



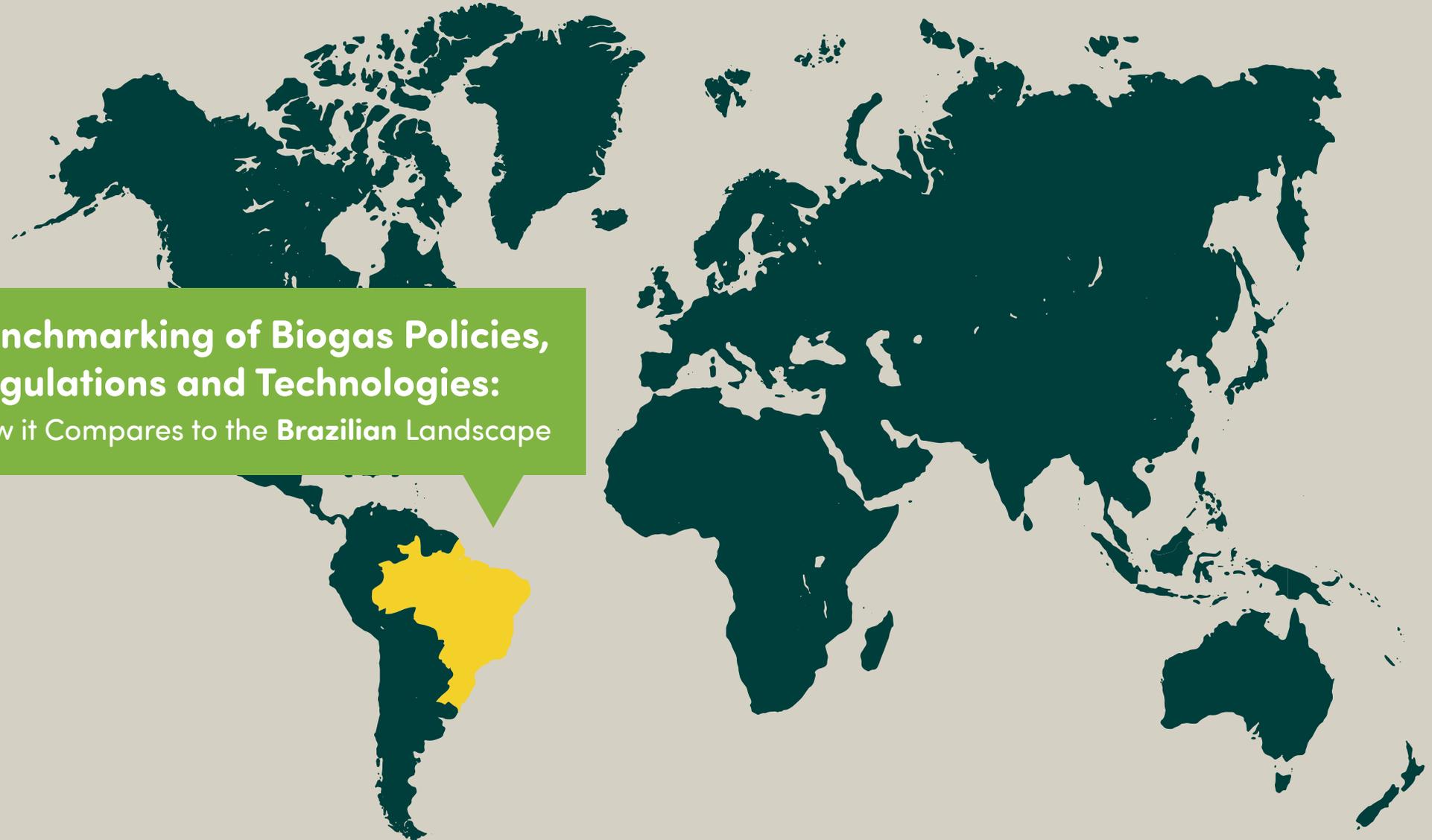
**WORLD BIOGAS  
ASSOCIATION**



**Biogás  
BRASIL**



**Benchmarking of Biogas Policies,  
Regulations and Technologies:  
How it Compares to the Brazilian Landscape**





The WBA is a non-profit association dedicated to the development of biogas globally. We are available to offer services to countries, cities and industries wanting to know more about biogas, its technologies, the policies and incentives needed to ensure biogas is made a core solution to resolving global challenges around sustainable development, climate change and public health.



UNIDO is a specialised United Nations agency with a unique mandate to promote inclusive and sustainable industrial development. It supports developing countries and emerging economies in building and transforming their industries.



The GEF Biogas Brazil Project was an initiative led by the Ministry of Science, Technology and Innovation (MCTI), implemented by the United Nations Industrial Development Organisation (UNIDO) and financed by the Global Environment Facility (GEF) aimed at supporting the development of the biogas and biomethane market in the country, strengthening public policies, technical training and investments, with a focus on emissions mitigation, waste management, energy security and the transition to a low-carbon, sustainable economy at the national level.

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## Abbreviations and Acronyms

<b>AD</b>	Anaerobic Digestion
<b>ADCS</b>	Anaerobic Digestion Certification Scheme
<b>BAT</b>	Best Available Techniques
<b>CAPEX</b>	Capital Expenditure
<b>CBIOS</b>	Decarbonization Certificates
<b>CGOB</b>	Biomethane Guarantee of Origin Certificates
<b>COP</b>	Conference of Parties
<b>GBRF</b>	Global Biogas Regulatory Framework
<b>GHG</b>	Greenhouse Gas
<b>GEF</b>	Global Environment Facility
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>LCA</b>	Life Cycle Assessment
<b>MSW</b>	Municipal Solid Waste
<b>NDC</b>	Nationally Determined Contribution
<b>Nm<sup>3</sup></b>	Normal Cubic Meter
<b>PLANARES</b>	National Solid Waste Plan
<b>OPEX</b>	Operational Expenditure
<b>PNRS</b>	National Solid Waste Policy (Política Nacional de Resíduos Sólidos)
<b>R&amp;D</b>	Research and Development
<b>SDGs</b>	Sustainable Development Goals
<b>tCO<sub>2</sub>e</b>	Tonnes of carbon dioxide equivalent
<b>UNIDO</b>	United Nations Industrial Development Organization

# Executive Summary

Around the world, countries are advancing policies, regulations and technologies to encourage the use of biogas technologies and enhance the economic, social and environmental performance of the sector. Brazil has significant untapped potential due to its vast agricultural base, diversified agro-industrial activities, and growing demand for cleaner energy sources. In recent years, the country has put mechanisms in place to capitalise on this potential and improve performance. This report conducts a benchmarking exercise to position Brazil against the global biogas sector and recommends tangible steps that can be implemented at the national level to foster the growing biogas sector.

The report is divided in two sections: policy and regulatory benchmarking and technical benchmarking. Eleven countries were selected, representing strong aspirational peers for Brazil: seven mature markets, namely Canada, Denmark, France, Germany, Sweden, the United Kingdom and the United States and four emerging markets, India, Mexico, Poland, and Portugal. They offer a balanced geographical distribution and operate under broadly comparable economic, energy system, agricultural, and feedstock conditions, allowing meaningful comparisons. They also provide a robust basis for identifying best practices, gaps, and potential opportunities relevant to the Brazilian context. The policy benchmarking comparison covered the following Global Biogas Regulatory Framework criteria:

1. National strategies
2. Financing and market mechanisms
3. Feedstock policies
4. Digestate policies
5. Gas quality regulations
6. Technical and operational standards
7. Permitting regulations
8. Planning regulations
9. Health, Safety and Environmental Protection

While the technical benchmark comparison covered:

1. Origin of technology
2. Feedstocks
3. Digesters
4. Biogas Application
5. Digestate

The full analysis is detailed in sections 3 and 4. The following 'easy wins' summarise the benchmarking comparison carried out in this report, outlining the targeted actions

that policymakers, industry leaders and financial institutions can take to catalyse biogas deployment, strengthen technological capabilities and promote economic and environmental benefits across the country.

1. **Create a dedicated biogas action plan** involving all relevant stakeholders, encompassing necessary policy and regulatory changes, supply chain and capacity building modelling, and financing needs. [3.1.1]
2. **Develop waste management policies with a mandate for waste segregation at source and stringent feedstock collection mechanisms** to maximise urban organic waste recycling and unlock the country's biogas potential by ensuring a reliable stream of feedstock to AD facilities. [3.1.3] [4.1.2]
3. **Support local innovation, research and development, diversification of biogas applications and national technology suppliers** to develop a strong national technological hub, scale up infrastructures and set special tax regimes for technology imports to maintain the resilience of the industry during this growing stage. [4.1.1] [4.1.3] [4.1.4]
4. **Leverage both large national-scale biogas production and local small-scale rural digesters** to ensure national energy security from green sources and empower rural and agricultural communities. [4.1.3]
5. **Develop a renewable fertiliser framework and quality standards** to encourage the use of digestate in agriculture, improve soil health, reduce emissions from the agricultural sector, and enable biogas facilities to valorise digestate. [3.1.4] [4.1.5]
6. **Skill up and build local capacities for the national biogas industry** with sector-specific training programs, openness to new technologies and innovations and a strong industry network to encourage knowledge gathering and sharing. [4.1.6]
7. **Develop biogas-specific planning and permitting guidance** at the national level grounded in clear technical standards, to accelerate the development of biogas and biomethane plants. Establishing harmonised requirements across states will reduce uncertainty for developers, shorten approval timelines, and support safe, predictable project deployment. [3.1.7]
8. **Create dedicated financing mechanisms for biogas and biomethane projects** – including credit lines, guarantees, concessional loans, and performance-based incentives – to reduce investment risk and mobilise private capital. Tailored financial instruments will help bridge current gaps in bankability, support early-stage projects, and scale biogas as a strategic low-carbon industry. [3.1.2]
9. **Implement national technical and safety standards through a certification scheme**, and develop Best Available Techniques (BAT) and operational guidance to ensure high-quality and safe project delivery. Adopting a certification scheme, such as the ADCS International framework, can drive continuous improvement, increase investor confidence, and elevate the overall performance of the sector. [3.1.6]



## 1. Introduction and Context

Brazil's biogas industry has grown steadily over the past decade, driven by the need to diversify the energy mix and reduce emissions in line with the country's climate commitments, including net-zero emissions by 2050. The sector benefits from abundant feedstocks, particularly residues from livestock, sugarcane, and food processing industries. Despite the enormous potential, effective production still accounts for only 5% of Brazil's ambitions. Barriers, including fragmented regulation, limited access to financing, technological gaps, and insufficient infrastructure, continue to constrain large-scale deployment. Globally, several countries included in this report, including France, Germany, Denmark, Sweden, and the United States, have demonstrated that supportive policies, coordinated institutional frameworks, and targeted incentives can foster the rapid expansion of the biogas sector.

By examining implemented policies, regulations, technologies, and investment environments across selected countries, the report seeks to identify opportunities and easy wins for scaling up biogas production and utilisation in Brazil.

## 2. Rationale for benchmark countries

The countries selected for the international benchmarking exercise represent strong aspirational peers for Brazil. Together, they offer a balanced geographical distribution and operate under broadly comparable economic, energy system, agricultural and feedstock conditions, allowing for meaningful comparison and providing a robust basis for identifying best practices, gaps, and potential opportunities relevant to the Brazilian context.

### Mature markets

Seven mature biogas markets are being used as reference points. These countries were selected due to their advanced stage of market development relative to other countries and their ongoing growth driven by supportive policies, technological advancements, and established standards. They provide aspirational examples of policies and technologies.

1. France
2. Germany
3. UK
4. Denmark
5. Sweden
6. USA
7. Canada

### Emerging markets

Four emerging biogas markets have been selected as reference points. These are comparable markets at similar emerging stages of their biogas sector, where there are direct learnings that can be adapted to Brazil.

1. Poland
2. Mexico
3. Portugal
4. India

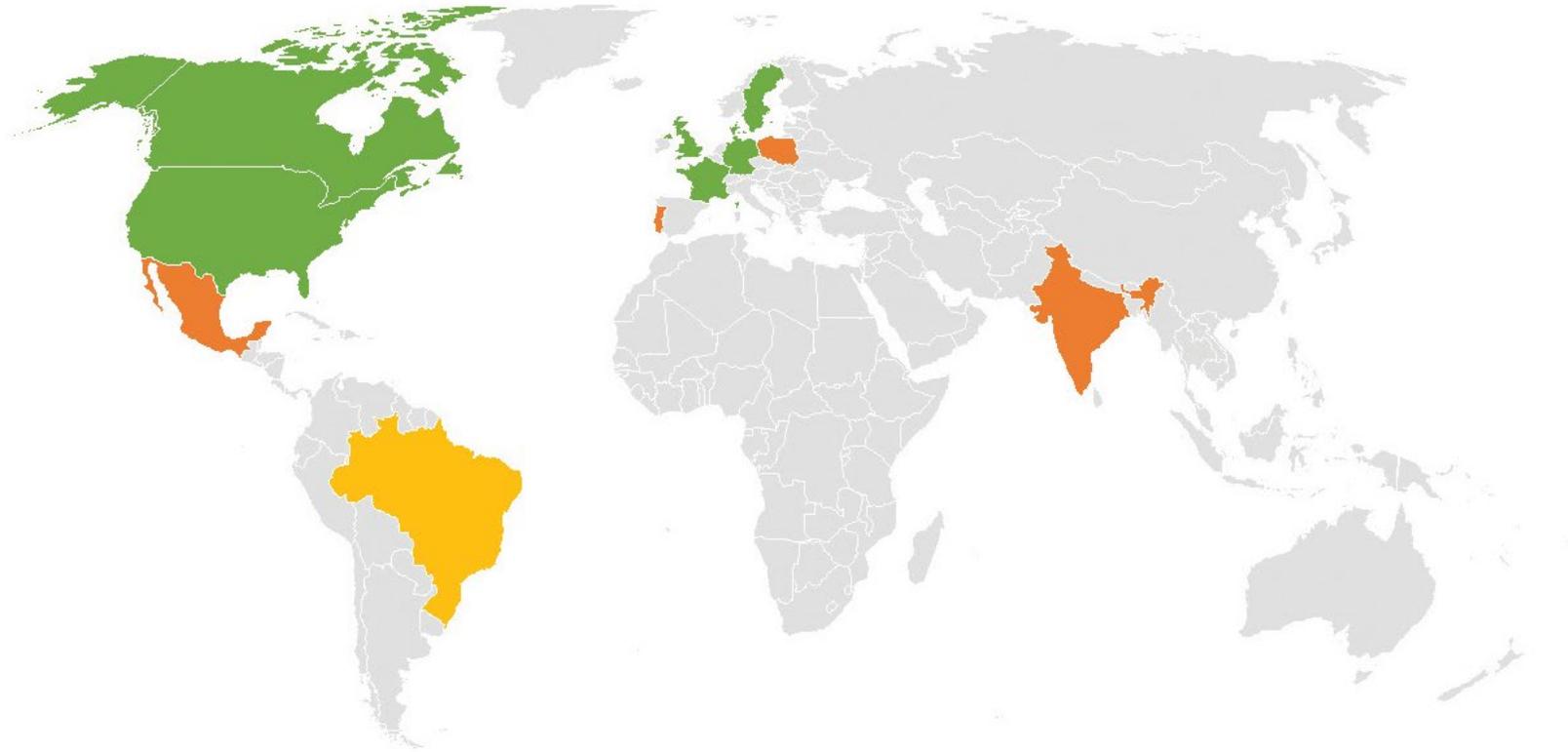


Figure 1: Map of countries covered in the international benchmarking analysis

### 3. Policy and Regulatory Benchmarking

This section of the report provides a comparative analysis of Brazil’s policy and regulatory framework for the biogas sector, benchmarking it against the 11 countries listed above. The key success factors identified in the Global Biogas Regulatory Framework (GBRF), developed by the World Biogas Association, will serve as the criteria for evaluating each section.

