitious blending targets under the Fuel of the Future Law.

The cornerstone of Brazil's biofuels programme is the RenovaBio Policy, which sets annual (declining) carbon intensity targets for transport fuels. The certification of biofuels under the programme is undertaken voluntarily by producers based on an auditable (by accredited inspectors) life cycle assessment. The government is currently undertaking a comprehensive evaluation of the programme. To maximise opportunities under RenovaBio, the government should ensure that the assessment includes a public evaluation of the following:

- achievement of the original decarbonisation targets and creation of a liquid certificate market
- average bio-certificate prices and impacts on consumer prices
- social, health and climate benefits (to the extent possible)
- diversification of fuels and energy security impacts (e.g. reduced imports of gasoline and diesel)
- land use and land-use change, including identification of possible methodological changes to include new feedstocks and/or technology routes and greater harmonisation with international practices.

More broadly, Brazil has considerable potential to expand its role as a global biofuels champion (both for domestic consumption and for export), but the opportunity hinges on broader understanding of the sustainability conditions of biofuels production. In particular, thorough assessments and transparent communication on land-use impacts and land-use change are imperative. Brazil already undertakes detailed assessments and imposes stringent land-use criteria for biofuels production, especially for sugarcane-based ethanol, which has dedicated areas for crop production. Similarly, robust land-use change evaluations should be undertaken for corn ethanol based on second cropping and for biodiesel from soybeans. The soybean feedstock is poised for considerable growth in the coming years in light of ambitious targets from the Fuel of the Future Law (such as higher biodiesel mandates and SAF targets). Brazil is commendable for taking a risk-based approach to indirect land use change. However, it should clarify its approach for high-risk feedstocks (such soybean), underpinned by transparent data on feedstock use for biofuel and food/feed

production. Equally important to undertaking assessments, Brazil should develop a platform for consolidating the information and ensure clear public communication on the results.

25. Promote the development of advanced biorefineries, leveraging existing strengths in biofuels production and opportunities for the bioeconomy.

Brazil has a mature and well-developed first-generation biofuels sector with sustainability requirements guided by RenovaBio. Despite Brazil's global leadership in first-generation biofuels, second to the United States, Brazilian policy makers recognise the need to decarbonise hard-to-abate sectors, including heavy-duty road, aviation, maritime and some energy-intensive industrial sectors like cement, steel and aluminium, among others. Brazil has recently passed the Fuel of the Future Law, a comprehensive legislation that provides a demand pull for ethanol, biodiesel and SAF, and set regulatory frameworks and authorities for biomethane, renewable diesel, CCUS and synthetic fuels. The Fuel of the Future Law is being implemented in co-ordination with other national policies, including the New Industry Brazil policy (for investment in innovation, commercialisation and deployment of new technologies) and the Ecological Transformation Plan (for financing investments to de-risk projects and deploy advanced sustainable fuels).

Brazil can lead the world in developing advanced biorefineries capable of producing a range of low-emissions biofuels and synthetic fuels, such as SAF, renewable diesel, methanol and other carbon-based fuels using biomass feedstocks, low-emissions hydrogen and captured carbon from co-located decarbonisation operations (e.g. from the paper industry). In addition, these biorefineries could produce clean, low-emissions hydrogen and ammonia, which does not require carbon. Potential economies of scope could reduce project costs, while strategic site selection near agricultural and industrial clusters could lower transport and distribution infrastructure needs and ensure steady demand for the biorefinery outputs.

Brazil has an unusual GHG emissions profile, with over 70% of emissions resulting from land-use change, agriculture and livestock. By integrating energy, agriculture

and environmental goals, Brazil may convert degraded pastures and land into energy sustainable crops and forests that would serve as feedstocks and/or power input for biorefineries.

26. Scale up low-emissions hydrogen by stimulating domestic demand creation and the potential for exports, developing hydrogen hubs to optimise infrastructure needs.

