



W H I T E P A P E R

B I O G A S

USES, ENERGY TRANSITION,
PUBLIC POLICIES AND
CHALLENGES

CESCONBARRIEU



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BIOGAS

USES, ENERGY TRANSITION, PUBLIC POLICIES AND CHALLENGES

Biogas has emerged as an attractive solution to three major issues facing the modern economy: (i) the transition of the world's energy matrix to renewable sources, (ii) solid waste management; and (iii) the removal of greenhouse gases from the atmosphere. Across the world, public and private initiatives are emerging to make use of each country's biogas production potential, adapted to local resource availability. In Brazil, there is also the desire to achieve greater energy self-sufficiency at the lowest possible cost, as well as to generate income and employment opportunities. In the countryside of São Paulo, the potential for producing renewable methane (6.4 million/m³ per day) still locked in the sugar-energy sector has been frequently compared to the pre-salt.

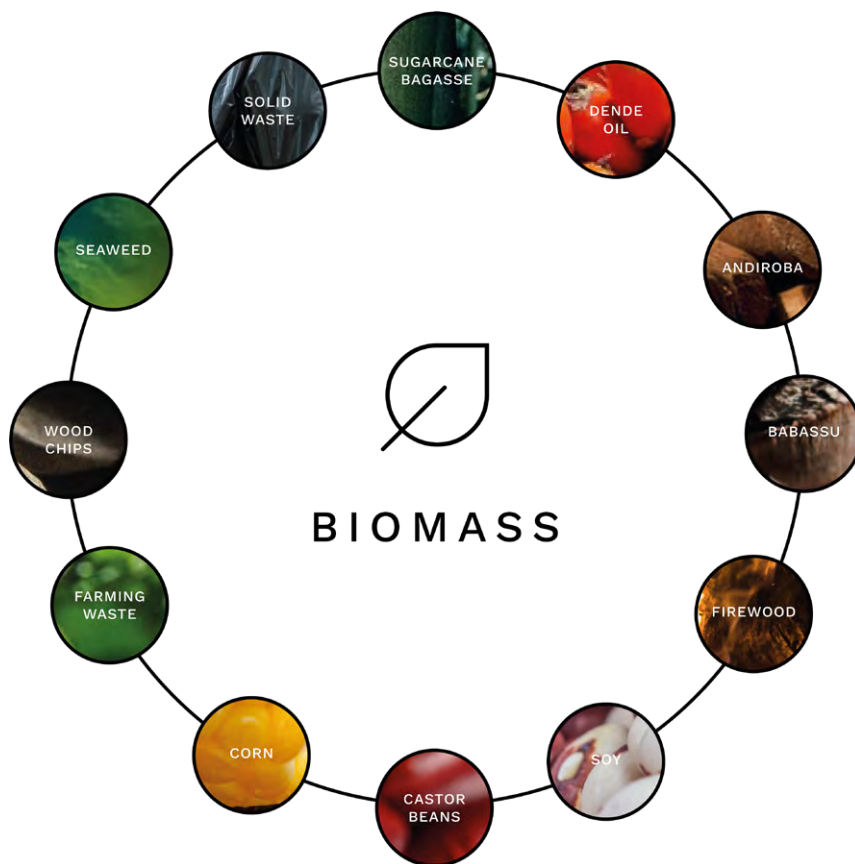
Projections in a study organized by the Brazilian Bioinnovation Association (ABBI) indicate a potential of US\$ 592.6 billion/year that could be added to the Brazilian economy with the full development of bioeconomy by 2050. To this end, actions to coordinate public policies encourage the financing of activities and clearly regulate the carbon market are urgently needed.

In this white paper, we will present the predominant sources and uses of biogas in Brazil, identifying the current scenario and future trends in the Brazilian energy matrix, as well as current national, foreign and multilateral legislative and executive initiatives. We will highlight the undeniable potential for biogas production in Brazil, which is mainly due to the management of landfills and agricultural waste, as well as some projects already under development that confirm the business community's optimism in investing in this sector.

We will analyze some of the current material and regulatory challenges, as well as the current regulation scenario. In this analysis, we will incorporate our suggestions resulting from extensive experience in the Brazilian energy sector and active conversations with key players in the market, to contribute to resolving these dilemmas.

BIOGAS

USES AND SOURCES IN BRAZIL



WHAT IS IT?

Biogas is a gaseous mixture composed primarily of methane, and CO₂, along with small quantities of other gases. It is produced through the anaerobic digestion of various types of Biomasses (organic matter of plant or animal origin) and can be utilized to generate heat, electricity and fuel.

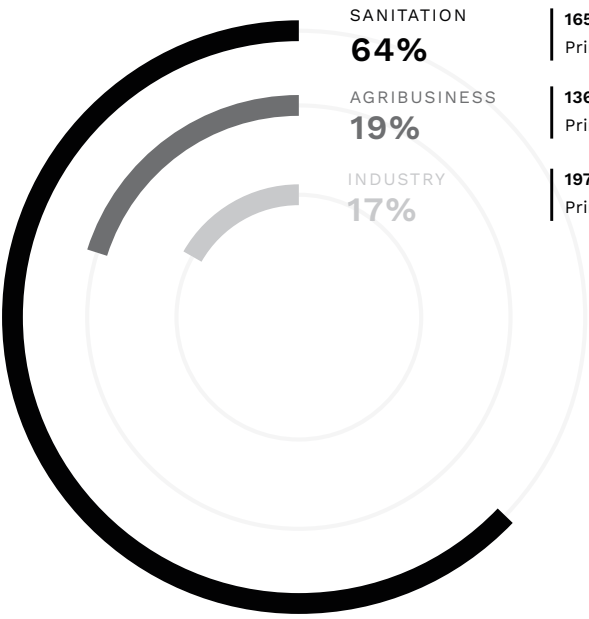
HOW IS BIOGAS PRODUCED?

Biogas is obtained through the **anaerobic digestion** of biomass.

For commercial purposes, this digestion takes place in **biodigesters**. Raw biogas consists of a mixture of gases such as methane, carbon dioxide, water vapor, ammonia, and hydrogen sulfide. Following treatment to remove dust, moisture and sulfur compounds, the biogas can be used to fuel **power plants, boilers** and **cogeneration plants**.

If **additional upgrading** is performed to remove carbon dioxide and other gases, **biomethane** can be obtained for use as a biofuel. This purification is typically achieved through chemical and/or physical absorption, adsorption, cryogenics or membrane technology. The by-product remaining after anaerobic digestion is **digestate**, which can be processed into fertilizer for agricultural applications.