#### 3.1 International policy and regulation benchmarking comparison

#### 3.1.1 National strategies

Rapid scale-up of the biogas industry requires that the country’s international agreements and national policies explicitly recognise anaerobic digestion (AD) as a key solution to address climate, energy, and food security challenges. National strategies must support policy and regulatory frameworks, while also promoting international collaboration in this area. Evaluating and understanding what constitutes effective biogas policy is vital to building a robust, resilient biogas sector.

GBRF criteria	Reference Countries	Brazil	Gaps
<p>Governments shall:</p> <ul style="list-style-type: none"> <li>• commit to relevant international targets and agreements.</li> <li>• establish national climate-mitigation targets incorporating biogas.</li> <li>• develop a national roadmap for the biogas sector.</li> <li>• identify priority end-uses of biogas to ensure effective deployment and alignment with national decarbonisation objectives.</li> <li>• establish blending mandates.</li> </ul>	<p><b>Sweden</b>            Signatory of the Paris Agreement (COP21), Global Methane Pledge (COP 26), Global Renewables and Energy Efficiency Pledge (COP28), Declaration on Reducing Methane from Organic Waste (COP29).</p> <p><b>Targets:</b></p> <ul style="list-style-type: none"> <li>• Net-zero by 2045.</li> <li>• Reduce GHG emissions by 50% below 2005 levels by 2030.</li> <li>• Reduce domestic transport emissions by 70% by 2030.</li> </ul> <p>There is no biogas-specific roadmap, but an industry-led biogas action plan was submitted to the government in 2025.</p> <p>Sweden has prioritised biomethane as a vehicle fuel (bio-CNG, bio-LNG) rather than being injected into the gas grid.</p>	<p>Signatory of the Paris Agreement (COP21), Global Methane Pledge (COP 26), Global Renewables and Energy Efficiency Pledge (COP28), Declaration on Reducing Methane from Organic Waste (COP29).</p> <p><b>Targets:</b></p> <ul style="list-style-type: none"> <li>• Net-Zero emissions by 2050.</li> <li>• Target to reduce GHG emissions between 59 and 67% by 2035 from 2005 levels.</li> </ul> <p>There is no biogas-specific roadmap or action plan.</p> <p>There is no clear priority use for biogas. However, a recent blending mandate under the Fuels of the Future Law has established provisions for injecting biomethane into the gas grid.</p>	<p>Lack of a national roadmap for the biogas sector.</p> <p>There is no clear priority use for biogas.</p>

Table 1: International benchmarking on national strategies

Country	Net zero by 2045	Net zero by 2050	Net zero by 2050 (conditional)	Net zero by 2070	No clear target
Germany	✓				
Sweden	✓				
Brazil		✓			
Canada		✓			
Denmark		✓			
France		✓			
Poland		✓			
Portugal		✓			
United Kingdom		✓			
Mexico			✓		
India				✓	
United States					✓

**Table 2: Emissions reduction targets set by Brazil and the reference countries**

## Analysis

Countries around the world have adopted net-zero emissions targets, recognising that deep decarbonisation across all sectors is essential to meet climate goals. As more countries formalise their targets and commit to tackling methane emissions directly, biogas becomes an important tool to bridge short-term mitigation needs with long-term climate neutrality. According to Figure 2, most countries fall under the “Net zero by 2050” category, showing strong global alignment with mid-century climate neutrality. However, Sweden is committed to neutralising emissions by 2045. It is presented here as an international benchmark because it represents one of the most coherent, mature, and well-integrated biogas governance models globally. The country demonstrates a strong commitment to international climate agreements, such as the Paris Agreement (COP 21), Global Methane Pledge (COP26), Global Renewables and Energy Efficiency Pledge (COP28), and Declaration on Reducing Methane from Organic Waste (COP29), aligning its domestic policy architecture closely with global targets. It has clear long-term and interim targets – net-zero emissions by 2045, a 50% reduction in GHG emissions from 2005 levels by 2030, and a 70% reduction in domestic transport emissions by 2030 – provide a solid governance foundation for sectors with high decarbonisation potential, such as biogas. (Ministry of Climate and Enterprise, 2024).

Although Sweden does not yet have a dedicated biogas roadmap, major elements of one are already in place. The Methane Action Plan (2022) incorporates biogas as a tool for methane mitigation across the waste and agriculture sectors, projecting 88% reductions in landfill methane emissions and 23% reductions in agricultural methane emissions by 2030, relative to 1990. The industry itself is also driving progress: the 2025 Biogas Industry Action Plan proposes a targeted Contract for Difference to reduce the cost of biogas as an industrial feedstock, with a set production ambition of 10 TWh by 2030. (Ministry of Environment, 2022).

Sweden has also clearly identified priority end-uses for biogas, with biomethane primarily deployed as a vehicle fuel – Bio-CNG for buses and trucks and Bio-LNG for long-haul heavy-duty transport – a choice significantly influenced by the country’s limited gas grid infrastructure consisting of only 600-620 km of transmission pipelines and around 3,000 km of distribution pipelines, concentrated mainly in the southwest and several small local and regional networks. Much of the country’s biomethane is transported by road, compressed or liquefied, to one of Sweden’s 295 filling stations (SCB, 2025). Sweden’s policy framework is successful because it prioritises the realities of its needs, situation, and infrastructure. This has included clear central targets and regulatory mechanisms, promoting confidence in the sector, demonstrated through the identification and targeting of the transport sector as the most impactful and efficient end-use for biogas. Brazil has clearly committed at the international level, submitting an updated NDC (NDC 3.0) that sets a net-zero by 2050 goal and a 2035 target to reduce GHG emissions by 59–67% below 2005 levels and signing the Paris Agreement (COP 21), GMP (COP26), GREEP (COP28), and RMOW (COP29). In taking this action, Brazil is faring well when compared to a majority of other countries. However, compared to Sweden, it lags in developing biogas-specific policy and market development, though progress is being made.

In 2024–2025, Brazil enacted the “Fuel of the Future” law and created a National Programme for the Decarbonisation of Natural Gas Producers and Importers, including incentives for biomethane and mechanisms such as blending targets. Regulators have moved to create a national biomethane programme and Guarantees of Origin (GO) – crediting mechanisms to integrate biomethane into the gas market. These are essential steps, but implementation is nascent: commercial biomethane production and grid-injection remain limited relative to the country’s vast feedstock potential, and the sector still needs clear, time-bound production targets, investment support (e.g., Contracts for Difference-style instruments, market based mechanisms or purchase guarantees), and local infrastructure planning to turn policy into scaled deployment.

## Recommendations

Brazil's "Fuel of the Future" law would be strengthened by the development of a clear national-level priority end-use for biogas as a matter of primacy and based on the needs of the country, following the example set by Sweden. Incorporating this into a biogas-specific roadmap or action plan, as recommended by the GBRF, would provide further fuel for rapid and efficient growth of the industry. An example of an incipient roadmap Brazil could draw from is Portugal, which has recently adopted an Action Plan for Biomethane 2024–2040 (CMR 41/2024), providing much-needed regulatory support for market creation and long-term sector scaling. The Portuguese plan lays out a phased approach, first establishing the biomethane market between 2024 and 2026 by targeting five priority sectors: municipal solid waste, wastewater, agriculture, livestock and agribusiness. Followed by strengthening and consolidating the industry between 2026 and 2040 to unlock its full potential, with clear production milestones of 2.7 TWh by 2030, up to 5.6 TWh by 2040. Although some gaps remain, Portugal illustrates how even countries at an early stage of development can offer strategic clarity through a dedicated biogas action plan.

Without targeted instruments (e.g., production targets, dedicated investment support, long-term offtake contracts or grid-connection incentives), Brazil's biogas potential will remain underutilised. Despite strong ambitions and promising early steps, it must still build the strategic, regulatory, and infrastructural foundations needed to fully mobilise its far greater capability.

### 3.1.2 Financing and market mechanisms

Countries can shift expenditure from fossil fuel subsidies to incentives for renewable and sustainable solutions, such as biogas, through targeted legal and policy instruments, complemented by capital support and other direct funding mechanisms. In countries where the biogas industry is still in its infancy, early financial support and incentive mechanisms are essential to lay the foundation, mobilise investment, and accelerate industry growth.



GBRF criteria	Reference Countries	Brazil	Gaps
<p>Countries should provide financial support and incentives for the biogas industry such as:</p> <ul style="list-style-type: none"> <li>• carbon incentives.</li> <li>• feed-in tariffs.</li> <li>• tradable certificates.</li> <li>• direct subsidies.</li> <li>• emissions trading schemes (ETS) that incorporate methane.</li> <li>• low-interest loans while ensuring that all public financing aligns with national climate and sustainability goals.</li> </ul>	<p><b>Carbon pricing and tax mechanisms:</b> <i>EU ETS (2005) and ETS2 (2027):</i></p> <ul style="list-style-type: none"> <li>• Emissions within the system are capped and this cap is reduced each year. Methane is listed among the GHGs that can be covered, but only the maritime sector is required to surrender allowances for methane (2026).</li> </ul> <p><b>Sweden</b></p> <ul style="list-style-type: none"> <li>• Carbon tax (1991) based on the fossil carbon content in fuel. Aims at reducing CO<sub>2</sub> emissions in sectors outside the EU ETS.</li> </ul> <p><b>Denmark</b></p> <ul style="list-style-type: none"> <li>• CO<sub>2</sub>e Tax on livestock and manure with a 60% tax deduction offered to incentivise farmers with low emissions.</li> </ul> <p><b>Canada</b></p> <ul style="list-style-type: none"> <li>• Pan-Canadian Approach to Pricing Carbon Pollution.</li> </ul> <p><b>Finance support mechanisms:</b> <i>Direct price support: revenue per unit of energy produced.</i></p> <p><b>Germany</b></p> <ul style="list-style-type: none"> <li>• Market premiums and tenders for biomethane, Combined Heat and Power (CHP) and grid injection.</li> <li>• GHG emissions quota mechanism on transport fuel that rewards carbon savings.</li> </ul> <p><b>Sweden</b></p> <ul style="list-style-type: none"> <li>• Ordinance 2022:225: Subsidies for biomethane injected into the gas grid or liquified.</li> </ul> <p><b>UK</b></p> <ul style="list-style-type: none"> <li>• Renewable Heat Incentive/Green Gas Support Scheme. <ul style="list-style-type: none"> <li>• Injection feed in tariffs for biomethane.</li> </ul> </li> <li>• Renewable Transport Fuels Obligation. <ul style="list-style-type: none"> <li>• End use market based mechanism including biomethane for increasing the renewable content of UK fuel.</li> </ul> </li> <li>• Compressed gas fuel duty reductions.</li> </ul> <p><b>Portugal</b></p> <ul style="list-style-type: none"> <li>• Ordinance 15/2023: Biomethane tenders.</li> </ul> <p><b>Grants, Subsidies, and Concessional Loans.</b></p> <p><b>Sweden</b></p> <ul style="list-style-type: none"> <li>• Purchase premium for buses, trucks and mobile machinery, powered by biomethane.</li> </ul> <p><b>Tax Credits and Fiscal Incentives</b></p> <p><b>USA</b></p> <ul style="list-style-type: none"> <li>• Sec. 48 ITC and Sec. 45z CFPC: Federal tax credit available to offset the cost of facilities, equipment and production of transportation fuels with lower carbon intensity.</li> </ul> <p><b>Sweden</b></p> <ul style="list-style-type: none"> <li>• Fiscal incentives: CO<sub>2</sub> and energy tax exemption scheme for biogas or biomethane used for vehicle fuel, heating generation and CHP.</li> </ul>	<p><b>Carbon pricing and tax mechanisms:</b></p> <ul style="list-style-type: none"> <li>• Law 15,042/2024 established the general framework for the Brazilian Emissions Trading System (SBCE), introducing a cap on emissions within the regulated sectors.</li> <li>• Law 13,576/2017 established the Brazilian National Biofuel Policy (RenovaBio), introducing national decarbonisation targets for fossil fuel distributors, which they must meet by purchasing decarbonisation credits (CBIOs). Biomethane producers are eligible to generate and trade CBIOs.</li> </ul> <p><b>Finance support mechanisms:</b></p> <ul style="list-style-type: none"> <li>• Ordinance MMA 71/2022 created the National Methane Emissions Reduction Programme (Zero Methane). It provides credit lines and special funding conditions to biogas and biomethane.</li> <li>• Law 11,488/2007 created the Special Incentive Scheme for Infrastructure Development (REIDI). It provides for the suspension of PIS (1.65%) and COFINS (7.6%) tax contributions on revenues arising from certain biomethane investments.</li> </ul> <p><b>Funding operated by the National Development Bank (BNDES):</b></p> <ul style="list-style-type: none"> <li>• Lines of credit with reduced interest rates to finance projects in various sectors (FINEM) and the acquisition or production of machinery and equipment (FINAME).</li> <li>• Law 12,114/2009 established the Climate Fund to support projects aimed at reducing GHG emissions and adapting to climate change. It offers lines of credit with reduced interest rates.</li> <li>• Law 14,995/2024 established the Eco Invest Programme, an instrument for attracting private investment to the country, structured in four sub-lines: mixed financing, long-term foreign exchange liquidity facility, promotion of foreign exchange protection and project structuring.</li> <li>• Law 15,103/2025 establishes the Energy Transition Acceleration Programme (PATEN) aimed at promoting the financing of sustainable development projects.</li> </ul>	<p>The SBCE system remains incipient, as the operational, legal, and technical structures required for a fully functioning carbon market are still under development. That poses an opportunity to include methane in the cap-and-trade structure, recognise mitigation technologies and create offset mechanisms for methane abatement.</p> <p>Brazil has no carbon tax mechanisms in place like those in EU countries, UK, and Canada.</p> <p>It has no dedicated financial support and incentives for biogas and biomethane.</p>

**Table 3: International benchmarking on financing and market mechanisms**

## Analysis

This section is structured into two main parts: (1) *Carbon-pricing and tax mechanisms*, and (2) *financial support mechanisms*. In many mature biogas markets, the trajectory towards sector maturity has involved a gradual layering of both.

### (1) Carbon-pricing and tax mechanisms

Tax mechanisms are instruments used by some countries to internalise the environmental costs of fossil-fuel emissions and steer investment towards low-carbon technologies. Well-designed carbon pricing ensures that biogas becomes increasingly cost-competitive, supporting the industry's long-term viability.

The EU Emissions Trading Scheme (EU ETS) is the European Union's flagship carbon-pricing instrument. It covers power, industry and aviation, and provides a complementary price signal to national carbon taxes by capping emissions and enabling market-based reductions. In Scandinavia, Sweden has had a carbon tax in place since 1991, based on the fossil-carbon content of fuel. It aims to reduce CO<sub>2</sub> emissions in sectors outside the EU ETS. The current rate stands at SEK 1,510 (US\$158) per tonne of fossil CO<sub>2</sub> emitted.