Brazil has made a tremendous legislative effort on low-emissions hydrogen and has enormous potential to become one of the major global players in the nascent low-emissions hydrogen market, leveraging its competitive advantage in low-cost renewable electricity (recognising other needs for electricity). However, the pathway to realisation requires significant effort, including to build the necessary skills, lower imports of natural gas and fertilisers, and increase domestic value creation in downstream industries. Though the export market offers considerable upside potential for Brazil, fostering a domestic market will be instrumental to jump-starting a successful hydrogen industry. Brazil has begun to consider domestic demand drivers for hydrogen, and additional impetus should be given to these efforts. Notably, Brazil's vast agricultural sector offers important opportunities for replacing nitrogen-based fertiliser imports with domestic fertilisers produced from low-emissions hydrogen. Replacing fossil fuel-based hydrogen with low-emissions hydrogen in refineries also offers an upside for hydrogen demand, as does leveraging Brazil's sizeable iron ore reserves to produce low-emissions processed iron for steelmaking. A hub-based model for hydrogen development based on existing and new industrial clusters can take advantage of synergies and shared infrastructure to support the decarbonisation of heavy industry in Brazil. In these hubs, Brazil can increase its domestic demand as a route to scale up domestic production while exploring how to unlock export opportunities, particularly moving up the domestic value chain, using this hydrogen downstream, to advance reindustrialisation and create local jobs. Brazil needs to consider the development of its hydrogen sector in tandem with an expansion of its electricity system, given the considerable need for additional power generation capacity (especially wind and solar) and transmission grid infrastructure that hydrogen production would require if those projects were connected to the grid. Co-ordinated system planning of the electricity and hydrogen systems, therefore, must be pursued.

27. Develop infrastructure around agri-industrial clusters that support localised market development of a range of sustainable fuels and products, and expand into low-carbon corridors.

Brazil's Fuel of the Future Law and National Hydrogen Program position the country for strong growth in sustainable fuels production. While the Law sets ambitious targets to motivate sectoral growth, the government's next focus should be to support implementation through detailed planning for the construction of transportation and distribution infrastructure. To optimise infrastructure and reduce risks of over-investment, Brazil could leverage its existing successful experiences in biofuels and expand the concept of hydrogen hubs by developing infrastructure around agri-industrial clusters that support the localised market development of a range of sustainable fuels and products (e.g. green ammonia and fertilisers). The cluster approach facilitates the bridging of producers and customers at a localised level through a more measured and strategic buildout of local infrastructure. As local ecosystems take hold, sustainable fuel networks can then leverage those successes to expand and integrate across regions. Brazil used a similar strategy to build out its power grid, which first focused on state-level networks that were later integrated across the country. Over time, infrastructure could be expanded via low-carbon corridors that connect key agri-industrial hubs (e.g. São Paulo-Campinas and the state of Paraná).

Data, statistics and tracking

Roles and responsibilities within Brazil's energy data system

The Ministry of Mines and Energy (MME): The MME is responsible for ensuring the policy framework and governance to co-ordinate energy data between the institutions of the energy sector, including agencies, EPE, the ONS, Petrobras and the CCEE.

The Energy Research Office (EPE): EPE is responsible for co-ordinating the preparation of the Brazilian Energy Balance (BEN), a document that provides historical data on the production and consumption of various energy sources in Brazil. It is additionally responsible for collecting and processing data on demand from electricity distributors and other energy-related data to support sectoral planning studies, such as electricity generation and transmission planning, gas pipelines, oil pipelines, oil and derivatives production, and biofuels, among others.

Brazilian Electric Energy Agency (ANEEL): ANEEL holds various data related to the electric sector in its different segments: generation, transmission, distribution and commercialisation. Notable data include concessions for generation, transmission and distributed generation. Additionally, ANEEL regulates the CCEE and the ONS regarding data and transparency policies.

The Brazilian Electricity Trading Chamber (CCEE): The CCEE is responsible for providing data related to the wholesale electricity market in Brazil. In this context, it collects, processes and provides transparency on data from the Market Clearing Price, energy auctions, charges and sectoral accounts.

The Brazilian Agency of Petroleum, Natural Gas and Biofuels (ANP): The ANP is responsible for regulating and maintaining databases related to the oil, gas and biofuels sectors. It has databases on the exploration, production and consumption of liquid energy sources.

Petróleo Brasileiro S.A. (Petrobras): Petrobras is a key supplier of data regarding the Brazilian oil and gas sector, particularly related to the exploration, production, refining and transportation of oil and gas.

The National Electric System Operator (ONS): The ONS is responsible for the physical data and operational information of the electric sector. This includes data on generation, transmission and load.