BIOGAS VOLUME PRODUCED IN 2025

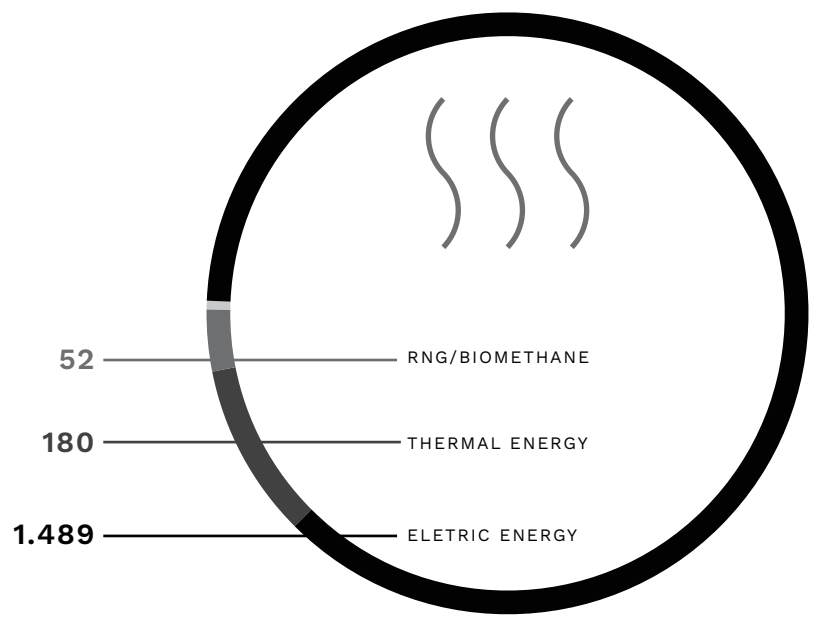


- 165 plants**
Primarily application: electricity generation and RNG/Biomethane
- 1365 plants**
Primarily application: electricity generation
- 197 plants**
Primarily application: electricity generation and RNG/ Biomethane

BIOGAS USE IN BRAZIL OPERATING PLANTS

In 2025, Brazil recorded 1,803 registered biogas plants, of which 1,727 were operational and 76 were under implementation. According to CIBiogás, the installed operational capacity reached 4.96 billion Nm³/year – a 6% increase compared to 2024.

In 2025, most of the operational plants were in Paraná (525), Minas Gerais (387), Santa Catarina (161). The biggest growth in the number of plants was seen in Santa Catarina (+14.3%).



RELEVANT COMMERCIAL ADVANTAGES



CONTINUOUS GENERATION

Biogas power generation is independent of weather conditions (unlike wind or solar power) and is non-intermittent energy source. Any feedstock seasonality can be mitigated by using a diverse mix of substrates.



STORAGE

Possibility of low-cost storage, either as raw material or compressed gas, enhancing supply reliability.



NEGATIVE CARBON FOOTPRINT

Low greenhouse gases emissions and mitigation of pollution from gases that would otherwise be released during waste decomposition, by using them for energy purposes - a clear advantage over fossil fuels.



LOCAL PRODUCTION

Lower vulnerability to external geopolitical factors, enhancing domestic energy security.



PRICE PREDICTABILITY

With exception of certain capital goods, the biomethane value chain is generally pegged to local inflation (IPCA) rather than the US dollar. This structure provides greater price predictability and insulates the biomethane from foreign exchange volatility.



WASTE MANAGEMENT

Sustainable use of solid waste, thus unlocking value from solid waste.

LANDFILL GAS

Ambitiously conceived, the National Solid Waste Policy initially determined the closure of dumps and their replacement by duly licensed sanitary landfills by August 2014. The deadline expired without that goal being achieved, owing to a combination of institutional neglect and insufficient resources to develop viable landfill infrastructure. Only in 2020, the Basic Sanitation Framework (Law 14,026/2020) extended these deadlines, ultimately setting 2 August 2024 as the deadline for municipalities to ensure environmentally sound final disposal of waste.

That deadline also passed without full compliance: surveys indicate that approximately one-third of municipalities continue to dispose of waste in open dumps.

These failures demand urgent, coordinated public-private action to accelerate landfill deployment and broader waste-management upgrades. Beyond the broader socio-environmental harm caused by the inadequate management of solid waste in open dumps, greenhouse gas emissions — principally methane — go uncaptured and uncontrolled. According to SEEG data, total Brazilian GHG emissions were estimated at 1.44 billion metric

tons in 2025, making Brazil the seventh largest greenhouse gas emitter in the world, behind China, the United States, India, the European Union, Russia, and Indonesia.

This volume, which is vented every year and exacerbating climate change, could be harnessed as a source of renewable energy in landfills properly equipped with collection, treatment, and processing systems to produce biogas and biomethane.

Brazil's potential for producing biogas and biomethane from landfills is evident from the disproportionate share of national production attributable to landfill-based plants. According to data from CIBiogás, in 2025 there were 165 biogas plants installed in landfills — processing solid organic waste and sewage sludge — while the gas generated at these facilities accounted for 64% of Brazil's total biogas and biomethane production.

The production of biogas and biomethane at sanitary landfills also represents an alternative source of operating revenue for landfill managers and could make it feasible to set up landfills in areas currently still reliant on open dump. Additional revenue streams from carbon credits further strengthen the economic case for such investments.

☆ SPECIFIC ADVANTAGES

Additional Revenue. Landfill managers can generate supplementary income from the sale of biogas and/or biomethane, as well as green CO₂, to their existing landfill revenues — as outlined below — thereby enhancing the overall commercial attractiveness of landfill operations.

End of landfills. Incentivising the capture of landfill gas can contribute to the closure of open dumps, given that the additional revenue streams described above can attract investors committed to ending this environmentally harmful practice.

🗑️ SPECIFIC CHALLENGES

Less power. Biogas produced in landfills does not rely on biodigesters — the landfill mass itself acts as the reactor from which the gas is captured — and consequently contains lower methane concentration than biogas generated in biodigesters.

Separation at source. A further challenge lies in securing adequate investment in proper separation of solid waste at source. Organic matter, which serves as a key feedstock for biogas production, must be separated from inorganic material, which should be directed to appropriate recycling or waste recovery streams.

Restrictions. A landfill's lifespan typically spans 10 to 15 years. Further, it is a regulated activity, with obligations such as waterproofing, to avoid contamination of water tables by leachate, and a ban on construction in environmental preservation areas.

LANDFILL GAS PROJECTS

In February 2025, BNDES approved a BRL125.7 million credit line for **Ciclus Ambiental** Rio to expand its bioenergy sanitary landfill at the CTR in Seropédica (RJ), increasing disposal capacity from 10,000 to 11,400 tonnes/day; such funding blending BRL88 million from Fundo Clima with R\$37.7 million from the Saneamento line.