Denmark has adopted an ambitious approach to taxing non-energy emissions. It has agreed to tax enteric fermentation and manure emissions from 2030, becoming the first country in the world to introduce an economy-wide carbon price for agricultural methane emissions. The agreed nominal rate is DKK 300 (US\$46) per tonne of CO<sub>2</sub> equivalent (CO<sub>2</sub>e), rising to DKK 750 (US\$116) per tonne in 2035. A 60% tax deduction is applied to farmers who reduce emissions, such as through biogas production, resulting in an effective tax of DKK 120 (US\$18.50)/t CO<sub>2</sub>e in 2030, increasing to DKK 300 (US\$46)/t in 2035 (Ministry of Green Transition, 2024). Preliminary assessments published in Denmark's Biogas Outlook 2025 indicate that the CO<sub>2</sub>e tax, when combined with favourable treatment for climate-efficient farms, could stimulate further digestion of manure and thereby expand biomethane production. (Biogas Denmark, 2025)

Canada is an example in the Americas of a country pricing carbon pollution. The government set a federal "benchmark" for carbon-pollution pricing, starting at CA\$95 (US\$67) per tonne of CO<sub>2</sub>e in 2025, rising to CA\$170 (US\$120) per tonne of CO<sub>2</sub>e in 2030. It requires provincial systems to cover a comparable share of emissions, send a clear carbon price signal (without offsetting it via rebates or tax reductions), protect only genuinely at-risk sectors from leakage and use credible offset credits.

Brazil, on the other hand, has established the general framework for the Brazilian Emissions Trading System (SBCE), introducing a cap on emissions in regulated sectors. However, it currently has no carbon tax mechanisms in place. The SBCE remains incipient, as the operational, legal, and technical structures required for a fully functioning carbon market are still under development. This presents an opportunity to include methane

in the cap-and-trade structure, recognise mitigation technologies, and create offset mechanisms for methane abatement.

### (2) Financial support mechanisms

Historically, most countries have relied on public incentives to support and provide certainty to biogas and biomethane producers. These include Feed-in Tariffs (FiTs), capital grants, operating subsidies and contracts for difference (a mechanism widely used whenever new industrial technologies emerge, for example, in wind energy and oil and gas). However, the long-term sustainability of the biogas market, like other markets, depends on its ability to evolve beyond reliance on public subsidies and toward an economically competitive, resilient model. (World Biogas Association, 2025). Germany's Renewable Energy Sources Act (EEG) promoted electricity production from biogas, resulting in a substantial increase in capacity between 2007 and 2014. However, following an amendment in 2014 that reduced financial incentives for biogas plants, sector growth has declined significantly, demonstrating the direct impact of such mechanisms on sector growth.

Brazil has been creating a supportive environment without relying on public incentives and subsidies. This approach includes programs such as: *RenovaBio*, which enables biomethane producers to generate and trade decarbonisation credits (CBIOs); the *Zero Methane Programme*, which provides credit lines and special funding conditions to biogas and biomethane; the *Energy Transition Acceleration Programme (PATEN)*, aimed at promoting finance of sustainable development projects; and the *Eco Invest Programme*, which serves as an instrument for attracting private investment to the country.

With the inclusion of biomethane in the Special Incentive Scheme for Infrastructure Development (REIDI), qualifying projects are now exempt from paying PIS (1.65%) and COFINS (7.6%) taxes on revenues during the implementation phase, reducing overall project costs. Large-scale biomethane plants can also access lines of credit with reduced interest rates from the National Development Bank (BNDES), including FINEM, the Climate Fund and Finame. However, a careful look is needed to ensure that small and medium-sized projects can also access tailored financing instruments, as they often face higher transaction costs and more limited collateral, despite their significant potential for distributed biomethane production.

## Recommendations

There are opportunities for Brazil to include methane in the SBCE cap-and-trade structure using a 20-year Global Warming Potential, recognise AD as an eligible mitigation technology under the SBCE, and create offset mechanisms for methane abatement, enabling biogas plants to generate verified emission reduction credits under the SBCE. Brazil is performing well in establishing financial mechanisms to support its sustainable development, and the biogas sector has been growing without subsidies. Although the

financial support mechanisms mentioned above include biogas and biomethane to some extent, dedicated financial support and incentives for these technologies remain necessary to accelerate the sector’s growth. A more in-depth analysis of existing financial mechanisms globally, including their structure, scope and comparative values, could be developed to better understand the potential pathways Brazil can pursue.

### 3.1.3 Feedstocks

Feedstocks are the cornerstone of the biogas industry. Many countries have adopted strategies to secure a reliable, long-term supply of feedstocks for the biogas sector, enabling it to fulfil its potential to mitigate climate change, displace fossil fuels, improve soil health and productivity, and advance public health and sanitation. This section examines strategies to ensure consistent feedstock availability, particularly from municipal solid waste, and compares international feedstock policies with those in Brazil, highlighting lessons and opportunities for policy development and market expansion.

### Analysis

The EU’s Directive 1999/31/EC laid the foundation for preventing or reducing adverse effects on the environment and risks to human health from landfills. Since then, countries have adopted stricter rules to reduce the volume of organic waste sent to landfills. In Sweden, the Waste Ordinance (2020:614) bans the landfilling of biowaste, initiates producer responsibility, and introduces a waste tax. To discourage landfilling, a landfill tax of SEK 725 per tonne (\$76 USD) was introduced with annual adjustments, similar to the approach taken in the UK.

The UK landfill tax, currently £126.15 (\$166 USD) per tonne for waste disposed of at authorised landfill sites, acts as a disincentive against sending organic and biodegradable waste to landfill. The UK Department for Environment, Food and Rural Affairs also has a hard target of less than 10% of waste to landfill in 2030. Other EU countries, including France, Denmark, Portugal and Poland, also impose landfill taxes, as shown in the above

GBRF criteria	Reference Countries	Brazil	Gaps
<p>Governments should ensure that they:</p> <ul style="list-style-type: none"> <li>enforce clear feedstock sustainability criteria for biogas and biomethane production.</li> <li>streamline feedstock collection systems.</li> <li>regulate the sector efficiently.</li> <li>mandate separate food waste collection and recycling.</li> <li>apply the waste management hierarchy to prioritise the recycling of organic waste.</li> <li>promote and support the digestion of manure as a key measure to reduce methane emissions from agriculture.</li> <li>ensure traceability and compliance across the entire biogas value chain.</li> </ul>	<p><b>United Kingdom</b></p> <ul style="list-style-type: none"> <li>Imposed Landfill tax currently at £126.15 (\$166 USD) per tonne for waste disposed at authorised landfill sites</li> <li>Simpler recycling regulation in England requires separate collection of organics (phased in between 2025 and 2027)</li> </ul> <p><b>Sweden</b></p> <ul style="list-style-type: none"> <li>To discourage landfilling, a landfill tax was put in place of SEK 725 per tonne (\$76 USD), which is yearly adjusted.</li> <li>Local waste management fees guarantee full cost coverage for collection, separation, treatment, recycling, planning and information.</li> </ul> <p><b>Germany</b></p> <ul style="list-style-type: none"> <li>Biowaste Ordinance (BioAbfV): specifies requirements for acceptable feedstocks, processing methods, product quality, hygiene, application, and compliance verification of materials intended for AD and composting.</li> </ul> <p><b>Portugal</b></p> <ul style="list-style-type: none"> <li>General Waste Management Regime (RGGR): There is a legal requirement for waste segregation and collection of biowaste. The law mandates that municipalities must operationalise the selective collection of biowaste.</li> </ul>	<ul style="list-style-type: none"> <li>National Solid Waste Policy - Law 12,305/2010: Prioritises energy recovery from waste over landfilling.</li> <li>National Solid Waste Plan - Decree 11,043/2022 sets targets for 2040: <ul style="list-style-type: none"> <li>✓ All Brazilian municipalities must implement initiatives for organic waste recovery, such as waste segregation, composting, anaerobic digestion, or mechanical-biological treatment.</li> <li>✓ 63.4% of biogas from AD and landfills will be used for energy.</li> <li>✓ All landfills must capture at least 50% of the biogas to be used for energy purposes, reaching an installed capacity of 257 MW.</li> <li>✓ Divert 27% of organics from landfill to AD or composting. About 8% of organics will undergo AD treatment with energy recovery from biogas.</li> </ul> </li> <li>Law 14,026/2020: Waste disposal fees ensure the financial sustainability of public sanitation services (collection, transport, treatment, and disposal) by charging waste generators for the treatment and final disposal of their waste. States and cities regulate the amount charged in their jurisdictions.</li> </ul>	<p>Lack of defined sustainability criteria for feedstocks (i.e. energy crops versus waste) and feedstock traceability.</p> <p>Lack of enforcement of waste segregation policies, despite the existing legal framework, due to gaps in local governance and financial constraints.</p> <p>Lack of a uniform nationwide landfill tax levied per ton of waste landfilled to potentially discourage landfilling and make AD economically competitive. The fee for waste-management services (collection, transport, disposal) does not operate like a “tipping fee” or landfill-gate fee as in some countries.</p> <p>No mechanism to disincentivise the sending of organic waste to landfills.</p> <p>Limited, fragmented and not yet strong or systemic incentives for manure/animal-waste digestion.</p>

Table 4: International benchmark on feedstock policies



**Figure 2: Landfill tax set in reference countries**

chart. By significantly increasing the cost of landfilling, businesses and municipalities are encouraged to adopt alternative waste management methods. This effectively makes AD and other circular solutions more financially attractive than the traditional landfill route.

The Brazilian Law 14,026/2020 (Novo Marco do Saneamento) establishes waste-disposal fees to ensure the financial sustainability of public sanitation services, including waste management, by charging waste generators for collection, transport, treatment and final disposal of their waste. However, in some circumstances, the fee may be low or absent. Each municipality decides whether to charge the fee, the amount, and how it is applied. There is no standardised federal landfill tax levied per tonne of waste to discourage landfilling and to increase the economic competitiveness of AD.

Article 22 of the Waste Directive (2008/98/EC) requires EU Member States to ensure that bio-waste is either separated and recycled at the source or collected separately and not mixed with other types of waste. Segregation policies are notably present in Sweden, Germany, France and Portugal. France’s *Compost Obligatoire* rules (2024) transpose the updated EU Waste Directive, outlining the purpose of enhancing feedstock for AD and composting. Germany’s Biowaste Ordinance (BioAbfV) specifies requirements for acceptable feedstocks, processing methods, product quality, hygiene, application, and compliance verification of materials intended for AD and composting.

The UK has mandated source segregation of food and organic waste for households and businesses under the Environment Act 2021 and the “Consistency in Household and Business Recycling” policy. This ensures high-quality feedstock for anaerobic digestion and supports large-scale AD deployment. This is being rolled out beginning with business collections in 2025 and finally covering domestic collections in 2027.

Brazil, along with India and Mexico, does not yet have such a mechanism in place. Separate organic waste collection is not universally implemented in Brazil, even though it is a target set by the National Solid Waste Plan (Decree 11,043/2022) for 2040. Actual coverage depends on municipal capacity, political will, resources, and local planning. This limits the capacity to utilise the organic fraction of municipal solid waste.

The UK is exemplary in its feedstock policies. Sustainability criteria are embedded in major support schemes, including the Renewable Heat Incentive (RHI) and the Green Gas Support Scheme (GGSS), mandating that a minimum share of biomethane or biogas must come from waste or residue sources. These criteria also enforce environmental safeguards, such as legal sourcing, biodiversity protection, and greenhouse gas emission reductions. By tying financial support to sustainability performance, the UK ensures that biogas production delivers genuine environmental benefits rather than incentivising unsustainable biomass use. The UK also sets a total carbon intensity requirement on the gas resulting which under the GGSS is 24 gCO<sub>2</sub>e/MJ, a 70% reduction on natural gas. The scheme is imperfect and can be improved but the core intent has been consistent for nearly 10 years and has evolved rather than being regularly and radically changed.

Brazil’s biogas incentives are largely linked to energy production, particularly through the *RenovaBio* program, rather than stringent sustainability criteria for feedstock. While environmental licensing requires adherence to federal environmental laws (e.g. CONAMA resolutions), there is less focus on ensuring feedstocks are strictly non-food waste or residues, meaning some biogas projects may still use feedstocks without strict GHG reduction requirements.

Most biogas production in Brazil is concentrated in the South (livestock) and Southeast (landfills, industry, etc), despite significant untapped potential in the Centre-West (grain, cattle feedlots, ethanol plants) and Northeast (sugarcane industry, biodiesel plants, hotels/tourism waste). Policy incentives could promote regional biogas expansion in these underdeveloped areas.

### Recommendation

Brazil would benefit from introducing sustainability criteria for feedstocks to incentivise the use of waste for anaerobic digestion and a focus on a total lifecycle carbon intensity to ensure any systems are net beneficial irrespective of feedstock. Section 2.2.2 of *Pillar 2 Feedstocks Policy* in the GBRF provides a detailed sustainability criteria that could be adopted by Brazil.

To capitalise on Brazil’s immense feedstock potential, it is important to introduce waste separation and collection mechanisms nationwide, particularly in urban areas. This would increase the reliability and quality of feedstock streams for efficient biogas and co-product production.

### 3.1.4 Digestate

Digestate is a valuable biofertiliser that provides a renewable source of essential nutrients – including nitrogen and phosphorus – and offers numerous benefits for agriculture and other land applications, particularly in areas where soil improvement is needed. Ensuring the production of high-quality digestate is crucial to maximising these benefits and should be a primary focus for AD operators and digestate producers. Likewise, digestate managers and end users must follow best management practices when handling and applying digestate to land to fully realise its agronomic and environmental value.

#### Analysis

Countries should set quality standards specific to digestate, covering management processes such as source segregation of wastes, the duration and temperature of the digestion process, oxygen uptake rate, and residual biogas potential, as well as parameters such as the absence of particulate contamination, additives, polymers, pathogens, and potential toxic elements. While this level of regulatory oversight is a reality in some mature markets, emerging markets such as Brazil are paving the way to get there. Brazil's National Fertiliser Plan 2050 sets a target to reuse municipal solid waste and by-products

with agricultural applications (e.g. digestate) to produce (bio)fertilisers and other farming inputs. However, it lacks policy guidelines and binding legislation. The targets, to reach at least 10% of national production by 2030, 30% by 2040, and 70% by 2050, make Brazil one of the few cases globally to explicitly quantify its trajectory for increasing the share of waste reuse for biofertiliser production. Most countries encourage circularity, but do not codify national percentage targets (Ministério da Agricultura e Pecuária, 2022).

In 2025, Portugal introduced Ordinance 5993/2025, granting end-of-waste status ("Fim do Estatuto de Resíduo", FER) to digestate (and compost) produced via anaerobic digestion or composting when intended exclusively for direct land application. This seems to simplify regulatory burdens for storage, transport, land application, and cross-holder transfers (Portugal, 2025). Similarly, several other countries have already given digestate an end-of-waste status (or equivalent). In the United Kingdom, digestate from food waste that meets PAS 110 (a long-established route) and the Environment Agency's resource frameworks is treated as a product rather than waste (British Standards Institution, 2014). Dutch guidance similarly treats digestate produced from authorised inputs in the Netherlands as a biofertiliser, with clear rules governing its use and trade (RVO, 2025).