Overview of the Brazilian energy information system

Key entities and main data output

Established in 2004, EPE is central to Brazil's energy data infrastructure and planning. It has the authority to conduct studies and projections of the energy matrix, which inform national energy policy and planning. It disseminates a wide range of information to various users, including: the Brazilian government, national and international energy statistics institutions, energy sector planners, researchers, private companies, and the general public.

EPE is legally responsible for preparing the BEN, which collects and consolidates information from the most relevant sectoral agents. It also produces other reports, such as the Electricity Statistical Yearbook or the annual Energy Efficiency Atlas. The Energy Efficiency Atlas is linked to the third strategic objective – promoting energy efficiency – in the Brazilian government's Multi-Year Plan. Additionally, EPE co-ordinates the SIMPLE/SAM system to collect information on electricity distribution, generation and transmission, including historical and forecast information, serving consumers who rely on the National Interconnected System's basic grid.

The BEN is a crucial tool for monitoring the effects of energy policies in Brazil, providing indicators such as the share of renewables and other sources in the energy and electricity matrix. Disaggregated energy supply and demand data have been available since 1970, covering more than 50 forms of energy and more than 90 activities, following uniform accounting criteria. This information supports the

compilation of the GHG inventory, various studies on financing the expansion of the energy supply and general on energy system planning. In addition, data on energy resources, reserves, energy installations, prices, emissions, economic indicators and population are available.

Complementing EPE's data work, the MME, in partnership with the Latin American Energy Organization and the Development Bank of Latin America, launched the Energy Information System (SIE Brasil) in 2019. This system consolidates historical energy data at global, national and state levels, supported by Normative Ordinance No. 12 (2021). SIE Brasil is overseen by the Department of Information, Studies and Energy Efficiency, which also prepares monthly bulletins and the Brazilian Energy Review. The Department actively participates in the BEN cycle, conducting direct research on fuel consumption in the thermal power plants of the National Interconnected System, essential for calculating emission factors for carbon projects.

Institutional and legal settings

Collaboration among key data stakeholders, including ANP, Petrobras, ANEEL, the ONS and the CCEE, is essential for the development of the BEN. Supply-side data collection is supported by EPE's agreements with distributors and energy-intensive sectors. While communication between institutions often relies on informal co-ordination through the MME, a cross-entity technical committee is being institutionalised, co-ordinated by EPE to work on the construction of the BEN through the evaluation of the country's energy system. A centralised system, the CADE Excel file, details energy data chains, and EPE co-ordinates the annual data agenda, finalising results in May of each year.

There is a legally binding regulatory framework for energy balances. To support energy sector planning, the MME and EPE have been working on a ministerial ordinance to institutionalise the annual update of the BEN statistics. The ordinance aims to ensure that agents holding concessions, permits or authorisations for electricity services and economic activities related to the energy and mining sector provide the necessary and sufficient data and technical information to prepare the BEN. Some regulatory bodies have legislation that regulates production and inventories and monitors sectoral sales by source and by state, which are crucial for the breakdown of energy consumption by economic sector.

However, there is currently no institutional obligation for industries to provide data or reports to all institutions involved in managing energy sector information. While there may be requirements related to environmental or financial obligations under broader regulatory frameworks, there are no mandates for the systematic provision of energy information, such as production, consumption or efficiency data, regardless of the companies' size or operational scale. This absence of obligations reflects a political-regulatory environment where data collection is largely based on voluntary contributions, market mechanisms or specific surveys rather than legal requirements.

Resources

Each agency has a specific funding mechanism. EPE operates based on an annually approved public budget, which is considered typically sufficient to cover costs for staff, consultants and regular development. New policy initiatives may provide additional opportunities; for example, PROCEL allowed for the allocation of a minimum share of utilities' revenues to fund data collection. International funding (e.g. Inter-American Development Bank, GIZ, the World Bank) may also support specific one-off data improvement activities.

Given the involvement of multiple entities in the energy information system, estimating the total number of full-time employees working on energy statistics is challenging. Most relevant entities are public, and hiring processes are generally conducted through competitive public exams that do not necessarily allocate staff exclusively to information management or energy statistics positions. Consequently, professionals from various academic and technical backgrounds contribute to the production and analysis of energy statistics. At EPE, most staff working on energy data are engineers and economists who handle statistics, among other responsibilities.