In April 2025, a partnership among **Asja, Migratio, CMU Energia and Ecosolo** announced two biogas plants in Paraíba – one in Campina Grande and another in Guarabira – each with installed capacity of 2.5 MW, representing a total investment of BRL40 million.

In January 2025, **Marquise Ambiental** announced R\$150 million investment to build a biomethane plant at the CTTR Amazonas, near Manaus. At full ramp-up, the facility is designed to produce up to 80,000 m³/day of biomethane.

In July 2025, BNDES approved BRL76.4 million for Grupo Solvi's Biometano São Leopoldo S.A. to build a biomethane plant at the São Leopoldo landfill (RS), with planned output of 32,400 m³/day; such resources coming from Fundo Clima and Finem.

In December 2025, BNDES approved BRL450 million for Biometano Verde Paulínia S.A. (BVP) to build a biomethane plant at the Orizon VR Ecopark in Paulínia (SP), with output capacity of up to 225,000 m³/day from landfill-derived biogas. The funding structure combines roughly 80% from the National Fund on Climate Change (Climate Fund) with 20% from the Finem (Financing for ventures)

AGRIBUSINESS POTENTIAL

As the largest producer of sugar and beef, and the second largest producer of ethanol, Brazilian agribusiness has significant potential for producing biogas and biomethane, both from a direct agricultural and an industrial standpoint (for classification purposes, the production of the sugar-energy sector is considered to be industrial rather than agricultural).

Sugarcane bagasse, vinasse, straw, filter cake and animal waste are among the organic feedstocks that can be fed into biodigesters to produce biogas and, after upgrading, biomethane.

The production of biogas and biomethane is also an important strategy for offsetting greenhouse gas emissions from the agricultural sector, principally those arising from crop burning and enteric fermentation in livestock.

Biogas from the sugar-energy sector is produced using vinasse and filter cake (and, in more advanced scenarios, straw and bagasse with adequate pre-treatment). Recent energy-planning estimates by EPE (*Empresa de Pesquisa Energética – Energy Research Company*) indicate that up to 6.4 billion Nm³/year of biogas could be produced from vinasse and filter cake by 2034 — equivalent to 3.5 billion Nm³/year of biomethane — with an additional 5.4 billion Nm³/year potentially available if 20% of straw and tops are sustainably harvested.

According to data from ABiogás, the biomethane production potential of southern Brazil stands out, with an estimated output capacity of 349.5 million Nm³/year. If converted to electricity, this output could satisfy 3.7% of industrial energy demand in the region, or alternatively power more than 450,000 homes.

☆ SPECIFIC ADVANTAGES

Scalability of biodigesters. Biodigesters are available across a wide range of capacities, enabling producers of varying scales to harness their agricultural residues for electricity self-generation.

Regional versatility. Considering the wide variety of agricultural residues that can feed biodigesters, the production of biogas and/or biomethane can be tailored to each region's resources and conditions.

Additional Revenue. By using agricultural residues to produce energy and biomethane, producers can generate supplementary income, since the feedstock is a by-product of their primary activity and therefore carries no additional acquisition cost. In addition, there is the possibility of using environmental attributes from the production of biomethane and the conversion of the internal fleet.

⚠ SPECIFIC CHALLENGES

Off-season. During off-season, when vinasse is unavailable, operational continuity may be compromised. To counteract this, the substrate retained in filter cake storage silos can be deployed to maintain biogas production. Another solution is to use corn vinasse during periods when sugarcane vinasse is not available. In addition to its manhole-covering properties, the use of corn vinasse has the potential to reduce costs since it degrades and decomposes more quickly, thus requiring a shorter hydraulic retention time and a smaller biodigester volume.

AGRIBUSINESS POTENTIAL PROJECTS

JBS utilises methane captured in its industrial operations as a fuel source for electricity generation. The methane, transformed into biogas, powers generators that supply energy to four Friboi factories and has already prevented the emission of 263,700 tCO₂e.

Energisa acquired control of Lurean, a company from Paraná, for R\$62.7 million, and will invest R\$100 million in its second biomethane production plant, with a production capacity of 28,000 m³/day upon completion. The Paraná company processes waste and commercializes organic fertilizer.

In 2025, the first biogas plant in the state of Minas Gerais was inaugurated, following a partnership between ZEG Biogás and Bioenergética Aroeira, a company that produces sugar, ethanol, and other derivatives. With an investment of R\$ 78.6 million, the plant will initially have the capacity to produce 15,000 m³/day of biomethane, with a planned expansion to 30,000 m³/day.

In partnership with the French company Albioma, the **Jalles Machado Group** has invested R\$30 million to install the first biogas production plant in Goiás. The plant already produces sugar, ethanol and electricity from sugarcane.

Adecoagro, a diversified agribusiness company in Latin America listed on the stock exchange, has started to fuel its fleet with biomethane produced from vinasse from the Ivinhema sugarcane mill. The aim is to fuel up to 66 sugarcane trucks.

RDP Energia has announced an investment of R\$50 million for the construction of the first biomethane refinery in Brazil that will use waste from pig farming. The plant will be located in Toledo/PR and is scheduled to start operating in 2026. The Toledo Bioenergy Center will be responsible for collecting the waste and generating biogas from it, with a volume already contracted by RDP Energia of 7.3 million/m³ per year.

The expansion of Geo Biogás & Carbon's **Tamboara** plant, supplied with filter cake, vinasse and straw improved its capacity from 1,500 Nm³/d to 25,000 Nm³/d.

BY-PRODUCTS

BIOFERTILIZERS AND GREEN CO₂

BIOFERTILIZERS

As one of the largest exporters of agricultural commodities, Brazil remains highly dependent on imported fertilizers, sourcing approximately 85% of its domestic consumption in 2025. This external vulnerability was exacerbated by recent global crises, such as the COVID-19 pandemic, the war in Ukraine, and ensuing economic sanctions against major suppliers like Russia.

In response to growing geopolitical and logistical vulnerabilities in the global fertilizer supply chain, the Brazilian federal government has implemented a comprehensive policy framework aimed at promoting domestic fertilizer production and reducing external dependence. The cornerstone of this effort is the National Fertilizer Plan (Plano Nacional de Fertilizantes – PNF 2022-2050), established by Decree No. 10,991/2022 and subsequently amended by Decree No. 11,518/2023, which outlines the strategic goal of reducing Brazil's fertilizer import dependency to 50% by 2050.

To operationalize this strategy, the government has pursued a multi-pronged agenda encompassing regulatory, legislative, and industrial measures. On the legislative front, the proposed PROFERT Bill (PL No. 699/2023) introduces tax incentives aimed at stimulating investment in strategic fertilizer production assets. Furthermore, Law 15.070/2024 establishes the regime for bio-inputs in agriculture and differentiates the treatment of this category from that of traditional inputs.