GBRF criteria	International Benchmark	Brazil	Gaps
<p>Governments should have a:</p> <ul style="list-style-type: none"> <li>defined role of digestate in fertiliser regulations.</li> <li>renewable fertiliser obligation.</li> <li>digestate certification mechanism.</li> <li>quality standards for digestate.</li> <li>required nutrient profiling of digestate.</li> <li>quality management systems for digestate.</li> </ul>	<p><b>Portugal</b></p> <ul style="list-style-type: none"> <li>Introduced Ordinance 5993/2025, which creates an end-of-waste criteria for digestate intended exclusively for direct use for land use purposes.</li> </ul> <p><b>Germany</b></p> <ul style="list-style-type: none"> <li>Circular Economy Act (Kreislaufwirtschaftsgesetz, KrWG): provides the overarching legal basis, defining when a recovered substance like digestate can cease being classified as "waste" and instead become a product again.</li> <li>Bio-Waste Ordinance (BioAbfV) Fertiliser: sets strict limits on contaminants (heavy metals, pathogens, etc.), hygiene treatment, and documentation to ensure that digestate used on agricultural, forest, or horticultural land is safe.</li> </ul> <p><b>India</b></p> <ul style="list-style-type: none"> <li>Fertiliser Control Order (1985) Recognise the solid and liquid fractions of digestate as an organic fertiliser.</li> </ul> <p><b>Canada</b></p> <ul style="list-style-type: none"> <li>T-4-112 – By-products and other "Waste-derived" materials sold as fertilisers or supplements.</li> </ul> <p><b>France</b></p> <ul style="list-style-type: none"> <li>SRF MSWR-6.2: Legally binding national standards and Quality Management System for digestate.</li> </ul>	<ul style="list-style-type: none"> <li>National Fertiliser Plan 2050 has a target to reuse municipal solid waste and by-products that have potential agricultural applications (e.g. digestate) to produce (bio) fertiliser and farming inputs. 10% of national production by 2030, 30% by 2040, and 70% by 2050.</li> <li>MAPA IN 27/2006: Establishes the maximum allowable concentrations for phytotoxic agents, pathogens to humans, animals and plants, toxic heavy metals, pests and weeds in biofertiliser.</li> <li>MAPA IN 61/2020: Establishes rules on definitions, requirements, specifications, guarantees, tolerances, registration, packaging, and labelling of organic fertilisers and biofertilisers intended for agriculture.</li> </ul>	<p>No legal fertiliser obligation.</p> <p>No digestate quality standard.</p> <p>No digestate certification scheme.</p>

Table 5: International benchmark on digestate policies

Brazil currently has no dedicated national decree or regulation that uniformly declares digestate from anaerobic digestion a biofertiliser by default. However, the PNRS (Law 12,305/2010) and MAPA IN 61/2020 provide a potential legal route for digestate classification, provided it meets regulatory requirements related to definitions, specifications, guarantees, registration, packaging, labelling, and agronomic and sanitary standards.

Furthermore, the EU has released the EU Regulation 2019/1099 on EU Fertilising products providing guidelines and quality standards for all fertilising products in order to be eligible to enter EU markets. EU states have been following these guidelines and implemented them in their domestic legislation, such as the Portuguese regulation, Ordinance 79/2022, sets maximum permissible levels for heavy metal content in digestate derived from livestock effluents – including cadmium, lead, copper, chromium, mercury, nickel, and zinc – as well as limits for pathogens, namely *Salmonella spp.* and *Escherichia coli*. It also defines the maximum annual quantities of digestate that may be incorporated into the soil (Portugal, 2022). France and Germany have likewise introduced national standards and quality management systems for digestate. In France, SRF MSWR-6.2 sets legally binding national standards and a quality management system for digestate. Germany has strong national standards for digestate quality and a quality management system in place. The German Biowaste Ordinance (BioAbfV) defines requirements for acceptable feedstocks, processing, product quality, hygiene, application, and compliance verification to ensure that digestate used on agricultural, forest, or horticultural land is safe. The Fertiliser Act and Ordinance specify minimum thresholds for contaminants and beneficial components.

India's Fertiliser Control Order (1985), Third Amendment Order 2025, adds arsenic to the list of regulated heavy metals. Mexico, by contrast, does not have digestate quality standards. Brazil, although lacking specific digestate quality standards, establishes, through MAPA IN 27/2006, maximum admissible limits for various contaminants in biofertilisers, ensuring they meet acceptable safety thresholds regarding heavy metals and biological hazards.

Beyond quality specifications, certification schemes aid in the safe and widespread adoption of digestate use as a fertiliser. In Sweden, digestate is crucial to the circular bio-based economy as a system for closing nutrient loops: returning nutrients from organic waste back to productive land, providing biofertiliser and enabling organic farming. The country has developed an independently verified certification scheme, SPCR 120, managed by Avfall Sverige (the municipalities' trade association for waste management), in consultation with agricultural and industry stakeholders, digestate producers, soil producers, and public authorities. It covers total nutrients, process aids used, feedstock origin, and compliance with limits on metals, pathogens, and visible contaminants (Avfall Sverige, 2025). Similar to Sweden, the UK's Biofertiliser Certification Scheme

ensures the quality and safety of renewable fertilisers, including digestate. The German Institute for Quality Assurance and Certification (RAL) takes this further by providing product-specific standards that exceed statutory requirements; while the independent Bundesgütegemeinschaft Kompost (BGK) oversees implementation, conducts facility audits, supports operators, and issues RAL quality labels.

### Recommendation

Although Brazil's National Fertiliser Plan (PNF 2050) sets ambitious goals for reusing solid waste and by-products in biofertiliser production – 10% of national output by 2030, 30% by 2040 and 70% by 2050 – these remain non-binding strategic targets rather than legal obligations. Theoretically, these targets are achievable; however, the current regulatory framework is insufficient: the country lacks a national digestate quality standard, MAPA's registration process is complex, and waste and fertiliser regulations are poorly harmonised. Without significant regulatory reform and economic incentives, Brazil is unlikely to meet the 2040 and 2050 targets, although moderate growth is feasible.

Brazil's biogas industry would benefit from a harmonised digestate regulatory framework and a clearly defined national role for digestate. Additionally, establishing a certification scheme for digestate and introducing a renewable fertiliser obligation for fertiliser suppliers and distributors, requiring a proportion of the fertiliser they supply to be derived from digestate, would stimulate market uptake, improve product quality and safety, provide legal certainty for producers and users, and create economic incentives to scale up anaerobic digestion and circular nutrient recovery in agriculture.



### 3.1.5 Gas Quality

Gas quality regulations define clear standards for parameters such as methane content, impurities, and moisture, ensuring that biogas can safely and efficiently replace diesel, natural gas, and solid fuels. Establishing well-defined quality criteria for biogas will facilitate its use for cooking, heating, electricity generation, grid injection, and powering vehicles, thereby expanding market opportunities. Governments play a crucial role in developing regulatory frameworks for biogas, biomethane, and bio-CO<sub>2</sub> by implementing technical safety measures and enabling off-take and smart grid initiatives.

#### Analysis

Across emerging biomethane markets, gas-quality regulatory frameworks are evolving at different speeds, with varying degrees of technical depth and institutional

maturity. The emerging markets considered in this analysis are Mexico, India, Poland, and Portugal. Mexico currently lacks a dedicated biomethane quality standard. The recently issued Regulation of the Biofuels Law (published October 2025) establishes a transitional pathway for biomethane by allowing the temporary use of existing natural gas specifications (NOM-001-SECRE-2010) until specific gaseous-biofuel NOMs are issued for biomethane. In practice, this means the Ministry of Energy (SENER) may authorise the injection, transport, and commercialisation of biomethane, provided it meets the NOM-001 technical requirements (e.g., Wobbe number, calorific value, impurity limits, methane content) at the point of entry to the network. This marks a major regulatory shift, as biomethane injection into the natural-gas grid was previously prohibited. (Mexico, 2025).

GBRF criteria	Reference Countries	Brazil	Gaps
<p>Governments should:</p> <ul style="list-style-type: none"> <li>• Develop quality regulatory frameworks for biomethane.</li> <li>• Define a preferred regulatory regime for biomethane outside of regulations applied to traditional gas grid.</li> <li>• Implement technical regulations.</li> <li>• Define gas-to-grid network entry requirements.</li> <li>• Implement quality standards for Bio-CO<sub>2</sub> and possible uses.</li> <li>• Develop a regulatory framework for gas off-takers, gas exchange arrangements.</li> <li>• Implement smart gas grid methods and initiatives.</li> </ul>	<p><b>Quality regulatory frameworks for biomethane:</b></p> <p><b>European Union</b></p> <ul style="list-style-type: none"> <li>• EN 16726: defines gas quality standards for natural gas (and biomethane).</li> </ul> <p><b>Canada</b></p> <ul style="list-style-type: none"> <li>• CAN/BNQ 3672-100 standard provides a technical quality specification for biomethane injected into the gas grid.</li> </ul> <p><b>United Kingdom</b></p> <ul style="list-style-type: none"> <li>• Working on developing a Policy Framework for Biomethane Production, consultations held in 2024.</li> </ul> <p><b>India</b></p> <ul style="list-style-type: none"> <li>• IS 16087: 2013 Biogas (Biomethane) Specification set by the Bureau of Indian Standards, specifies composition, quality parameters, and test methods.</li> </ul> <p><b>Technical regulation:</b></p> <ul style="list-style-type: none"> <li>• Technical and contractual requirements set by gas network operators following European standards for biomethane/ natural gas quality.</li> <li>• EN1623-1: focus on injection, integration and safe utilisation of biomethane into the natural gas grid and for use in transport. Specifies the requirements and test methods for biomethane at the entry point.</li> <li>• EN 16723-2: that sets specifications for biomethane used as transport fuel.</li> </ul> <p><b>France</b></p> <ul style="list-style-type: none"> <li>• EGAlim: provides “right to injection” and recognises the “right to connect” to the gas networks</li> </ul> <p><b>Germany:</b></p> <ul style="list-style-type: none"> <li>• Gas Network Access Regulation - GasNZV Paragraphs 34 to 36: <ul style="list-style-type: none"> <li>✓ Biomethane gets priority access to capacity contracts.</li> <li>✓ Grid operators must enable biomethane injection, provided gas quality at the entry point meets DVGW standards.</li> <li>✓ More flexible balancing rules apply to biomethane because its injection profiles differ from fossil natural gas.</li> <li>✓ Reduced or adapted capacity requirements may apply to encourage biomethane producers to inject into the grid.</li> </ul> </li> </ul>	<p><b>Quality regulatory frameworks for biomethane:</b></p> <ul style="list-style-type: none"> <li>• Resolution ANP 886/2022: Specification of biomethane from landfills and sewage treatment plants.</li> <li>• Resolution ANP 906/2022: Specification of biomethane from agricultural and commercial waste.</li> </ul> <p><b>Technical regulation:</b></p> <ul style="list-style-type: none"> <li>• Resolution ANP 987/2025: Technical, economic, and legal requirements for obtaining authorisation to produce biofuel, including biomethane.</li> </ul>	<p>Lack of smart grid methods and initiatives.</p> <p>Lack of quality standards for Bio-CO<sub>2</sub> and possible uses.</p> <p>Heterogeneous gas-to-grid network entry requirements.</p>

Table 6: International benchmark on gas quality standards

By comparison, India has already implemented dedicated biomethane quality specifications, issued by the Bureau of Indian Standards (BIS), in the IS 16087 series on Biogas (Biomethane) Specification. These specify composition, quality parameters, test methods, and application domains, including stationary engines, automotive CBG, and pipeline supply. Earlier editions of IS 16087 were used primarily for biomethane (also known as compressed biogas (CBG) or Bio-CNG in India) delivered to the transport sector. The 2025 revision strengthens laboratory methods, tightens limits for moisture, H<sub>2</sub>S and CO<sub>2</sub>, and aligns automotive and industrial uses with safety and engine-compatibility requirements (Bureau of Indian Standards, 2025).

In Poland, injection requirements and gas-quality parameters for biomethane are defined through a combination of national regulations, network codes, and technical standards, rather than a single document. Polish and EU standards PN-C-04750:2011 (natural gas parameters) and PN-EN 16723:2016 (biomethane for grid injection and transport), together with operator network codes (IRiESP/IRiESD), are applied by Gaz-System and PSG in practice to assess whether biomethane meets injection-quality requirements.

Portugal has been actively enabling their national biomethane expansion. The national Biomethane Action Plan (2024–2040) aims to scale production and integrate grid injections, while grid operator REN has signalled plans and timelines to enable renewable gas injections (including biomethane) in the coming years. However, Portugal has no dedicated national biomethane quality regulation; instead, it recognises and applies relevant European standards for gas quality, including EN 16723-1 (biomethane for injection), EN 16726 (general gas-quality parameters for “Group H” gas), and related ISO/EN standards for gas infrastructure and quality control.

The absence of dedicated, fit-for-purpose regulations for the biomethane sector has delayed progress in many emerging markets. By contrast, mature markets have established comprehensive frameworks that set clear technical standards, prioritise grid integration, and provide commercial certainty.

France has one of the most advanced enabling environments, contributing to an 838% rise in grid injection over the last 5 years (France, 2025). Its “right to inject” law ensures grid access for biomethane producers, enabling easier gas network connection for many small and medium-sized agricultural biomethane plants. The Order of November 23, 2020 sets gas composition standards for biomethane injection, while the Order of September 3, 2025 establishes procedures for controlling biomethane production facilities connected to a natural gas network.

Germany provides another best-practice example. Under the Gas Network Access Regulation (GasNZV), paragraphs 34–36, biomethane is prioritised for capacity contracts,

and grid operators must facilitate injection when gas-quality requirements (DVGW standards) are met. Additional flexibility, such as adapted balancing rules and reduced capacity requirements, makes biomethane injection economically feasible across a range of plant sizes.

In the context of smart gas-grid implementation, Denmark and Sweden both illustrate advanced pathways for integrating biomethane into national gas systems. Both countries have developed robust gas-quality and injection practices, with Sweden progressing toward a national biogas registry and a Guarantees of Origin (GOs) system. Legal provisions are in place, even if full implementation is still ongoing. These systems enable contractual mass balancing (book-and-claim) and digital tracking of renewable gas, ensuring that end users can verify the origin, production pathway, feedstock, and support status of the biomethane they purchase. Such registry-and certificate-based mechanisms promote transparency, interoperability, and more efficient biomethane integration across gas networks.

None of the countries analysed, including Brazil, has implemented quality standards for biogenic CO<sub>2</sub>. In most European countries, CO<sub>2</sub> purity and quality requirements depend on the application, contractual arrangements, and EU/state-aid rules (e.g., Bioenergy with Carbon Capture and Storage [BECCS]). This remains a critical regulatory gap in the context of carbon-capture investments, synthetic-fuel markets, and emerging CO<sub>2</sub>-based circular-carbon value chains.

### Recommendation

Emerging markets such as Brazil should prioritise issuing dedicated biomethane quality standards and consolidating injection requirements into clear, uniform network-operator guides. Following this example of more mature markets would increase clarity, confidence and speed in developing their biomethane pathways, whilst facilitating project deployment.

In situations where the biomethane input constitutes a very small flow into a larger volume of natural gas mix, it is both desirable and feasible to permit certain exceptions or expanded compliance limits that recognise the dilution that occurs while remaining within the overall safety and gas quality requirements of the grid. Similarly, the implementation of metering tolerances and operational status data exchange proportionate to flow volume is advisable. There should be flexibility provided for regulatory breaches that have no practical impact on grid operators or biomethane producers.

Brazil also has the opportunity to lead in developing and implementing application-specific quality standards for biogenic CO<sub>2</sub>, thereby providing transparency, legal certainty, and a foundation for increased future global market use.

### 3.1.6 Technical and Operational Standards

A key challenge for the biogas industry is that its standards are derived from a wide range of sources, disciplines, and legal or policy frameworks across the energy, fertiliser, and agricultural sectors. In mature markets with well-established biogas industries, mechanisms have emerged to guide practice and regulation. Countries committed to accelerating the safe and sustainable growth of their biogas sector should develop centralised design and construction standards for biogas plants, require risk-assessment-based plant design, and set operational standards for anaerobic digestion and renewable gas operations. Alongside that, this section also explores the application of best available techniques (BAT) across all stages of a biogas project, including design, installation, construction, operation, technology, and decommissioning, to support countries in rapidly developing a high-performing industry whilst minimising environmental impacts.