EPE has implemented a capacity-building programme on data science to better structure and integrate data, resulting in the dissemination of new interactive dashboards. EPE is also set to receive additional employees following the latest public competitive examination, which should strengthen staff capacity. While resources are generally considered adequate for the data tasks, the potential lack of capacity to retain talent due to the country's fiscal situation in the medium and long term is a risk that institutions should consider.

Key data collection methodologies

The collection of energy supply data is generally supported by the obligation of agents to report data to regulators and system operators. Regulatory agencies such as ANP and ANEEL have resolutions and contract terms that require companies to provide data about their activities, either directly or through the ONS, the CCEE and EPE. The ANP collects data on the oil and gas market and provides a dashboard with consolidated information. This enables the collection of data for different fuels (oil, gas, oil products, biodiesel, ethanol, biomethane) on a monthly basis from the different energy producers.

The collection of demand data is based on a mix of legally mandated and voluntary processes. EPE conducts sample online surveys of large autoproducers (e.g. producers of sugar and alcohol, cellulose, metallurgy, oil, gas, agriculture, and ceramics, among others), uses sales information from energy suppliers coupled with assumptions for further allocation across sectors and uses, and interacts with several trade associations for key industrial sectors. Specific surveys from the Brazilian Institute of Geography and Statistics are used in the BEN cycles (e.g. agricultural census, continuous national household sample survey), mainly for estimates of fuelwood consumption.

EPE also has strong modelling capabilities, and has developed demand models for end-use data, adapting to the data available across the country. It has models for the residential sector, industry, agriculture, services, transport and electricity demand. An important input for improving the demand models is the Survey of Possession and Habits of Consumption of Electrical Equipment in the Residential Sector, conducted under PROCEL.

Success stories and future goals

Brazil's energy information system continues to evolve, enhancing data dissemination and transparency while improving coverage. Examples of recent advancements include the integration of solar thermal data into the BEN and the modelling of electricity consumption in road transport, separated from the residential and commercial sectors. Broader initiatives to digitalise information and to explore artificial intelligence-based data management tools are underway to improve data accessibility and optimise existing workstreams.

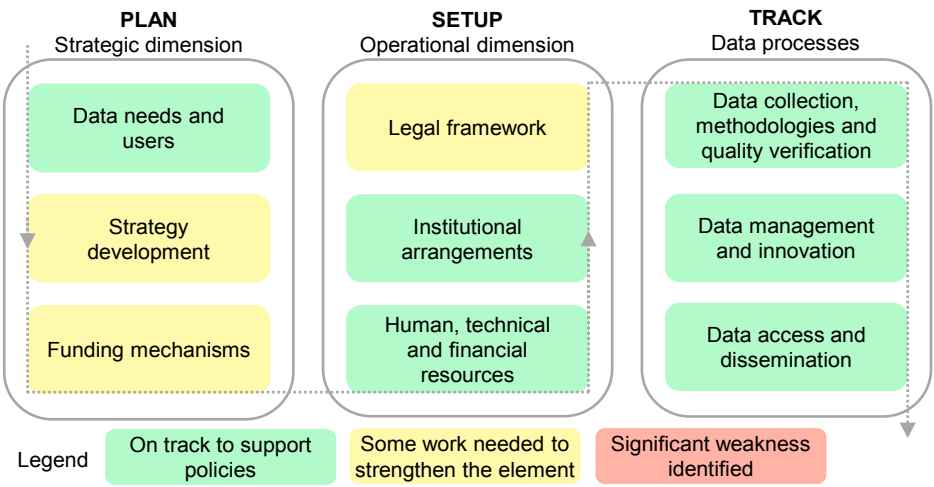
EPE and the Centre for Strategic Studies and Management recently established data collection on energy technology RD&D within the Energy Big Push programme, launching the I-Nova innovation platform. These data have been instrumental in supporting the improvement of policies and governance of science, technology and

innovation activities in the mining and energy sectors. They also provide guidelines to prioritise R&D in strategic areas such as hydrogen, biofuels, energy storage, digital transformation and others.