On the industrial front, Petrobras has launched a comprehensive effort to restore its fertilizer operations. Three nitrogen fertilizer plants — in Paraná, Bahia, and Sergipe — were reactivated, together meeting approximately 20% of the country's total nitrogen fertilizer demand.

In parallel, Petrobras resumed construction of the UFN-III plant in Mato Grosso do Sul, which has remained unfinished since 2014. Once completed, it is expected to supply 15% of national demand, potentially raising Petrobras' total market coverage to 35% of Brazil's needs. These efforts are aligned with the current Administration's broader industrial policy and reflect Petrobras' renewed strategic role in national food and energy security.

Among the most significant private investments is EuroChem's US\$1 billion phosphate fertilizer complex in Serra do Salitre (Minas Gerais), inaugurated in March 2024. Once fully operational, the facility is expected to supply approximately 15% of Brazil's total phosphate fertilizer production, bolstering national self-sufficiency and contributing directly to the objectives of the PNF.

Brazil's dependency on imports remains substantial. According to data from Secex/Conab, fertilizer imports reached a record 45.5 million tonnes in 2025, reflecting the growing demand for agricultural inputs in the country's expanding agribusiness sector.

Within this broader context, biogas emerges as a key complementary solution, offering potential not only for clean energy generation but also for the local production of biofertilizers and the circular use of agricultural waste streams. As such, the development of biogas infrastructure is increasingly seen as a strategic component in Brazil's long-term fertilizer resilience strategy.



BRAZIL - A MAJOR IMPORTER OF FERTILIZERS. WHY?

- ☑ Production and marketing suffer from high domestic taxation.
- ☑ The price of the main raw material, natural gas, is higher than prices abroad.
- ☑ Importing fertilizers from Russia and other countries used to be the cheapest and most reliable supply option - until the Ukraine War.

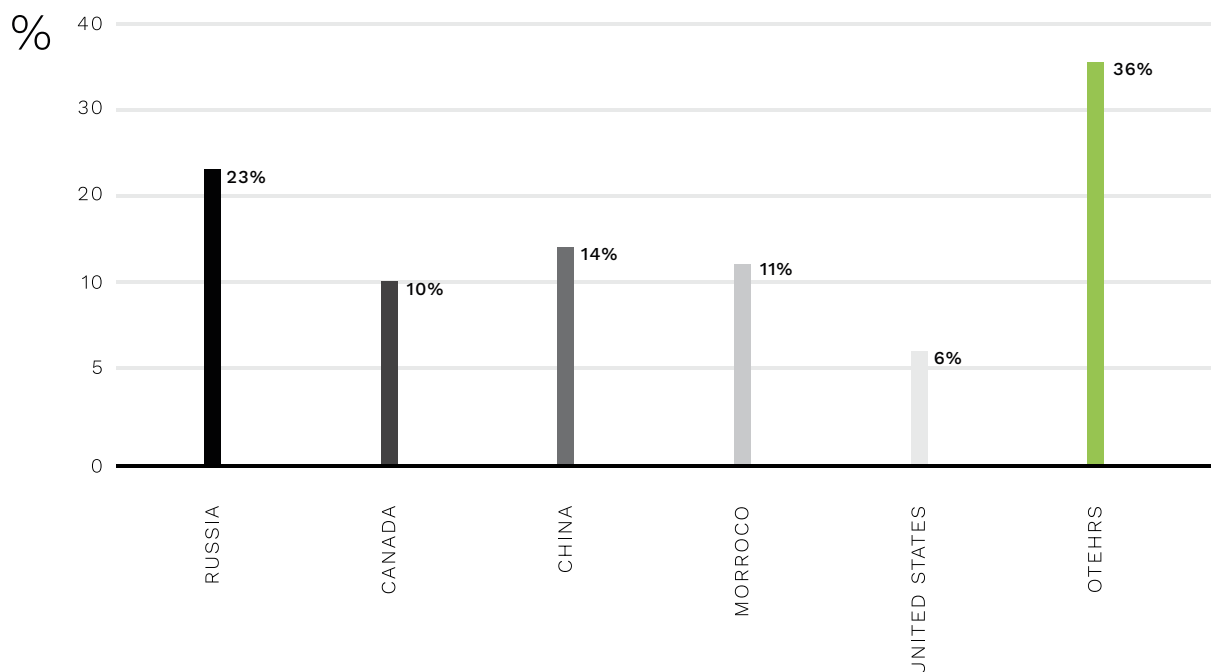


BIOFERTILIZERS ADVANTAGES

- ☑ No unhealthy odors
- ☑ No pathogenic organisms
- ☑ pH between 7.0 and 8.5, helping to correct soil acidity Intelligent management of solid waste after biogas production Internalization
- ☑ Promotion of the circular economy

FROM WHOM BRAZIL BUYS FERTILIZERS

(2025)



FROM BIOGAS TO BIOFERTILIZERS

Anaerobic biodigestion of biomass acts on soluble or solid but suspended waste. Larger volumes of solid waste tend to accumulate at the bottom of biodigesters, reducing their capacity. This is digestate, whose fertilizing potential could revolutionize the national industry and mitigate dependence on chemical fertilizer imports.

After being removed to the biodigester's discharge box, the digestate already has a high concentration of nutrients and can be transformed into liquid biofertilizer, or dried and granulated for use in solid form.

GREEN CO₂

From the purification of biogas into biomethane, green carbon dioxide (Green CO₂) is extracted. This by-product can be further treated to achieve a concentration of 99% and food-grade quality.

After this process, Green CO₂ is liquefied and stored for sale, especially for the gasification of liquids and the freezing of food in the food industry, the heat treatment of welds in the metallurgical industry and the treatment of effluents in the sanitation industry.

Coming from a renewable source, GHG emissions are avoided.

MARKET



In Seropédica (RJ), Gás Verde is operating Brazil's first Green CO₂ plant, supported by R\$ 40.9 million in BNDES financing, including R\$ 17.1 million from the Climate Fund. The adjacent biomethane facility already processes around 130,000 Nm³ of landfill biogas per day, with CO₂ accounting for approximately 39.2% of this volume. The new unit captures and purifies up to 100 tons of CO₂ per day for commercial use – such as in the food and beverage industries – while also preventing its atmospheric release, contributing to GHG emission reduction.