#### Analysis

Building a reliable and sustainable biogas industry requires clear technical and operational standards. Few countries, most notably Germany and India, have government-led or government-issued technical standards tailored to the biogas industry. Although

Germany's generally accepted technical rules are not laws, they are widely recognised and technically robust requirements for the safe and compliant use of biogas and the injection of biomethane. They set standards covering minimum safety requirements, engineering quality, and environmental protection. The German Technical and Scientific Association for Gas and Water (DVGW) rulesets include technical, safety, and operational requirements for biogas upgrading and grid injection (DVGW G 265-1 and DVGW G 265-2). The Association of German Engineers' Biogas Guidelines serve as a reference for operators and investors to evaluate the design quality and operation of a biogas plant (VDI 4631 – "Quality criteria for biogas plants").

India has formal national biogas standards issued by the Bureau of Indian Standards (IS 9478:2023, Code of Practice). However, these standards still lack the technical depth and industrial applicability of European or ISO biogas standards. Other countries rely on technical standards, such as CEN, ISO, and EN standards, regulatory guidance documents such as BAT/BREF documents under the EU Industrial Emissions Directive (IED), and standard rules including legally binding permit conditions.

GBRF criteria	Reference Countries	Brazil	Gaps
<p>Countries should:</p> <ul style="list-style-type: none"> <li>• Develop Industry-Wide Best Available Techniques (BAT) and Implementation Guidance for BAT.</li> <li>• Require risk-assessment-based plant design.</li> <li>• Develop design and construction standards.</li> <li>• Set operational standards for AD operations.</li> <li>• Require management systems and competence.</li> <li>• Require quality, management and use of outputs from operations.</li> <li>• Require emergency response planning.</li> </ul>	<p><b>Germany</b></p> <ul style="list-style-type: none"> <li>• VDI 4631 "Quality criteria for biogas plants").</li> </ul> <p><b>India</b></p> <ul style="list-style-type: none"> <li>• IS 9478:2023, Code of Practice.</li> </ul> <p><b>European Union</b></p> <ul style="list-style-type: none"> <li>• Has developed BAT "reference documents" and "conclusion documents" covering specific agro-industrial activities.</li> </ul> <p><b>Sweden and Denmark</b></p> <ul style="list-style-type: none"> <li>• TemaNord 2020:524: BAT in smaller biogas plants in the Nordic countries.</li> </ul> <p><b>United Kingdom</b></p> <ul style="list-style-type: none"> <li>• Generic risk assessment for anaerobic digestion facilities. <ul style="list-style-type: none"> <li>✓ Statutory guidance SR2021 No6.</li> <li>✓ Statutory guidance SR2021 No7.</li> <li>✓ Statutory guidance SR2021 No8.</li> <li>✓ Statutory guidance SR2021 No9.</li> <li>✓ Statutory guidance SR2023 No1: Capture, treat and store biogas from lagoons and tanks.</li> </ul> </li> <li>• OFGEM standards for the Green Gas Support Scheme set some technical standards for anaerobic digestion plant.</li> </ul>	<p>No comprehensive, unified technical standard covering all stages (design, construction, operation, and decommissioning).</p>	<p>No comprehensive, unified technical standard covering all stages (design, construction, operation, and decommissioning).</p>

Table 7: International benchmark on technical and operational standards

In England and Wales, a set of environmental permitting rules (standard rules permits) encompassing technical and operational standards for biogas plants covers each activity they perform. The Environment Agency (EA) sets out fixed, non-negotiable technical and operational requirements that biogas/AD operators must meet to qualify for a “standard rules” environmental permit. The EA also produces generic risk assessments for all standard rules permits, outlining potential risks and how to manage them, resulting in risk-assessment-based plant design. Facilities with a treatment capacity of less than 100 tonnes per day and accepting no more than 35,000 tonnes on site per year must comply with statutory guidance SR2021 No. 7 and SR2021 No. 9, while facilities with a treatment capacity of over 100 tonnes per day and accepting up to 100,000 tonnes on site per year must follow SR2021 No. 6 and SR2021 No. 8 to minimise risk. Statutory guidance SR2023 No. 1 applies to the capture, treatment, and storage of biogas from lagoons and tanks (Environment Agency of England, 2023). EA standard rules further define operational standards, including maximum plant capacity, permitted feedstocks, environmental protection measures, emission limits, storage and processing conditions, monitoring requirements, and engineering and safety specifications. Although these rules impose biogas industry-specific, detailed requirements on anaerobic digestion plants, they are regulatory permitting conditions, not technical standards in the sense of CEN, ISO, EN standards, or BAT/BREF documents. Nonetheless, in practice, they serve as detailed technical and operational benchmarks for AD plants, as obtaining the necessary operator permit requires adherence.

BAT, or best available techniques, should be understood as the environmentally “best” approaches, covering how plants are designed, built, maintained, operated, and the technologies they employ. EU member states are required to use the EU developed BAT reference documents, which cover specific agro-industrial activities, in integrated environmental permits. For instance, Poland has issued sectoral BAT implementation guidelines. However, these documents address biogas only indirectly (e.g. through manure used as a feedstock) and do not establish detailed BAT requirements for biogas plant design and operation.

The Nordic Council of Ministers, the official Nordic Region inter-governmental co-operation body (Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland and Åland), developed a Nordic BAT project for smaller biogas plants. This guidance seeks to support operators, environmental consultants, and environmental authorities in issuing environmental permits and supervising biogas installations that treat between 30-100 tonnes of feedstock daily. (Nordic Council of Ministers, 2020)

In Brazil, there is currently no comprehensive, unified technical standard equivalent to those in more mature markets that covers all stages of a biogas plant’s lifecycle (design, construction, operation, and decommissioning). Some reference documents and guides

exist, produced by industry associations such as ABiogás, and partnerships (public and private), including the GEF Biogas Brazil Project, which outline “good practice” recommendations for design, operation, safety and more. However, because there is no dedicated NBR (Brazilian Reference Standard) solely for biogas plants, practitioners and regulators frequently rely on a patchwork of reference standards from other sectors (labour, safety, construction, natural gas regulations), as well as on “natural gas / gaseous fuels” standards for areas including structural design, electrical installations, gas piping, emissions and workplace safety. This patchwork creates legal and technical uncertainty, irregular safety and environmental performance, and increases barriers for investors or developers who wish to follow “international best practices”.

### Recommendation

Brazil currently lacks a holistic, binding technical & operational standard regime for biogas. There is a significant opportunity to introduce:

- ✓ a national standard for design, construction, operation and safety of anaerobic digestion, biogas, biomethane, and bio-CO<sub>2</sub> plants (beyond just gas-quality and end-use requirements);
- ✓ integration of “best available techniques” (BAT) principles, covering emissions, waste, digestate management, gas upgrading, energy efficiency, safety, accident risk, and occupational safety, drawing on international experience;
- ✓ a more robust certification or compliance framework, accompanied by monitoring schemes for plant operation - not only for gas quality but also environmental and safety performance.

### 3.1.7 Permitting

This section outlines how an effective permitting system can support the safe and timely deployment of biogas projects, while maintaining strong environmental safeguards. A lack of streamlined permitting remains one of the most significant global challenges faced by the industry. The industry should aim to introduce and prioritise the principles of a risk-based regulatory approach, in which permitting requirements are proportionate to each project’s potential environmental impact, taking into account factors such as site sensitivity, project scale, the nature of feedstocks, and proposed mitigation measures.

### Analysis

Globally, there are very few exemplary models for biogas project permitting. In both mature and emerging markets, biogas and biomethane plants typically still require multiple separate permits and decisions issued through multi-stage and multi-authority permitting processes. As a result, developers face lengthy timelines, administrative uncertainty, and duplicated requirements. Nonetheless, certain reference countries have adopted some specific positive practices that demonstrate pathways for improving efficiency while maintaining high environmental and safety standards.

The European Union has taken steps to progressively simplify permitting for renewable energy projects, including biogas and biomethane, under the Renewable Energy Directive (RED II/RED III). The directive requires member states to establish a single administrative contact point and apply clear time limits to permit-granting processes, in order to reduce delays and administrative complexity, including provisions to accelerate permitting processes whilst ensuring public concerns and environmental standards are respected.

In the United Kingdom (UK), the Environment Agency (EA) applies a risk-based approach to environmental permitting. Rather than applying uniform requirements across all installations, the EA assesses facilities based on their risk profile, considering factors such as size, feedstock type, technology used, emissions potential, and proximity to sensitive receptors. This risk-based framework enables regulators to implement controls proportionate to the level of risk, concentrating the most stringent oversight on higher-risk sites. By incorporating pre-assessed risk criteria, such framework streamlines the permitting process, increasing its efficiency.

Mexico is in the process of introducing simplified biogas sector permitting mechanisms under the new Biofuels Law. This establishes two permitting regulatory pathways:

1. Large-scale commercial projects - The Federal Ministry of Energy issues permits for large-scale commercial biofuel activities, including: AD plants, biomethane upgrading, grid injection, and companies creating/transporting LBG.
2. Small-scale and research projects - A lighter touch approval regime for research projects, small-scale projects (e.g. community and on-farm), designed to reduce administrative burden and support innovation.

Brazil's permitting policies are mostly decentralised to states and regional governments. In the context of biogas and biomethane, the states of Paraná and São Paulo have both taken clear steps to streamline their permitting processes. These efforts have led to measurable improvements, including shorter licensing timelines, reduced duplication of documentation, more precise technical requirements for AD and upgrading plants, and more accessible digital platforms for application submission and tracking. In Paraná specifically, agro-industrial biogas projects have reported more predictable approvals due to clearer guidance on waste management and emissions control (Paraná, 2025). São Paulo has advanced the adoption of standardised criteria for biomethane projects, thereby increasing investor confidence and enabling faster project deployment (CETESB, 2024). These examples suggest that while permitting remains decentralised, Brazil is not lagging behind global peers. Several states are proactively modernising their procedures in line with emerging international best practice. However, Brazil has no national permitting guidelines for biogas and biomethane.

A more in-depth analysis of the existing permitting policies for biogas and biomethane in Brazil and globally could be developed. It would provide valuable insights into potential pathways that Brazil can pursue.

### Recommendation

Brazil has the opportunity to pioneer a single window permitting process for biogas projects that ensures national priorities are met whilst promoting positive economic, environmental, and social outcomes. A comprehensive review of current permitting practices across the country, based on the recommendations made in the GBRF, would help identify opportunities to streamline and harmonise permitting procedures in coordination with sub-national governments.

GBRF criteria	Reference Countries	Brazil	Gaps
<p>Countries must:</p> <ul style="list-style-type: none"> <li>• Take a risk-based approach to environmental regulation and use a hierarchy of regulatory tools based on risk.</li> <li>• Develop and implement a hybrid zoning and permitting matrix.</li> <li>• Offer an expedited service for biogas projects.</li> <li>• Develop a permitting template.</li> <li>• Develop a single environmental permitting framework.</li> </ul>	<p><b>United Kingdom</b></p> <ul style="list-style-type: none"> <li>• The England and Wales Environment Agency has generic risk assessments for all standard rules permits and a publicly available core guidance document that sets out how the Regulations should be applied.</li> <li>• The requirement to do a climate change: risk assessment and adaptation.</li> </ul> <p><b>European Union</b></p> <ul style="list-style-type: none"> <li>• Renewable Energy Directive includes provisions that simplify permitting processes to help set renewable energy projects in motion, while taking into account legitimate concerns of citizens and respecting environmental standards.</li> <li>• Guidance provided to Member States on good practices to speed up permit-granting procedures for renewable energy projects (SWD/2022/149).</li> </ul>	<p>Permitting policies are mostly decentralised to states and regional governments.</p>	<p>National permitting template for biogas projects.</p> <p>Expedited process for biogas projects.</p>

Table 8: International benchmark on permitting

### 3.1.8 Planning

Infrastructure planning is fundamental to the successful deployment of biogas projects. In addition to waste management and energy generation assets, biogas projects need to be embedded within strategic plans at the national and regional level. Achieving this requires a planning system that balances national priorities, such as decarbonisation, energy security and waste reduction, with local needs and constraints, including land availability, community acceptance and environmental protection. This section, therefore, outlines key considerations for integrating biogas infrastructure into planning policy, including spatial planning and zoning approaches, alignment with national frameworks, land allocation, standards for application assessment, balancing national and local interests, and community engagement.

#### Analysis

Across the EU, several Member States have established dedicated siting and land-use policies for biogas plants, providing clear, harmonised guidance for developers. Countries such as Germany and Denmark typically set explicit rules on minimum distances from residences and water bodies, designate zones where agricultural or agro-industrial AD facilities are permitted and apply consistent national or regional planning criteria. EU-wide directives complement these frameworks – including the Nitrates Directive, Waste Framework Directive and Industrial Emissions Directive – by establishing uniform standards for feedstock handling, digestate application and environmental protection.

As a result, biogas development in the EU generally benefits from predictable zoning classifications, well-defined permitting pathways and coordinated environmental requirements.

Brazil lacks tailored integration of biogas facilities into siting or land-use regulations. Instead, projects are governed by a combination of general land-use rules, municipal zoning plans, state-level environmental licensing requirements and federal environmental legislation such as the Forest Code. These instruments establish restrictions for installations in sensitive areas – including Permanent Preservation Areas (APPs), Reserved Legal areas, conservation units and indigenous or Quilombola territories – but they do not provide dedicated siting parameters for AD plants, such as minimum distance requirements or nationally defined biogas zoning categories. As a result, the siting of biogas plants in Brazil is determined on a case-by-case basis, creating significant variation between states and municipalities.

#### Recommendation

Biogas plants should be embedded and integrated within the local economy and supply chains. This includes sourcing feedstocks from local businesses, farms, and municipalities; supplying digestate to local farms or residents; employing local people and companies in the plant construction; and sourcing building materials and equipment locally wherever feasible.

GBRF criteria	Reference Countries	Brazil	Gaps
<p>Countries must:</p> <ul style="list-style-type: none"> <li>• Adopt spatial planning and alignment, zoning approach.</li> <li>• Integrating biogas facilities into the national planning policy framework.</li> <li>• Ensure suitable and adequate allocation of land.</li> <li>• Align planning with environmental permitting.</li> <li>• Ensure standards for evaluating planning applications.</li> <li>• Balance national interest with local needs in decision-making.</li> <li>• Consult and engage with local communities.</li> </ul>	<p><b>France</b></p> <ul style="list-style-type: none"> <li>• Decree number 2023-175 on the acceleration of renewable energy production. Title II simplification and territorial planning measures aimed at accelerating and coordinating the implementation of renewable energy projects and industrial projects necessary for the energy transition.</li> </ul> <p><b>Germany</b></p> <ul style="list-style-type: none"> <li>• The German Planning system implements a preparatory and legally binding land-use plan that considers facilities' measures to counteract climate change, such as renewable energy.</li> </ul>	<p>In Brazil, land use is defined by a set of laws, public policies, and territorial planning instruments that guide how different areas can be used – agriculture, livestock, environmental conservation, urban areas, indigenous reserves, etc.</p> <ul style="list-style-type: none"> <li>• Forest Code (Law 12,651/2012): establishes mandatory registration of rural properties (CAR)</li> <li>• City Statute (Law 10.257/2001): Regulates land use in urban areas and defines instruments such as: <ul style="list-style-type: none"> <li>✓ Master Plan (mandatory for cities with &gt;20,000 inhabitants).</li> <li>✓ Urban zoning.</li> <li>✓ Land use and occupation.</li> <li>✓ Urban land subdivision.</li> </ul> </li> </ul> <p><b>Zoning Laws and Municipal Master Plans:</b> The most direct instruments of urban land-use planning are decentralised to regional governments. They determine types of use (residential, industrial, commercial, mixed).</p>	<p>Lack of national land-use rules and land allocation procedures for biogas plants, as essential waste management and energy infrastructures.</p>

Table 9: International benchmark on planning

To support the sustainable expansion of biogas and biomethane infrastructure, Brazil should develop more precise, biogas-specific planning guidance at the national level. This would include establishing transparent standards for evaluating planning applications, to ensure decisions are predictable, evidence-based and proportionate to the risks involved, while aligning with both national priorities and local sensitivities.