Strong collaboration with the IEA has enabled Brazil to share comprehensive national energy balances for many years, and more recently standardised fuel statistics questionnaires, energy technology RD&D data, data on end-use prices, and end-use data and efficiency indicators – all part of the broader set of IEA data requirements for member countries. Potential refinements of energy data include developing methodologies for biomass consumption tracking, creating a new useful energy balance, increasing data on appliances, increasing geographical granularity, better monitoring isolated systems, understanding the relationship with the water sector and enhancing interaction with private enterprises. These objectives signal Brazil's commitment to robust energy data development.

The plan to include a monitoring component within PLANTE, incorporating macroeconomic indicators, sectoral indices and analyses of social implications of energy use, reflects Brazil's ambition to effectively integrate data into the policy and planning cycle.

Brazil's self-assessment of the national energy information system



Source: IEA (2024), Designing an Energy Statistics Roadmap.

Recommendations

28. Develop a strategy to guide the evolution of the energy data system in the mid-term (five years).

Over the years Brazil has developed consolidated work on energy data compilation and dissemination, with EPE acting as a main data repository and dissemination platform (e.g. annual energy balance, efficiency atlas, electricity statistics, and energy technology RD&D statistics, among others); some data compilation activities also take place in the MME (e.g. production of the SIE Brasil). Data accessibility is a major asset for the country, as is the integration of data into longer term energy plans (e.g. PDE). Importantly, data address a large array of users: individual citizens, the press, investors and market agents, and decision makers and policy makers.

A mid-term energy data strategy, either internal or public, would be beneficial to the government to focus on long-term objectives and describe the potential trajectory of the energy data system required to keep policy and planning relevance within an evolving landscape. The strategy, which could receive input from user consultations, could describe mechanisms to engage users and address their different needs, identify priorities, and sustain resources. The strategy should include implementation criteria for internal procedures and milestones in terms of data collection, management and dissemination.

Showcasing through a strategic vision the value of investing in data would facilitate data adoption for decision making and even stronger integration with policy, including its effective monitoring. A mid-term strategy would also help relevant data institutions address any potential turnover of individual staff.

29. Further strengthen the institutional set-up for the provision of official energy statistics.

The Brazilian energy data system is centred on EPE's well-consolidated compilation of data from across the energy industry and energy consumers, including those generating electricity. EPE is officially mandated by law to develop the national energy balance. To facilitate the underlying processes of data collection and sharing, the MME is formalising through an ordinance the technical working group formed by the core energy sector entities. The collection of energy supply data is generally

supported by the obligation of agents to report data to regulators and system operators, while the collection of demand data is based on a mix of legally based and voluntary processes.

Given its high policy ambition, most notably the PLANTE plan, Brazil has the opportunity to further enhance its ability to deliver high-quality energy data by: considering options to expand the legal basis of its data collection (e.g. for the industry sector); assessing the value of expanding its official mandate beyond the energy balance; enhancing its dialogue with key data institutions beyond the energy sector (such as the national statistical office); and further integrating statistical approaches into its data processes. A diagnostic of the various energy statistics output would be beneficial to acquire a clear mapping of the multiple underlying data flows and their nature.

Although EPE team members working on data are qualified energy experts who also undergo constant upskilling programmes, sustained data delivery also requires continuing to address potential resource risks. Most notably, budgets for IT infrastructure must be secured in all institutions that sustain databases, given the constant investment required to maintain and adapt technologies over time (e.g. cloud services) and to ensure data security while guaranteeing free and broad access to users.

30. Adapt the development of policy-relevant data to a rapidly evolving energy landscape.

Based on the data compiled from across sources, EPE has continuously developed a variety of indicators beyond the energy balance to help monitor policy progress in the country. Examples of recent data developments include the Inova-e platform for RD&D, linked to the participation of Brazil in Mission Innovation. The plan to integrate a solid tracking component in PLANTE is yet another indication of the country's ambition to maintain and strengthen the data policy link going forward.

Brazil has the opportunity to further enhance the policy relevance of its data by looking at potential development in priority areas that are currently covered in less detail, or emerging in the energy landscape, including those within the broader social dimension.

Opportunities within the energy domain include: quantification of energy demand at a granular level (e,g. up to the useful energy balance) covering, for example, use for appliances and cooling; energy use in data centres; and the development of hydrogen and critical minerals data.