In Igarassu (PE), a new biomethane plant is under construction, supported by R\$ 90.2 million in BNDES financing, including R\$ 72.2 million from the Climate Fund. It is expected to produce 45,600 Nm³ of biomethane per day from landfill biogas, while also capturing and treating the separated CO₂. The project contributes to climate goals by simultaneously avoiding methane emissions and ensuring CO₂ is not released untreated into the atmosphere.

INTERNATIONAL OVERVIEW

Concerns about climate change and energy dependence linked to geopolitical risk factors have sparked a veritable biogas race, with each country seeking to generate biogas from the biomass inputs available in the local economy.

For example, countries such as the Czech Republic, France, Germany and Italy make use of agricultural waste to generate biogas, while Sweden, Finland and Norway make more use of metropolitan and industrial sewage.

According to the World Biogas Association, biogas production has the potential to cut 10% to 13% of current greenhouse gas emissions by combining the generation of biogas through the use of landfills and sewage with the elimination of gases that would be emitted by solid waste, fossil fuel-based fertilizers, crop burning and deforestation. Among other recommendations, the association names anaerobic digestion (i.e. the process by which biogas is obtained) as the preferred method of treating all biodegradable waste.

MULTILATERAL AND BILATERAL INITIATIVES



A global trade association focused on biogas that bring together national associations, operators in the sector, developers, equipment suppliers, entities from the solid waste and agriculture sectors, as well as academics. Committed to the #pathwaysto2030 agenda, which aims to prevent global temperatures from rising above 1.5°C, it promotes events, publications and discussions focused on developing the sector on a global scale. There is a partnership between WBA and the Brazilian State Government of São Paulo. The aim of the agreement is to develop and implement biogas policies and promote knowledge exchange.



The European Biogas Association represents approximately 8,000 entities covering the entire biogas and biomethane chain. With a mission to advocate for the recognition of the commercial viability of biomethane, its work focuses on promoting the large-scale use of renewable gases and organic fertilizers throughout Europe. Its R&D projects include the Titan Project (2022 - 2026) to develop competitive hydrogen production from the direct conversion of biogas into hydrogen and the FertiCovery (2025-2028) to advise policymakers and stakeholders on alternative fertilising products, promoting soil health at regional and local scale.



International public-private initiative targeting efficient short-term use of methane as an energy source in the biogas sector, coal mines and oil and gas systems, collaborating with international organizations such as the United Nations Economic Commission for Europe, the Climate and Clean Air Coalition, the Global Methane Hub and the World Bank to reduce global methane emissions. It provides various resources and tools, such as the Anaerobic Digestion Screening Tool developed by the US Environmental Protection Agency together with GMI, which is used to assess the feasibility of biogas production projects.



Launched in 2022 as part of the REPowerEU Plan, the Biomethane Industrial Partnership (BIP) is a public-private partnership to help achieve the goal of annual biomethane production of 35 billion m³/year by 2030, with the aim of reducing Russia's dependence on natural gas, contributing to a cleaner energy system and diversifying farmers' income.

Launched in 2022, the Biomethane Action Plan proposes measures that should be implemented to support the production of biogas, with a view to refining it into biomethane, and the direct production of biomethane from solid waste. It highlights the guideline that sustainable biomethane production should be based on solid waste rather than human or animal food products, in order to avoid land use problems.



With the aim of boosting the biogas and biomethane industry in southern Brazil, UNIDO has **entered into a partnership** with the International Center for Renewable Energy — Biogas and SEBRAE Paraná. The partnership focuses on discussions regarding public policies and the development of business models.

INTERNATIONAL INITIATIVES



China relaunched its carbon credit program, introducing new eligibility rules for projects, such as: (i) developing broad and accurate accounting of emissions reductions; (ii) estimates of emissions reductions must be conservative; (iii) transparency in the disclosure of project information; and (iv) not being dually registered in another emissions trading system. Among the projects that could fall under the new guidelines are carbon capture, utilization and storage, methane mitigation and waste treatment. The new Plan, launched in 2025, aims to expand the scope of the Chinese carbon market to new industrial sectors.



The German biogas sector is governed by regulations applicable to both the agricultural sector (predominantly production) and the energy sector (use of biogas). The central legislation is the Renewable Energy Act, which is supported by several other regulations, such as the Organic Waste Regulation, the Fertilizer Act, the Circular Economy Act, the Sustainable Biofuels Regulation, among others.



Launched in November 2022, the Ministry of New and Renewable Energy's Biogas Program aims to create new biogas plants to produce fuels and electricity and to reduce the use of fertilizers. The program will be implemented by Indian state development agencies and provides financial incentives for the implementation of biogas plant construction projects.



Japan has set a target of reducing greenhouse gas emissions and achieving carbon neutrality by 2050. To this end, the Renewable Energy Act revised in 2022 provides for the Feed-in Premium (FiP) scheme, which allows renewable energy generators to receive a premium when selling at wholesale or through over-the-counter transactions. Concomitantly, and demonstrating concern about the possible environmental impacts of renewable sources, the Environmental Impact Assessment Act requires assessments of possible impacts arising from the implementation of renewable energy projects (in the case of biomass, above 112.5 MW), which can affect the project's implementation period.



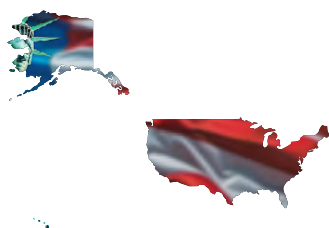
Currently, the main piece of Nigerian legislation on renewable energy is the Electricity Act 2023 - the definition of renewable energy includes those generated by the degradation of biomass. This act obliges the Nigerian Electricity Regulatory Commission (NERC) to simplify project licensing to increase the share of such energy in the Nigerian matrix. Recently the government has initiated the development of its National Hydrogen Policy, in order to create a robust regulation of the sustainable energy market.



Developed in accordance with the Paris Treaty, the National Integrated Energy and Climate Plan 2023-2030 proposes measure 1.12, which aims to promote renewable gases by approving specific plans for the integration of these gases, the use of biomethane in transport and the promotion of advanced biofuels. Measure 1.15 deals with the reduction of greenhouse gases by recovering energy through the management of solid agricultural waste and garbage.



In the UK, it is agroforestry and food waste that are emerging as inputs for biogas production. The Green Gas Support Scheme provides incentives for the construction of new biomethane plants — interested parties must apply for registration by March 31, 2028, as extended by the government at the end of 2023. Payments will be made quarterly for a period of 15 years and calculated according to the amount of biomethane a participant injects into the system. To provide resources for this initiative, the British government has established the Green Gas Levy, which obliges gas suppliers to pay quarterly levies.



In 2022, the Biden administration passed the Inflation Reduction Act, which provides, among other things, tax credits for companies that build biodigesters. Added to this is the growing concern about organic waste management - Maryland, Massachusetts and Vermont have passed measures obliging certain large waste generators to deliver such waste to anaerobic digestion or composting facilities.