### 3.1.9 Health, Safety and Environmental Protection

As with other energy operations, biogas plants require rigorous regulatory oversight to safeguard workers, the public, and the environment from the risks associated with the plant lifecycle - the design, construction, operation, and maintenance phases. Given the multifaceted nature of this sector, its risk profile incorporates factors from various industries, including waste and recycling, onshore gas production, agriculture (encompassing crop feedstocks and liquid/solid digestate), and construction (design, construction, and maintenance of assets). Establishing a comprehensive, national-level risk profile is essential for monitoring and benchmarking performance whilst guiding

continuous improvement. This section outlines the key health, safety and environmental protection considerations that regulators should address to ensure sector expansion is both safe and aligned with the Sustainable Development Goals.

### Analysis

The European Union Industrial Emissions Directive (2010/75/EU) requires implementation of an environmental management system (EMS), including risk assessment, planned preventive maintenance, staff training programmes, emergency plans, monitoring and performance indicators, and the use of best available techniques (BAT) as clarified in the guideline “BAT Conclusions for Waste Treatment (2018)” covering biological hazards associated with organic waste, safety systems, safe design principles, leak prevention, containment, and operational controls.

French legislation additionally covers items listed in the Global Biogas Regulatory Framework (GBRF) criteria. The Environmental Code regulates permitting for installations

GBRF criteria	Reference Countries	Brazil	Gaps
<p>Regulators should:</p> <ul style="list-style-type: none"> <li>Require a documented health and safety policy on site.</li> <li>Require the implementation of an environmental policy and an environmental management system (EMS) on site.</li> <li>Safeguard against biological risks.</li> <li>Ensure safety in design and operation.</li> <li>Ensure the competency of staff and contractors working on-site.</li> <li>Require sites have a plan for emergencies.</li> </ul>	<p><b>India</b></p> <ul style="list-style-type: none"> <li>Factories Act, 1948 requires an emergency plan to be prepared for sites that undertake hazardous processes (including CBG plants) and requires employers to ensure the health and safety of all workers on site. They must provide information, instruction and training.</li> <li>Occupational Safety, Health, and Working Conditions (2020) is the labour law in India, which is aimed at improving health and safety at work across a number of sectors. It requires protecting workers from biological risks, plants must have a written occupational health and safety policy, and all staff must be competent and trained.</li> <li>PNGRB T4S regulations ensure safety is considered in the design stage of AD plants.</li> </ul> <p><b>European Union</b></p> <ul style="list-style-type: none"> <li>EU Industrial Emissions Directive 2010/75/EU requires member states to have an EMS in place.</li> </ul> <p><b>France</b></p> <ul style="list-style-type: none"> <li>Labour Code requires all employers to have a documented health and safety policy.</li> <li>Environmental Code outlines the requirements for submission prior to the construction of an AD plant.</li> </ul>	<ul style="list-style-type: none"> <li>NR-20 - Health and safety at work with flammable and combustible substances.</li> <li>Resolution ANP 987/2025: Requires all authorised biomethane installations to have a risk assessment document archived, subject to inspection.</li> <li>Resolution ANP 987/2025: Requires all authorised biomethane installations to have: <ul style="list-style-type: none"> <li>✓ a plan for a security and fire protection system,</li> <li>✓ an area classification study,</li> <li>✓ reports on the Atmospheric Discharge Protection System (ADPS) and electrical grounding plan.</li> </ul> </li> <li>Resolution ANP 987/2025: Requires all authorised biomethane installations to have: <ul style="list-style-type: none"> <li>✓ operating procedures with instructions for carrying out the facility's operational activities, covering at least start-up, shutdown and everyday operation situations,</li> <li>✓ equipment inspection and maintenance plan(s),</li> <li>✓ proof of use and procedure for issuing work permits for non-routine activities.</li> </ul> </li> <li>Resolution ANP 987/2025: Requires all authorised biomethane installations to have proof of staff training and a certified board professional responsible for operating the site.</li> <li>Resolution ANP 987/2025: Requires all authorised biomethane installations to have an emergency response plan.</li> </ul>	<p>There are guidelines for biomethane along with other biofuels, but no national-level guidelines for biogas plants intended for heat or electricity production.</p>

Table 10: International benchmark on health, safety, and environmental protection measures

classified for environmental protection (ICPE), covering a wide range of activities, including waste treatment, energy production, and the handling of hazardous substances. The Labour Code sets out employer obligations for worker protection. Together, these instruments address core health, safety, and environment elements, such as documented safety policies, EMS requirements, biological risk mitigation, design and operational safety, staff and contractor competency, and emergency planning. However, there is no single, specific, consolidated HS&E framework or risk profile for the biogas industry at the national level.

In emerging markets such as India and Mexico, HS&E regulations exist but are typically general rather than biogas-specific. India's Factories Act (1948) requires emergency plans for sites undertaking hazardous processes (including biomethane plants) and mandates that employers ensure the health and safety of all workers on site, including through information, instruction and training. The Occupational Safety, Health and Working Conditions Code (2020) strengthens these obligations, including protections for workers against biological risks and requirements for written occupational health and safety policies. While these laws apply to biogas facilities, the absence of sector-specific provisions can limit the effectiveness of risk mitigation, potentially leading to uneven social and environmental outcomes.

In Brazil, the National Agency of Oil, Gas, and Biofuels (ANP) regulates biomethane quality standards. This includes authorising and overseeing production facilities and commercialisation of biomethane, establishing rules for Guarantees of Origin (CGOB), and regulating biomethane's integration into Brazil's natural gas market through the transmission system, ensuring safety, compliance, and traceability. Resolution ANP 987/2025 establishes authorisation rules for the production of biofuels, including biomethane, and sets out documentation requirements for the operation of production installations, covering physical-chemical properties, handling and storage procedures, health and safety measures, and environmental considerations.

For biomethane derived from certain feedstocks, the resolution requires additional technical documentation proving the installation has:

- (a) a microorganism-retention filter,
- (b) an odorization system,
- (c) when applicable, a secondary containment barrier.

This regulation is technology-agnostic, enabling biomethane facilities to integrate into broader biofuel policy frameworks.

## Recommendation

Although Brazil has guidelines for biomethane plants regulated by the National Agency of Oil, Gas, and Biofuels, and Resolution ANP 987/2025 safeguarding health, safety and environmental protection, these provisions only apply to biomethane installations; Brazil lacks equivalent HS&E guidance for biogas plants producing heat or electricity. Rather than establishing a separate guide or regulatory pathway, Brazil could explore developing a single, comprehensive HS&E framework and national risk profile for the biogas industry.

Such a framework would provide consistent, predictable requirements across biogas and biomethane facilities, supporting safe sector expansion with ensuring protection of workers, communities and the environment.

## 3.2 Conclusion

Overall, the policy benchmarking analysis shows that, while Brazil has made important strides in establishing instruments to support the biogas sector, it still lags behind more mature global markets in strategic coordination, regulatory clarity, financing mechanisms, and technical and safety standards. The comparison highlights that leading countries have adopted integrated national strategies, robust digestate and feedstock policies, and well-defined gas quality and operational standards, creating stable conditions for investment and innovation. Brazil, on the other hand, presents a patchwork of promising but dispersed initiatives that would benefit from consolidation into a coherent national framework. Canada and the United States, although recognised as mature markets, have not been featured in the exemplar policies section. This reflects the fact that, despite the scale and longevity of activity in these jurisdictions, their policy frameworks do not currently demonstrate the same level of coherence, consistency, or replicability as those highlighted elsewhere, particularly in relation to clearly defined, nationally coordinated measures that can be readily transferred or adapted to other contexts. The following section assesses Brazil's current technological position and outlines practical pathways to strengthen domestic capabilities across technology supply, feedstock optimisation, digester design, biogas applications, and digestate management.

## 4. Technical Benchmarking

### 4.1 International technology benchmarking comparison

This section of the report compares the Brazilian biogas sector to the 11 pre-selected countries, using a series of technical criteria that will highlight Brazil's performance relative to international peers regarding technology sourcing, types of digester biogas production and application, feedstocks use, and digestate utilisation.

#### 4.1.1 Origin of technology

The origin of AD technology used in each country provides insights into how countries structure and grow their biogas industries. *Table 10* compares Brazil's technology-sourcing strategy with those of emerging and mature biogas markets. Understanding whether markets prioritise domestic innovation, international imports, or a hybrid approach, helps indicate the development stage of the industry and highlights opportunities and vulnerabilities within each approach.

#### Analysis

Research on the origin of AD technologies displayed in *Table 10* reveals significant distinctions in sourcing strategies for anaerobic digestion (AD) technology across markets. The information was compiled through a combination of publicly available data and practical, market-informed insights into suppliers and products.

Brazil stands out as the only emerging market that relies on both domestic and international sources for its technology and equipment. In contrast, most emerging markets - such as Poland, Mexico and Portugal - primarily rely on importation of technology and equipment, versus India which predominantly uses nationally sourced technologies.

Mature markets such as Canada, France, Germany, the UK, and the USA favour primarily domestic solutions, reflecting established domestic industries with strong technological knowledge. However, some mature markets, such as Denmark and Sweden, continue to rely on foreign suppliers for industry growth despite having strong domestic AD industries. Interestingly, other European countries with national production capabilities, such as France, also import technologies. This phenomenon is likely due to their geographic location, with the ease of intra-EU logistics making imports from neighbouring EU countries such as Germany (an early mover in the sector and now a global leader in biogas technologies) representing a negligible financial and logistical challenge.

Brazil's technology-sourcing strategy differs significantly from other emerging markets. India's AD industry is predominately nationally focused, thanks to comprehensive government programmes, and policy incentives, enabling widespread availability of domestic technologies, especially in rural areas (Koonampilli, Kavya; World Biogas Association, 2024) (Shashidhara, 2024). In contrast, Mexico faces slow sector development and heavy dependence on imported equipment, with local supply and government support remaining

Country	National (Country)	International (Continental and trans-continental import)
Brazil	✓	✓
Canada	✓	✓
Denmark		✓
France	✓	✓
Germany	✓	✓
India	✓	
Mexico		✓
Poland		✓
Portugal		✓
Sweden	✓	✓
UK	✓	✓
USA	✓	

**Table 11: Origin of technology**

limited, hindering domestic technical reliability and (Borja-Vega & Aragon-Briceño, 2018). Brazil's dual strategy of combining domestic production with international imports is closer to mature European market strategies than its emerging market counterparts. This dual approach grants Brazil's AD industry both versatility and flexibility, through allowing them to leverage proven international technical expertise whilst developing their local market.

Finding balance between improving the domestic technology production and relying on certified foreign technology will be a key aspect in developing a successful Brazilian biogas market. Domestic technology may not yet cover all market needs or match the performance of imported equipment, and a less reliable domestic technology risks hindering national growth or damaging market confidence. Conversely over-reliance on imports introduces vulnerabilities to international market dynamics and supply chain disruptions. Brazil could, in theory, adopt a "domestic-only" strategy, similar to the USA or India, but its rapid biofuel demand expansion needs, combined with immense untapped biogas potential (World Biogas Association; Karina Navarro, 2025) (Anaerobic Digestion Community, 2024) require the active integration of proven global solutions and expertise. Finding a balanced approach, maintaining access to and adopting cutting-edge technologies from abroad while simultaneously investing in strengthening domestic technological capacity, will be crucial for Brazil's long-term success through ensuring the sector is grown using best technologies, to secure long-term competitiveness.

## Recommendation

Brazil's biogas industry is expanding rapidly but faces strategic decisions that will shape its long-term sustainable growth. Brazil benefits from international technological imports but must ensure it also prioritises strengthening its domestic technological ecosystem to reduce dependency on foreign suppliers, mitigate supply-chain risks, and stimulate local economic development through job creation. Building robust local research, manufacturing, and technical support infrastructure would enable Brazil to address sector challenges with locally tailored solutions and enhance its global competitiveness.

As one of the earliest biogas movers in South America looking into improving its domestic manufacturing of biogas technologies, Brazil has potential to benefit from becoming a regional exporter of biogas technologies, especially as neighbouring countries begin to scale their AD industries in the region.

Key to these recommendations is for Brazil to maintain its openness to international collaboration, while accelerating the development of domestic technologies, capabilities and infrastructure to support long-term resilience and regional leadership.

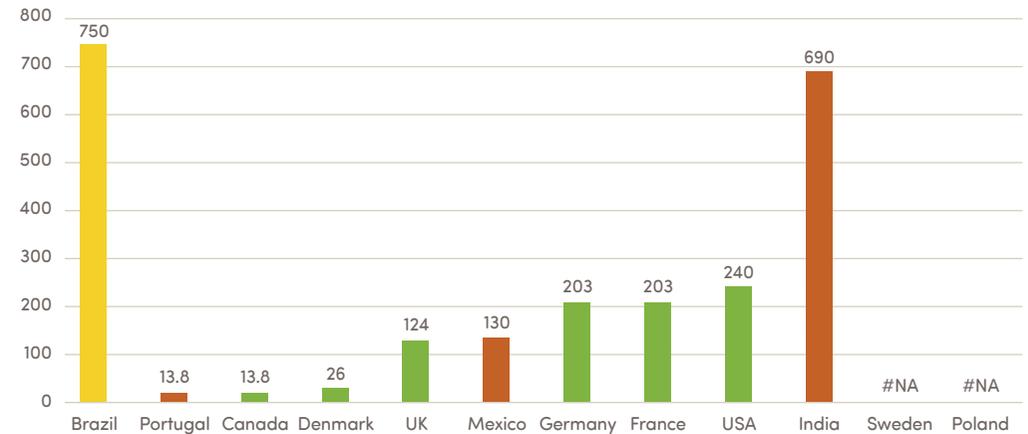
### 4.1.2 Feedstocks

A country's feedstock availability and energy potential is a key factor in assessing a country's capacity to develop and scale a strong and resilient biogas industry. *Figure 4* and *Table 11* compare Brazil's current feedstock energy potential against the feedstocks being used across the reference countries. The analysis will examine whether Brazil is fully capitalising on its vast feedstock availability and potential and whether further efforts are needed to valorise feedstocks effectively.

### Analysis

*Figure 4* shows that Brazil has the highest feedstock energy potential of all countries in this benchmarking exercise, with 750 TWh available from anaerobic digestion – surpassing India (690 TWh) and far exceeding mature markets such as the UK, USA, France, and Germany. This gap highlights a theoretical market dominance: if fully exploited Brazil could position itself as a global leader in biogas production.

*Table 11* demonstrates that, alongside quantity, Brazil also has a highly diverse feedstock base available for use; from animal manure and agricultural waste to food waste and wastewater. This mirrors the feedstock profiles of most mature markets such as the USA and France, which prioritise the use of animal manure and agricultural waste without neglecting additional feedstocks including food waste and wastewater. On the other hand, emerging markets like Portugal and Mexico source only one or two primary feedstocks, reflecting their narrower waste-management systems and less diversified AD industries.



**Figure 3: Feedstock Energy Potential (TWh)**

Another notable characteristic of the most mature markets is use of co-digestion processes. Particularly in Germany, France, the UK and the USA, household and industrial food waste feedstocks are mixed with other feedstocks, such as wastewater in the USA, to enhance process efficiency and energy yield (US EPA, 2025). In contrast, emerging markets including Brazil, don't yet widely co-digest food waste with other types of feedstocks. This disparity in process and treatment of feedstock may be attributed to differences in the maturity of available technology, waste collection infrastructure, or policy drivers, with established market incentivising biogas production from AD as a form of urban and industrial waste management instead of centring it around agricultural residues.