Examples within the broader social dimension of energy include: quantification of the use of fuelwood and charcoal in households to get a clearer picture on clean cooking and energy poverty, isolated systems, jobs, impacts of investment, and gender. In those cases, data work could benefit from partnerships with other institutions, either in the statistical or the research space.

This evolution should be supported by a concrete action plan that tackles the key bottlenecks, with a clear allocation of responsibilities, intermediate milestones and a mechanism tracking implementation.

Annexes

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Abbreviations and acronyms

ANEEL	National Electric Energy Agency
ANP	National Agency for Petroleum, Natural Gas and Biofuels
ARCONORTE	Northern Region Electrical Interconnection System
BEN	Brazilian Energy Balance
BIP	Brazil Climate and Ecological Transformation Investment Platform
BNDES	Brazilian Development Bank
BRL	Brazilian real
CBIO	Decarbonisation Credits
CCEE	Electricity Trading Chamber
CCS	carbon capture and storage
CCUS	carbon capture, utilisation and storage
CDE	Energy Development Account
CMSE	Electricity Sector Monitoring Committee
CNPE	National Energy Policy Council
DRI	direct reduced iron
ENCE	National Label of Energy Conservation
EPE	Brazilian Energy Research Office
ETS	emissions trading system
EUR	euro
EV	electric vehicle
FDI	foreign direct investment
FEM	Free Energy Market
FONTE	Energy Transition Forum
GDP	gross domestic product
GHG	greenhouse gas
HBI	hot briquetted iron
IBAMA	Brazilian Institute of Environment and Renewable Natural Resources
ICS	Institute for Climate and Society
IEA	International Energy Agency
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
MCMV	My House, My Life Programme *Minha Casa Minha Vida*
MEPS	minimum energy performance standards
MME	Ministry of Mines and Energy
NDC	Nationally Determined Contribution
ONS	National Electric System Operator
PBE	Labelling Program
PDE	Ten-Year Energy Expansion Plan

PLD	Settlement Price of Differences
PLANTE	Energy Transition Plan
PNE	30-year National Energy Plan
PNPB	National Program for the Production and Usage of Biodiesel
PNTE	National Energy Transition Policy
PotencializEE	Transformative Investment Program for Industrial Energy Efficiency
PROCEL	National Electricity Conservation Program
PV	photovoltaics
R&D	research and development
RD&D	research, development and demonstration
SAF	sustainable aviation fuel
SBCE	Brazilian Greenhouse Gas Emissions Trading System
SIESUR	South American Electrical Interconnection System
SME	small and medium-sized enterprise
TES	total energy supply
TFEC	total final energy consumption
USD	United States dollar
VRE	variable renewable energy

Units of measurement

boe	barrels oil equivalent
EJ	exajoule
GW	gigawatt
kb/d	thousand barrels per day
kg	kilogramme
kg CO_2-eq/kg H_2	kilogramme carbon dioxide equivalent per kilogramme hydrogen
kW	kilowatt
kWh	kilowatt hour
md/b	million barrels per day
Mt CO_2-eq	million tonnes carbon dioxide equivalent
Mt H_2	million tonnes hydrogen
MW	megawatt
Nm^3	normal cubic metre
PJ	petajoule
t CO_2	tonne of carbon dioxide
TJ	terajoule
TWh	terawatt hour

See the IEA glossary for a further explanation of many of the terms used in this report.

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Energy Policy Review

Government action plays a pivotal role in ensuring secure and sustainable energy transitions. Energy policy is critical not just for the energy sector but also for meeting environmental, economic and social goals. Governments need to respond to their country's specific needs, adapt to regional contexts and help address global challenges. In this context, the International Energy Agency (IEA) conducts Energy Policy Reviews to support governments in developing more impactful energy and climate policies.

This *Energy Policy Review* was prepared in partnership between the Government of Brazil and the IEA. It draws on the IEA's extensive knowledge and the inputs of expert peers from IEA Member countries to assess Brazil's most pressing energy sector challenges and provide recommendations on how to address them, backed by international best practices. The report also highlights areas where Brazil's leadership can serve as an example in promoting secure and clean energy transitions. It also promotes the exchange of best practices among countries to foster learning, build consensus and strengthen political will for a sustainable and affordable energy future.