In 2025, the Trump administration revoked or suspended key sustainability measures, including provisions under the Inflation Reduction Act of 2022 relating to clean energy and infrastructure. It also withdrew the United States from the Paris Agreement. Moreover, a "national energy emergency" was declared with the stated aim of accelerating authorizations for fossil fuel energy generation.

Agreement. Moreover, a "nation energy emergency" was declared intending to accelerate authorizations to the fossil energy generation.

AUTHORIZATIONS MAPPING

GAS MARKET REGULATORY FRAMEWORK

LAW 14,134/ 2021 AND DECREE 10,712/ 2021 (MODIFIED BY DECREE 12 ,1 53/ 2024)

Provides for and regulates activities related to transportation, flow, treatment, processing, underground storage, packaging, liquefaction, regasification and marketing of natural gas and establishes equivalent regulatory treatment of biogas with Natural Gas, provided that the specifications established by the ANP are met.

INCENTIVE PROGRAMS, DESCARBONIZATION AND CERTIFICATION

“FUEL OF THE FUTURE” LAW

LAW NO. 14,993/2024

Establishes the National Decarbonization Program for Natural Gas Producers and Importers and the Incentive to Biomethane.

KEY MEASURES

- Annual GHG emissions reduction target applicable upon the commercialization, self-production and self-importation of natural gas.
- **0.5%** reduction of emissions in 2026, with the potential to progressively increase such percentage to **10%** in subsequent years.
- Satisfaction of targets must be made through use of biomethane in the consumption of natural gas.
- Alternatively, targets may be satisfied by acquisition of **Biomethane Guarantee of Origin Certificates (CJOB)**.

BIOMETHANE GUARANTEE OF ORIGIN (CJOB).

DECREE NO. 12,614/2025 (REGULATES LAW NO. 14,993/2024)

Regulates the national program created by the Fuel of the Future Law and establishes the Biomethane Guarantee of Origin Certificate (CJOB).

KEY MEASURES

- Annual target-setting: the CNPE must set the annual compulsory target. In 2026, a new measure was introduced establishing a 0.5% reduction target.
- Individualization of targets: each regulated agent's target is calculated based on parameter such as the CNPE target and the agent's relative participation, among other factors.

- Compliance mechanisms: Regulated agents may meet their targets by directly consuming biomethane or purchasing and retiring (i.e., cancelling) CGOBs, which are valid for up to 18 months.
- Issuance of CGOBs: CGOB issuance will depend on certification by an accredited agent, who must verify: (i) the origin of the feedstock and (ii) the efficiency level of the production facility.
- Penalties: Failure to meet the targets may result in penalties ranging from BRL 100,000 to BRL 50 million, in addition to other sanctions provided by law, as suspension of the facilities' operations.

FEDERAL STRATEGY TO ENCOURAGE THE SUSTAINABLE USE OF BIOGAS AND BIOMETHANE

DECREE Nº 11,003/ 2022

Outlines the federal strategy to encourage the sustainable use of biogas and biomethane, identifying the priority waste sources for biomethane production in Brazil: **(i)** Municipal solid waste (landfills); **(ii)** Sewage treatment plants (sanitation); **(iii)** Sugar-energy chain residue (vinasse, filter cake); **(iv)** Livestock waste (swine and poultry farming, etc.).

METHANE ZERO PROGRAM

MMA ORDINANCE NO. 71/2022

Focuses on reducing methane emissions by incentivizing biodigesters, gas purification systems, and biomethane production/compression.

It promotes "green corridors" (fueling stations for heavy vehicles powered by biomethane) and provides tax exemptions for related production and logistics infrastructure.

RENOVABIO

LAW NO. 13,576/2017

Allows certified biofuels producers to issue Decarbonization Credits (CBIOs) based on their lifecycle carbon footprint. Fossil fuel distributors must purchase these credits to meet their mandatory individual decarbonization targets.

INTEGRATED PRODUCTION: BIOINPUTS AND CO-PRODUCTS

REGULATION OF BIOINPUTS

LAW NO. 15,070/2025

Regulates the research, production, registration, and incentives for bioinputs derived from biological processes, which includes the technologies and systems connected to the biodigestion ecosystem.

RULES ON BIOFERTILIZERS

MAPA NORMATIVE INSTRUCTION (IN) NO. 61/2020

Sets requirements, registration procedures, and quality standards for digestate (the organic residue left after biomethane extraction) to be legally commercialized and used as an agricultural biofertilizer.

ANP RESOLUTIONS

PRODUCTION

ANP RESOLUTION N° 987/2025

REGULATION OF THE BIOFUELS PRODUCTION

Regulates the authorization for carrying out biofuel production activities and the operating authorization for biofuel production facilities.

SPECIFICATION

ANP RESOLUTION N° 886/2022

SPECIFICATION OF BIOMETHANE FROM LANDFILLS

ANP RESOLUTION N° 906/2022

SPECIFICATION OF BIOMETHANE FROM AGRICULTURAL ORIGIN

COMMERCIALIZATION

ANP RESOLUTION N° 52/2011

REGULATION OF COMMERCIALIZATION OF BIOMETHANE

CGOB

ANP RESOLUTION N° 996/ 2026

REGULATES THE OPERATIONAL PROCEDURES AND TECHNICAL REQUIREMENTS DUE TO ISSUANCE OF CGOB

Establishes the operational procedures and technical requirements for the issuance of CGOBs, the generation of volume backing, and the accreditation of Certifying Agents.

STORAGE AND TRANSPORTATION

ANP RESOLUTION Nº 971/2024

REGULATION OF LNG STORAGE AND TRANSPORTATION ACTIVITIES

Regulates bulk liquefied natural gas (LNG) and biomethane storage and transportation activities through modes other than pipelines.

ANP RESOLUTION Nº 973/2024

REGULATION OF THE GNC STORAGE AND TRANSPORTATION ACTIVITIES

Regulates bulk compressed natural gas (GNC) and biomethane storage and transportation activities through modes other than pipelines.

SHIPMENT

ANP RESOLUTION Nº 51/2013

REGULATION OF THE NATURAL GAS SHIPMENT

Defines the terms and procedures for shipper authorization.

BIOMETHANE GUARANTEE OF ORIGIN CERTIFICATES (CJOB):

- **Nature and Transferability:** The CJOB is a book-entry security that may be freely traded until its definitive retirement (withdrawal from circulation). Each certificate can be used only once to demonstrate compliance with a regulated agent's mandatory annual individual target.
- **Fungibility:** ANP concluded that fungibility among certificates is not automatic. The "fungibility through validation" model is applied — without automatic recognition of equivalence, as already provided for in current regulations — prioritizing a cautious approach based on case-by-case analysis. Each case will be evaluated based on criteria such as methodological equivalence, environmental integrity, traceability, and system governance.