Brazil's predominance of animal manure and agricultural waste as primary feedstocks reflect the country's vast cattle industry and expansive agricultural sector (World Biogas Association; Karina Navarro, 2025). India's feedstock profile for biogas production is similar with high agricultural availability and manure use, yet it does not fully exploit its food waste and wastewater (Koonampilli, Kavya; World Biogas Association, 2024). This represents a missed opportunity in both countries, given their growing urban populations and resulting increased food waste production and management pressures. Conversely, mature markets such as Germany, the UK, and France display diversified feedstock profiles but show lower total feedstocks energy potential. This lower energy potential likely reflects the realities of their advanced industries, which are efficiently exploiting their feedstock resources and processing their diverse range of feedstocks through efficient waste-management systems. For example, with a similar feedstock energy potential of 203TWh, France and Germany have respectively managed to exploit 11.3% and 42.85% of their energy potential from biogas (*Figure 4* and *Figure 6*) and are considered leaders of the biogas sector despite still being below 50% energy potential exploited.

Country	Feedstock 1	Feedstock 2	Feedstock 3	Feedstock 4
Brazil	Animal manure	Agricultural waste	Household and industrial food waste	Wastewater
Portugal	Animal manure			
Canada	Household and industrial food waste	Wastewater		
Denmark	Household and industrial food waste codigestion with other feedstocks	Wastewater	Animal manure	Agricultural waste
Mexico	Household and industrial food waste			
Germany	Agricultural waste	Household and industrial food waste codigestion with other feedstocks	Animal manure	Wastewater
France	Animal manure	Agricultural waste	Household and industrial food waste codigestion with other feedstocks	Wastewater
USA	Animal manure	Agricultural waste	Wastewater	Household and industrial food waste codigestion with other feedstocks
UK	Agricultural waste	Household and industrial food waste codigestion with other feedstocks	Wastewater	Animal manure
India	Agricultural waste	Animal manure	Wastewater	Household and industrial food waste
Sweden	Household and industrial food waste codigestion with other feedstocks	Wastewater	Animal manure	Agricultural waste
Poland	Agricultural waste	Household and industrial food waste		

**Table 12: Feedstock used by country (Ranked by usage, from most to least)**

While these mature markets are taking advantage of the feedstock diversity available to them, Brazil's high energy potential suggest the country's biogas sector has not yet begun to exploit its vast resources for at scale energy generation, only tapping into 1.33% of its total theoretical biogas potential in recent years, far behind the German example (42.85%). In contrast, India, despite being another emerging market and having slightly lower potential, has concentrated on rapid expansion of its domestic AD market with national policy support and focus on rural accessibility, making significant progress especially for agricultural and manure-based systems (Shashidhar, 2024). This has positioned India as an emerging leader in terms of volume of biogas produced (Figure 6).

### Recommendation

Brazil's feedstock quantity and diversity represent a major strategic advantage, granting flexibility in resource utilisation to underpin a resilient and scalable biogas from AD sector, capable of adapting to shifts in agricultural and urban waste output. However, large portions of available feedstock remain untapped, with sector growth constrained by a lack of requisite infrastructure and insufficient technology and waste management policies to facilitate sourcing and processing of feedstocks.

The sectors future success will depend on closing the gap between the 750TWh potential and the current realised capacity of 10 TWh (Figure 6). This will require:

- ✓ Learning from policy-led growth models, drawing from European waste-segregation and collection strategies, to adopt efficient waste management policies for sourcing feedstock (European examples listed in section 3.1.3).
- ✓ Develop national policies supporting local market development through incentives and technology advancement support, following the example of India.
- ✓ Expand infrastructure for feedstock collection, transport and pre-treatment.
- ✓ Integrate food waste and wastewater more systemically.

Improve policy alignment between the waste management and energy sectors. Addressing these structural and regulatory barriers would aid in unlocking the feedstock advantage Brazil possesses, allowing realisation of its capacity to be a global biogas industry leader.

### 4.1.3 Digesters

This section examines the scale of biogas markets and anaerobic digester technologies across emerging and established markets, providing insights into the relative maturity and structural characteristics of each country's biogas sector. *Figure 5* presents the number of active digesters per country, while *Table 12* identifies the most prominent digester types in each market.

By analysing both the quantity and type of digesters, it is possible to position the Brazilian biogas industry relative to the global biogas landscape of established and emerging markets, identifying key factors that may enhance sector efficiency, technology adaptation, and future growth potential.

#### Analysis

The comparative data in *Figure 5* and *Table 12* demonstrates that Brazil, with 1,633 AD plants above most countries surveyed, but lags significantly behind Germany, which leads with 10,090 active digesters. Germany's position reflects their high level of market maturity, supported by a substantial policy environment, and extensive integration of AD within agricultural and municipal waste systems. The USA and France also represent strong established industries, with 1,917 and 1,830 digesters respectively, forming a cluster of mature markets positioned numerically only moderately ahead of Brazil. Among emerging markets, India's 876 digesters indicate significant ongoing development, but at a density that remains low relative to the country's massive feedstock potential. Meanwhile, the lower end consists of a mix of established and emerging markets in the UK, Sweden, Mexico and Canada; operating a smaller yet meaningful number of plants, especially when compared with Poland, Denmark, and Portugal's very limited installations.

However, the lack of consistency in national reporting practices for AD plant numbers is an important limitation to consider. The US, Brazil, Mexico and India include small scale (sub-0.5MW) digesters, such as on-farm plants, in their census. Potentially significantly inflating their totals relative to countries including Portugal, the UK, Germany and France, who only account for large scale plants usually with capacities over 1MW. As a result, some leading established markets, like the UK or France, appear to have substantially lower numbers of digesters than some emerging markets, despite deploying on average larger plants with higher production capacity. This discrepancy is evident when comparing markets total biogas production (*Figure 6*), as well as considering the prevalence of CSTR reactor use (*Table 12*), typically deployed in larger-scale installations.

Brazil's intermediate position in digester numbers, coupled with their technological diversity, suggests an emerging market with ambitions that privilege practicality. Indeed, the dominance of cheaper technologies such as lagoon and UASB reactors represents a

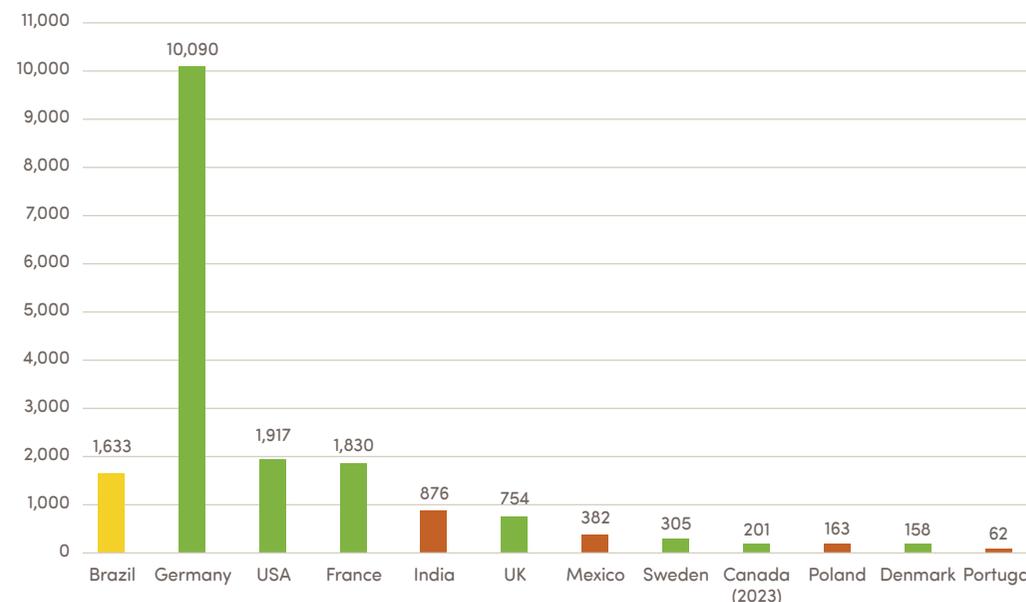


Figure 4: Number of digesters by country

consistent pattern including other emerging industries such as India and Mexico (*Table 12*). Most likely reflecting efforts to keep costs down and take advantage of existing agricultural and municipal systems. However, this may come at the expense of the higher efficiency and productivity offered by large-scale CSTR fleets seen in mature markets like the USA and Germany.

Brazil's comparatively low digester density relative to its theoretical feedstock potential (*Figure 4*), combined with limited deployment of large-scale, higher-capacity systems, signal that barriers including insufficient investment, regulatory complexity, and fragmented infrastructure may be constraining the pace and scale of Brazil's biogas sector development.

#### Recommendations

Brazil's biogas sector displays considerable flexibility, technological adaptation capabilities, and potential for further expansion. Nevertheless, the current predominance of low-efficiency infrastructures constrains growth, especially when compared to the scale achieved in Germany, or the high-efficiency, lower-density configurations typical of France and the USA.

Country	Feedstock 1	Feedstock 2	Feedstock 3
Brazil	Covered Lagoon (with or without mixer)	Rigid vertical (upward flow/UASB*)	CSTR*
Germany	CSTR	Rigid vertical (upward flow/UASB)	
USA	CSTR	Covered Lagoon (with or without mixer)	Rigid vertical (upward flow/UASB)
France	CSTR	Rigid vertical (upward flow/UASB)	
India	Covered Lagoon (with or without mixer)	CSTR	
UK	CSTR	Rigid vertical (upward flow/UASB)	
Mexico	Covered Lagoon (with or without mixer)	CSTR	
Sweden	CSTR	Rigid vertical (upward flow/UASB)	
Canada	CSTR	Covered Lagoon (with or without mixer)	
Poland	CSTR		
Denmark	CSTR	Rigid vertical (upward flow/UASB)	
Portugal	CSTR		

\*UASB: Upflow Anaerobic Sludge Blanket (Most common for wastewater treatment)

\*\*CSTR: Continuous Stirred Tank Reactor

**Table 13: Digester types used by country (Ranked by usage, from most to least)**

To accelerate progress, Brazil should aim to prioritise installations of higher capacity digesters, fostering CSTR adoption for higher yields, and leveraging lessons from countries with mature, policy-supported markets as well as high feedstock availability and diversity. Strategic emphasis on a lower number of higher capacity and more efficient systems (mirroring UK strategy) over a high density of low capacity and efficiency technologies, will be crucial to unlocking Brazil's vast biogas potential and advancing its competitiveness in the global AD market.

Sub-national strategies (state or city level) should also be considered to ensure Brazil continues to benefit from the advantages of a strong network of small digesters and rural feedstock opportunities, harnessing and reinforcing the potential of this existing network through a model similar to India's.

By taking a dual approach, prioritising large scale CSTR systems with high capacity and efficiency for national energy integration, while continuing to support small scale systems for rural access and local community socio-economic benefits, Brazil has the opportunity to leverage two very strong advantages of the biogas sector: the ability to produce renewable energy at national scale and its capacity to empower communities at local scale.

#### 4.1.4 Biogas application

Biogas utilisation is a strong indicator of sector maturity, including the range of revenue creation opportunities available to producers. More mature biogas industry's usually favour higher-value products that require advanced technologies (biomethane upgrading), while less developed industries opt for electricity and heat generation with the associated lower costs and easier deployment.

The comparative data in Figure 6 and Table 13 on 2024 energy production from AD, highlight Brazil's relative position among emerging and established biogas markets in terms of total biogas output and diversity of end-uses, allowing for deeper analysis of its current state and opportunities for biogas utilisation relative to global peers.

#### Analysis

Brazil's 2024 total biogas output of 10 TWh (Figure 6), sits far below its theoretical massive feedstock potential of 750 TWh (Figure 4), as well as substantially behind established AD leaders like Germany (87 TWh), the USA (61.6 TWh), and France (25 TWh). Even India, the most similar emerging market to Brazil, demonstrated significantly higher 2024 energy production of 37.7 TWh. Furthermore, Denmark's comparable energy production to Brazil is done on a notably smaller feedstock base, a characteristic the UK shares whilst producing double Brazil's 2024 energy output.

Particularly when benchmarked against India, with its broadly similar feedstock availability, the underperformance of Brazil's AD sector indicates missed opportunities to scale production and optimise feedstock use. The low conversion ratio between potential and actual production suggests structural constraints, including insufficient investment, underdeveloped infrastructure, and both unsatisfactory operational and technological efficiency, that prevent more full exploitation of its biogas resources.

Although Brazil's application diversity holds similarities to other mature markets, its deployment of more advanced technologies remains limited. According to Table 13, Brazil currently utilises biogas for electricity and heat generation, whilst also operating 47 biomethane plants (World Biogas Association; Karina Navarro, 2025) alongside stated ambitions to explore sustainable aviation fuels and biomethane for vehicles. Brazil's North American counterparts, the USA and Canada, limit their biogas applications to electricity, heat and biomethane to grid, similar to most emerging markets like Poland and India. However, European leaders like France, Germany, and the UK, have already established multi-modal biomethane uses, alongside traditional electricity and heat, with additional ambitious hydrogen production integration in the UK. Mexico, despite lagging behind other emerging markets in terms of plant numbers and production capacity (Figure 5, Figure 6) has articulated ambitions to develop biomethane usage for both grid injection and transport, alongside exploring hydrogen production, aligning with European model trajectories.

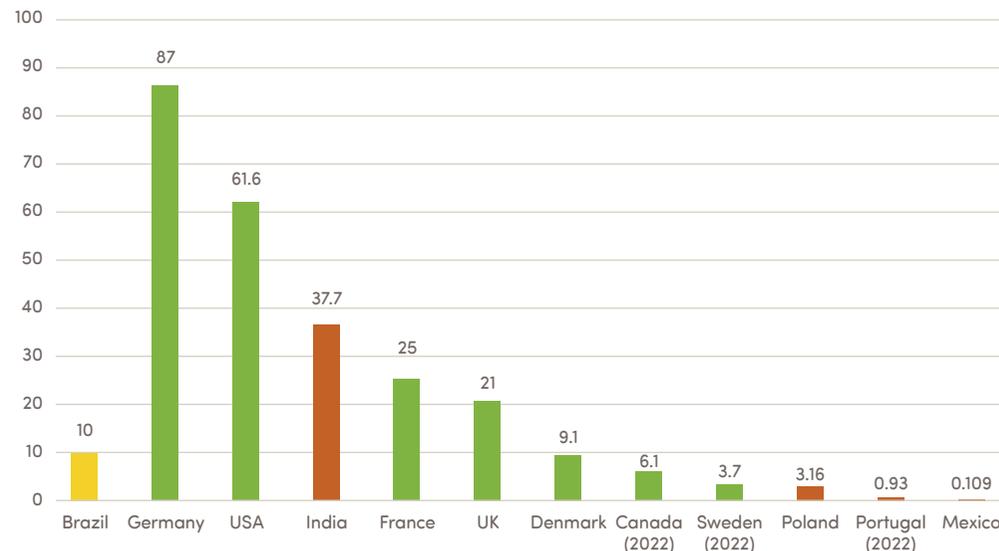


Figure 5: Total energy production from anaerobic digestion by country (TWh)

Country	Electric Energy	Thermal Energy	Biomethane (to grid)	Sustainable Aviation or Maritime Fuel	Biomethane for vehicle fuel	Hydrogen Production
Brazil	✓	✓	✓	+	✓	
Mexico	✓	✓	+		+	+
India	✓		✓			
Poland	✓		✓		+	
Portugal	✓		+			
USA	✓		✓			
Canada	✓	✓	✓			
France	✓	✓	✓	✓	✓	
Germany	✓	✓	✓		✓	
UK	✓	✓	✓	✓	✓	✓
Sweden	✓	✓	✓	✓	✓	
Denmark	✓	✓	✓		✓	

✓ Current biogas application; + Aim to develop this biogas application

Table 14: Biogas application by country (Actual and Ambitions)

## Recommendations

The comparative analysis strongly suggests that Brazil’s limited AD energy output is an issue of market structure, sector maturity and prioritisation of technologies rather than resource constraint. This is positive for the scaling potential it implies, particularly as countries with similar feedstock resources achieve far higher outputs.