BANKABILITY ROADMAP

Bankability refers to a project's ability to manage uncertainty, meet the risk tolerance of external financiers, and demonstrate solid performance. To be considered bankable, a project must have a robust contractual foundation that aligns with stakeholder expectations and should be assessed holistically, with a focus on identifying, managing, and appropriately allocating risks.

This risk structure can generally be organized into key areas that are essential for the success of any project finance initiative.

SOLID FINANCIAL MODEL

A sound financial model incorporates three fundamental aspects: (i) financial viability, (ii) solvency, and (iii) return.

To achieve this, the model must be based on realistic assumptions regarding pricing strategies, interest rates, economic indicators, tax planning, and scenario analysis.

EFFICIENT RISK ALLOCATION

Risks should be allocated to the party best equipped to manage them, considering expertise, internal systems, and available resources. Efficient risk allocation is fundamental to demonstrating credibility during financial analysis.

LEGAL AND REGULATORY ASPECTS

The analysis must also consider the applicable regulatory framework, ensuring that contractual structuring aligns not only with international best practices but also with local legal and governmental requirements.

The legal aspects of a project also encompass environmental and labor considerations. Investors are typically hesitant to accept projects that pose significant environmental or labor risks, considering that, in Brazil, legal remedies may entail substantial awards in damages.

GOVERNANCE

Another central dimension of bankability is governance. Investors must have access to relevant information to verify their rights and assess whether the project aligns with their risk appetite.

Projects are considered bankable when all key risks (financial, allocative, regulatory, compliance, and operational) are identified and demonstrably manageable. In this sense, bankability represents a dynamic equilibrium between project structure and financiers' expectations. Achieving this goal will allow for access to competitive financing, enhance long-term project viability, and support the broader goal of infrastructure development.

In Brazil, national development banks have historically played a central role in financing biogas projects, largely due to their positive environmental impacts and contribution to the country's energy transition. These institutions remain among the most important sources of long-term financing for projects involving renewable energy and decarbonization.

Moreover, biogas projects may benefit from a wide range of financial instruments designed to support sustainable investments. Green bonds, incentivized debentures, and other sustainable finance instruments have become increasingly relevant, particularly for projects that demonstrate that they contribute to greenhouse gas emissions reductions, carbon avoidance, and the expansion of renewable energy sources.

At the same time, private investments have experienced substantial growth. Investment funds, infrastructure funds, private equity firms, and strategic investors have increasingly identified biogas as an attractive asset class, driven by the sector's long-term growth prospects, predictable revenue streams, and strong environmental, social, and governance (ESG) credentials.

As discussed throughout this chapter, the biogas industry offers multiple financing alternatives and diversified revenue sources, including the commercialization of biomethane, environmental certificates, carbon credits, and waste management services. When supported by appropriate contractual arrangements, a reliable feedstock supply, and a robust regulatory framework, these characteristics significantly enhance the bankability of biogas projects, making them increasingly attractive to both lenders and equity investors.

FINANCING RESOURCES



CBIOS – DECARBONIZATION CREDITS

- Instrument registered in book-entry form, whose purpose is to prove the individual target of the fuel distributor.
- CBIOS are traded by biofuel producers on B3.
- Compulsory and individualized targets are applied to each fuel distributor, proportional to their respective market share in the sale of fossil fuels in the previous year. These targets are made public.
- Proof that the target has been met is provided by checking the amount of CBIOS on your property.
- Up to 15% of the target can be verified in the following year, but only if full compliance with the target in the previous year has been proved.
- Criteria for reducing the target, based on the purchase of biofuels. The trading of decarbonization credits must take place in an environment that guarantees the anonymity of the parties, except in direct negotiations by financial institutions with primary issuers and buyers, in the contracting or future sale of credits, excluding trading on the spot market with identification of the parties, and in the contracting of over-the-counter derivative transactions that have the credits as their underlying asset.
- In 2026, distributors will have to acquire 48.09 million CBIOS.

RELEVANT DATA

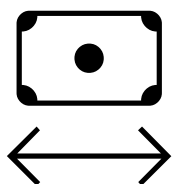


147 million tons of CO₂ were avoided until 2025.

R\$ 18.25 billion in CBIOs were marketed



Average price of each CBIO in the first bimester of 2026 = R\$ 31.40



INCENTIVIZED SECURITIES

- They include Infrastructure Debentures and Incentivized Debentures, and the same project can be issued with both if the limits on the amounts raised set out in Decree 11,964/2024 are respected.
- All the funds raised must be earmarked for the implementation of investment projects in infrastructure or intensive economic production in research, development, and innovation considered to be a priority in the manner regulated by the Executive Branch.
- Infrastructure Debentures: Tax benefits for the issuer of the debentures, which may, when calculating net profit, deduct the amount of interest paid or incurred; and exclude, when determining real profit and the CSLL calculation base, the amount corresponding to 30% of the sum of interest paid for that year.
- Incentivized Debentures: Investors enjoy an exemption from income tax in the case of individuals, or a reduction to 15% in the case of legal entities.
- Framework and monitoring of projects regulated by Decree 11,964/2024, including (i) acquisition of buses powered by biofuels and biogas for urban or urban public transportation systems; (ii) production of biofuels and biogas, except for the agricultural phase; and (iii) pipelines for transporting biofuels.

PROJECTS

WTE Biogás Franca SPE issued incentivized debentures to finance the implementation of a facility dedicated to the production of biogas from organic waste and effluents, as well as the production of biomethane.

Regera Grid Holding S.A. issued incentivized debentures to finance the expansion of the Regera Ouro Verde plant, which generates electricity from biogas and also produces biomethane.

Barueri Energia Renovável S.A. also issued incentivized debentures to finance a waste-to-energy project aimed at generating electricity from solid waste.

PUBLIC FINANCING SOURCES

BNDES:

- Climate Fund – Energy Transition. Minimum financing amount of R\$ 20 million, and maximum of R\$ 500 million.
- Finem – Infrastructure for processing, compression: Minimum financing amount of R\$ 40 million; or R\$ 20 million for direct public administration.
- Finem – Infrastructure for flow and transportation by pipelines, liquefaction, and regasification terminals: Minimum financing amount of R\$ 40 million; or R\$ 20 million for direct public administration.

FCO (Managed by Banco do Brasil): Max. of R\$ 20 million.

FNE (Managed by Banco do Nordeste): Max. of 50% of the project's total amount.

FNO (Managed by Banco da Amazônia): Infrastructure Investments were estimated at R\$ 3.4 million in 2026.

BANDES – FUNSES: financing of activities and sectors that promote decarbonization within the State of Espírito Santo.

COMMERCIAL AND REGULATORY CHALLENGES



HIGH COST OF ENTRY

The cost of capital and infrastructure is comparatively higher than for other renewable energy technologies that have already been consolidated (e.g. wind and solar), reducing the competitiveness of projects. The characteristic decentralization of biogas and, consequently, the small scale of the projects also raise barriers to entry into the sector.



UNRECOGNIZED ATTRIBUTES

The electricity market does not yet consider the environmental benefits and storage capacity of biogas, leading to a scenario of competitive inequality with other clean energy sources.



MANPOWER

Shortage of qualified manpower, and difficulty in providing standardized training, given that the subject still lacks the systematization of sufficient information and knowledge to form a common base of best practices that will enable the qualification of professionals in all the regions where the projects are located.



NETWORK CONNECTION

This topic will be dealt with specifically below.



GUARANTEES

Difficulty in setting up contractual instruments with sufficient term and scale so that they can be used as guarantees for the purposes of raising finance, especially for smaller projects.



RED-TAPE

Actors in the biogas sector are subject to the extensive regulation of several other sectors, such as electricity, sanitation, environment, solid waste, natural gas, and agriculture.

CHALLENGES

INFRASTRUCTURE CONNECTION

Despite being interchangeable with natural gas, the distribution of biogas/biomethane to end consumers faces logistical challenges similar to those of natural gas. Distribution infrastructure remains limited and is often absent in regions where biogas production potential has been identified, thereby increasing project costs.

Nonetheless, given the strategic importance of harnessing the full potential of biogas/biomethane production, market players are announcing initiatives to address this challenge, including:

☒ Insert biogas/biomethane **directly into the distribution network:**

- Since 2018, the Cegás distribution network has received biomethane produced by **GNR Fortaleza**, a partnership between **Ecometano** and **Marquise Ambiental**, from the Oeste Caucaia Municipal Landfill. The daily supply of biomethane resulting from this agreement represents 20% of the volume distributed by Cegás.
- **Orizon** and **Copergás** (the gas distributor in Pernambuco) signed a biomethane supply contract, with contracted volumes increased to 130,000 m³/day by the end of 2023. Supply commenced in March 2026.
- Compagas recently announced an initiative aimed at blending up to 15% biomethane into its distribution networks by the end of 2026, representing a volume equivalent to approximately 100,000 m³/day.
- In 2026, the interconnection of Solví Essencis Ambiental's biomethane plant, located in the state of São Paulo, to Comgás' natural gas distribution network was approved.

- EcoGeo, a joint venture between Ecopar and GeoGreen BioGás, invested R\$ 140 million to build Goiás's first commercial-scale biomethane plant in Guapó. To transport the gas to the public transit system, a new pipeline is being built through a partnership with GoiásGás, GeoGreen BioGás, and the BRT Consortium.

☒ Insert in the **gas transportation network:**

- **Transportadora Brasileira Gasoduto Bolívia-Brasil (TBG)** announced its intention to incorporate biomethane into its operations, leveraging its gas pipelines running through the Center-South region, including major producing states such as São Paulo and Paraná.
- **Gás Verde** and **Nova Transportadora do Sudeste (NTS)** have signed a partnership agreement to inject biomethane into NTS's transportation pipeline network, with supply commenced since 2024.

☒ Creation of **receptive hubs:**

- Approach chosen by **TBG** to overcome the challenge of geographically dispersed biomethane production sources.
- At a public hearing before the Mines and Energy Commission, ATGÁS — the Association of Natural Gas Transportation Companies by Pipeline — defended, among other proposals, the creation of receiving hubs as a means of achieving scale and accommodating various delivery modes, including pipelines, LNG, and CNG.

GROWTH PROPOSALS



AGENDA

Development of a focused agenda, specialized in biogas and biomethane, with the creation of specific committees to discuss the necessary legislative and regulatory changes that take standardization into account.



SOLID WASTE

Clearly define the responsibility of solid waste generators and determine mechanisms that encourage the intelligent management of such waste.



ENVIRONMENTAL STANDARD

Verify and define environmental licensing standards that are nationwide, seeking to harmonize interaction and encourage standardization at the municipal, state, and federal levels.



SOCIAL

Encouraging the installation of “biodigesters in the hinterland”, with a view to micro-scale production and energy independence for small agricultural producers / family farmers.



TRAINING

Encouraging and subsidizing initiatives to train qualified workers, with the government making these initiatives widely known.



FINANCING INSTRUMENTS

Bringing together players in the sector to create standards for contracts / project documents, thus facilitating the interface with financial agents.



FISCAL

Granting tax benefits or equal treatment in the biogas production chain vis-à-vis the production chain of other renewable energies.



NATIONAL SUPPLY

National and international cooperation aimed at improving the supply chain for equipment and supplies on national territory.

FINAL THOUGHTS

Biogas and biomethane are key to building a cleaner and more resilient energy matrix. Added to this is the need to encourage more investment in basic sanitation and intelligent solid waste management.

For an emerging economy like Brazil's, which requires job and income generation combined with a sustainable environmental policy, it is urgent that public authorities foster a robust biogas industry. Brazil has undertaken international climate commitments that must be honoured — both for the sake of the environment and to reinforce Brazil's standing on the international stage as an environmental powerhouse.

This is a challenging task that involves several obstacles familiar to the Brazilian business community: the need to optimize regulatory procedures and make the market attractive to investors, which requires transparency, regulatory stability, and legal certainty. Priority must be given to standardizing and specifying various aspects of the sector — from environmental licensing and regulatory authorizations to project contracts — with a view to facilitating access to financing and training sufficient manpower to meet the demand projected for the coming years.

is the difficulty of financing projects involving the agricultural sector, given that geographical dispersion makes any disputes subject to numerous local courts, which are often less sophisticated and not used to business and disputes of this nature. The enforceability of guarantees can be negatively affected in this context.

There is, as has been aptly noted, a pre-salt field in the farms of Brazil's interior with untapped potential for biogas and biomethane production, awaiting the resolution of the regulatory and commercial challenges described above. In addition, open dumps must be rapidly closed and converted into sanitary landfills, so that the gases resulting from the decomposition of solid waste can be captured and used sustainably.

Brazil has the conditions necessary, by virtue of its territorial extension and population size, as well as its well-established agribusiness sector and diversity of biomass inputs, to become a clean, renewable, and sustainable energy powerhouse. All three levels of government must address the challenges set out in this paper and bring together business and civil society in pursuit of this goal.

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