Infrastructure scaling (gas grid expansion), investment incentives (feed-in-tariffs), advanced technology deployment (biomethane to grid), and adequate regulatory frameworks are all pivotal factors that promote strong and diverse biogas applications. Sweden, France and the UK have all benefitted from optimised feedstock conversion and diversified applications, following government policies pushing the sector’s technical knowledge and infrastructure forward.

Brazil’s ambitions to develop sustainable aviation and mobility fuels are promising, reflecting international best practice. However, realising this potential will require a significant scale up in CSTR deployment, facility upgrades, and supporting innovation to match established markets.

Catching up with leading mature markets will require sustained investment in advanced technologies and willingness to produce higher cost but higher-value outputs

(biomethane, sustainable aviation fuel). Alongside establishing a clear policy framework: setting targets (blending mandates, sustainable fuel mandates) and improving national infrastructure (grid pipelines and entry points for biomethane injection).

A coordinated policy and investment approach would significantly shorten the timeline to increase Brazil’s biogas production, diversify its portfolio of high-value applications, and accelerate the deployment of advanced technologies. This would support both national decarbonisation goals and broader value-chain development, enabling Brazil to position itself alongside global leaders in the biogas and biomethane sector.

### 4.1.5 Digestate

Valorising digestate represents a significant source of income for the biogas sector; however, securing access to the fertiliser market remains a challenge in multiple countries. Where digestate is unable to enter agricultural or commercial markets, it can become a disposal burden that undermines the economics of AD projects. *Table 14* summarises digestate management practices across a range of emerging and mature markets, enabling assessment of Brazil’s performance and identifying actions needed to increase digestate valorisation

Country	Used by local farmers (in exchange of feedstock)	Access to fertiliser market	Discarded (no market/no user)
Brazil	✓	✓	✓
Portugal			✓
Germany	✓	✓	
USA	✓	✓	✓
India	✓	✓	
France	✓	✓	
UK	✓	✓	
Denmark	✓	✓	
Canada	✓		
Sweden	✓	✓	
Poland	✓	✓	
Mexico	✓		

Table 15: Digestate opportunities by country

## Analysis

According to Table 14, Brazil demonstrates mixed digestate utilisation practices: it is commonly used by local farmers in exchange for feedstock, alongside access to the broader fertiliser market, allowing digestate to function as a revenue-generating co-product. However, in some instances digestate is still discarded, likely due to an absence of willing local users, a lack of market entry or challenges meeting fertiliser standards. These gaps highlight clear opportunities for optimisation.

In contrast, most established AD markets, like Germany, USA, France, UK, Denmark, and Canada, avoid discard by predominantly valorising digestate through either agricultural reuse or commercial fertiliser sales, thereby minimising wastage and maximising value creation. The USA discards digestate in some instances at wastewater treatment plants to reprocess it (US EPA, 2025).

At the other end of the spectrum, emerging markets such as Mexico and Portugal exhibit similar challenges with digestate as those seen in Brazil. A reliance on farmer digestate-feedstock exchange is present, with persisting substantial barriers to fertiliser market integration, resulting in digestate surplus and so disposal.

## Recommendations

Brazil's mixed performance on digestate reflects both good practice and systemic challenges. As in many biogas markets, Brazil benefits from a widespread digestate-feedstock exchange model, advancing local opportunities and fostering a circular economic pattern, whilst nurturing strong sectoral ties between the biogas and agricultural sectors. However, the persistent discarding of digestate implies incomplete market integration. Key barriers may include regulatory gaps, insufficient quality standards, a lack of renewable fertiliser incentives, and hypothetically a farming sector lacking awareness of digestate's agronomic value for the soil. Compared with established markets like Germany or the UK, where near-total productive outlets for digestate utilisation is supported by strict standards and a well-developed regulatory framework (Environment Agency, 2025) (European Union, 2019), Brazil requires further progress to fully integrate digestate into the fertiliser market.

Digestate needs to be positioned as a key component of Brazil's broader biogas value chain. To better unlock its potential, Brazil should focus on enforcement of quality standards for digestate (such as plastic limits), alongside expanding farmer educational outreach on digestate advantages to facilitate its uptake. Coupled with incentives to reduce the use of artificial fertilisers, these initiatives will help eliminate digestate waste, enhancing the value of biogas production, supporting a sustainable circular economy and improving soil health.

## 4.1.6 Challenges

Both established and emerging biogas markets face operational, technical, and financial challenges that dictate the best development pathway they should follow for optimal growth. A comparative analysis of these challenges helps position Brazil relative to its global peers, supporting the development of targeted, actionable recommendations to tackle said challenges and accelerate sector growth.

### Analysis

Financial obstacles are a universal contributor to underperformance and slow development, regardless of industry or country. Established markets often cite financing as a major barrier to further growth. The Brazilian biogas sector should take financing into account, with stronger government incentives to facilitate investment in more efficient and complex technologies. However, as an emerging market, the Brazilian sector does not yet fully capitalise on all the existing revenue opportunities offered by the biogas sector, most significantly full monetisation of the digestate stream or maximising biogas production to take advantage of its high feedstock availability.

Omitting the technology gap, a plausible key factor limiting Brazil's ability to harness the full potential of its existing biogas industry is a lack of knowledge and expert operators able to maximise the output of their biogas facilities. Skill shortages are a recurrent challenge across mature and emerging markets. Countries such as Mexico, Poland and India (Annex) report limited opportunities to access trainings, leading to a lack of fully trained operators. Even established markets like Canada face increased risk from working operators with low levels of technical understanding. Italy's current shortage of skilled energy sector workers to meet their growing biomethane demand has even led to the September 2025 launch of The Biomethane Academy, a sector backed training academy aiming to bridge the current gap quickly and efficiently through training for plant operators and managers. (Consorzio Italiano Biogas, 2025) Lack of skills and knowledge not only affect daily operations, reducing technology performance, but also slow adoption of advanced digester technologies, ultimately constraining biogas yields in the short and long term.

Identifying the key constraints limiting Brazil's biogas production potential is vital for developing the solutions needed to overcome them and unlock national sector growth. *Figure 4* and *Figure 6* show that Brazil's current realised energy output from AD is only a small fraction of its theoretical potential, suggesting operational inefficiencies, gaps in technology uptake, and suboptimal process management when compared with market leaders like Germany and the UK. Brazil's relatively small and fragmented biogas network also contributes to skilled AD personnel shortages, mirroring challenges observed in Mexico and India. The sector's youth and decentralised structure limit opportunities for knowledge sharing, technical training, and coordinated collective scaling.

Exploring *Table 14* further, digestate management and valorisation challenges further highlight systemic barriers, reflecting both the market's immaturity and its incomplete integration with the markets of its secondary products. While Brazil enables on-farm digestate reuse and some fertiliser sales, significant volumes are still discarded due to inadequate market infrastructure, a lack of regulatory standards and persistent perception barriers. Addressing logistical, regulatory and perception obstacles is essential to enable digestate's economic and agronomic value, granting the biogas sector an additional constant stream of revenue whilst supporting a circular economy model.

### Recommendations

As an emerging market facing a plurality of challenges, Brazil should focus on a coordinated strategy centred on professional development pathways, regulatory strengthening, and market integration to accelerate sector growth.

The Brazilian biogas industry should implement sector-specific training programs to facilitate professional development, increasing the knowledge and skills of existing personal. Additionally, they should promote networking opportunities and spaces to generate interest in

the industry. An increase in operators' skills will simultaneously facilitate technology adoption, support national innovation efforts, and ensure the biogas industry operates efficiently with minimised risk.

Greater digestate market integration is also needed to reduce waste, provide an additional revenue stream, and strengthen the economic performance of AD facilities. This will be realised through development of specific regulations to support digestate valorisation and fostering strategic partnerships between the AD and agricultural sector.

By focusing on the professionalisation of the industry and developing the underused digestate market, the Brazilian biogas industry can work towards fully realising the revenues from its existing biogas infrastructure, enhancing sector resilience and providing the confidence and capital to support the broader transition to a high-value, diversified biogas market. In doing so, it can create more long-term momentum to unlock Brazil's vast biogas opportunities and sustainable revenue through technological adoption, innovation, diversification of biogas applications and a skilled workforce.



## 5. Easy wins for the Brazilian biogas market growth

As Brazil positions itself to become a global leader in renewable energy, the biogas sector stands out as one of the country's most accessible and high-impact opportunities to accelerate the green transition. Building on Brazil's abundant organic waste streams, strong agricultural base, and rapidly expanding biomethane market, a range of practical, high-value policy measures can unlock immediate gains for national growth. The following 'easy wins' summarise the benchmarking comparison carried out in this report, outlining the targeted actions that policymakers, industry leaders and financial institutions can take to catalyse biogas deployment, strengthen technological capabilities and promote economic and environmental benefits across the country.

**1. Create a national biogas action plan, supported by state-level plans, to ensure a strategic, coordinated approach to developing the sector.** Policies and regulations needed to support a high-performing biogas industry are spread across multiple government departments and agencies, and without alignment, the industry cannot scale effectively. The action plan must include time-bound actions with defined ownership, be developed through robust and inclusive stakeholder engagement to secure buy-in and align across all sectors. It should also incorporate a financial plan, supply chain modelling, capacity-building requirements, an implementation plan, and a monitoring and evaluation framework to ensure feasibility and accountability. [3.1.1]

A well-structured biogas action plan aligned with the Global Biogas Regulatory Framework and reflecting all easy win recommendations in this section will provide direction and signal long-term commitment to investors, attract public and private investment, standardise technical and environmental rules, accelerate project deployment and create jobs. This will position Brazil as a world leader in the biogas industry and enable it to scale effectively. [3.1.1]

**2. Develop waste management policies with a mandate for waste segregation at source and stringent feedstock collection mechanisms** to maximise urban organic waste recycling and unlock the country's biogas potential by ensuring a reliable stream of feedstock to biogas from AD facilities. Over 45% of Brazil's MSW is organic waste. In the Southern region, 69.3% of the population is served by separated collection services, whereas in the Northeastern region, only 4.4% of the population has access to such services. (Clean Air Task Force; THINKCities Consulting; PNRS Institute; WasteMAP, The Waste Methane Assessment Platform, 2025) [3.1.3] [4.1.2]

**3. Support local innovation, research and development, diversification of biogas applications, and national technology suppliers** to develop a strong national technological hub, scale up infrastructure, and establish special tax regimes for technology imports to maintain the resilience of the industry during this growth stage. Policies must be enacted by the Brazilian government to encourage diversification

of biogas applications beyond electricity generation, including biomethane for transport, industrial heat, and grid injection, thereby expanding market opportunities and improving project viability. Targeted incentives for national technology suppliers and equipment manufacturers are needed to foster industrial development and ensure that the growth of the biogas sector delivers long-term economic and technological benefits within Brazil. [4.1.1] [4.1.3] [4.1.4]

**4. Leverage both large national-scale biogas production and local small-scale rural digesters** to ensure national energy security from green sources and empower rural and agricultural communities. Large-scale projects can provide reliable baseload renewable energy, support biomethane injection into gas networks, and contribute meaningfully to decarbonising industry and transport. At the same time, small-scale rural digesters can improve farm-level energy self-sufficiency, reduce waste management costs, enhance soil fertility through digestate use, and generate additional income streams, thereby strengthening rural livelihoods while supporting Brazil's broader climate and energy transition objectives. It can also provide a clean source of power for houses in regional areas that are reliant on burning wood or other harmful substances for heating and cooking. Brazil must encourage biogas as a solution in all scales. [4.1.3]

**5. Develop a renewable fertiliser framework and quality standards to encourage the use of digestate** in agriculture to improve soil health, reduce emissions from the agricultural sector and allow biogas facilities to valorise digestate. Such a framework, when introduced in Brazil, would enable digestate to improve soil health, enhance nutrient recycling, and reduce reliance on synthetic fertilisers, thereby lowering agricultural sector emissions. At the same time, standardised regulations would allow biogas facilities to properly valorise digestate as a marketable by-product, improving project economics and reducing waste disposal costs. This is crucial to reducing reliance on harmful chemical fertilisers. [3.1.4] [4.1.5]

**6. Skill up and build local capacities for the national biogas industry** with sector-specific training programs, openness to new technologies and innovations and a strong industry network to encourage knowledge gathering and sharing. The training of local personnel through programs tailored to Brazil's diverse agricultural and industrial contexts will be essential for scaling up the domestic biogas industry. Achieving this will require coordinated government action to engage educational institutions in delivering specialised training in biogas operations and maintenance. [4.1.6]

**7. Develop biogas-specific planning and permitting regulations at the national level grounded in clear technical standards, to accelerate the development of biogas and biomethane plants.**

Unclear and fragmented planning and permitting processes remain a constraint on the timely deployment of biogas and biomethane facilities in Brazil. Establishing national requirements explicitly tailored to biogas and biomethane facilities, covering environmental licensing, land-use planning, grid and gas network connections, and health and safety, would significantly reduce regulatory uncertainty. These regulations should be streamlined and clear, designed to support the growth of the industry whilst maintaining environmental safety and without imposing excessive regulatory burdens that could create bottlenecks, as seen in other countries. [3.1.7]

**8. Create dedicated financing mechanisms for biogas and biomethane projects**

– including credit lines, guarantees, concessional loans, performance-based incentives and an ambitious blending mandate – to reduce investment risk and mobilise private capital. Despite strong feedstock potential, access to appropriate financing remains a key barrier for many biogases and biomethane projects in Brazil, particularly at the early stages of market development. Tailored financial instruments will help bridge current gaps in bankability and reduce perceived risks. Over time, these mechanisms can help build a robust project pipeline, attract institutional investors, and establish biogas as a competitive and strategic component of Brazil’s low-carbon energy and industrial landscape. [3.1.2]

**9. Implement national technical and safety standards with a certification scheme and develop Best Available Techniques (BAT) and operational guidance to guarantee high-quality and safe project delivery.**

Establishing national standards for design, construction, operation, and monitoring aligned with international best practices would improve project quality and reduce operational and environmental risks. Robust technical and safety standards are essential to ensure the long-term credibility, performance, and social acceptance of the biogas sector. Complementing these standards with a national certification scheme, such as the ADCS International framework, enhances transparency and increases investor and lender confidence. The development of BAT guidance and standard operating procedures would further support operators, regulators, and financiers, ensuring consistent performance, high safety levels, and strong environmental outcomes across Brazil’s growing biogas and biomethane portfolio. [3.1.6]

Looking ahead, a future Global Environment Facility (GEF) supported project can build on the work of the GEF Biogas Brazil Programme and translate the above easy wins into concrete outcomes for Brazil. Brazil’s deployment of these solutions can serve as a catalyst for South-South cooperation, an emerging initiative with considerable potential to strengthen biogas sectors in many countries. It can support technology transfer and demonstration projects adapted to Brazilian conditions and amplify impact by facilitating peer learning, regional market development, and the dissemination of scalable policy and regulatory models for biogas and biomethane. In parallel, targeted capacity-building and knowledge-sharing initiatives can help upskill policymakers, regulators, financial institutions, and project developers, fostering a common understanding of best practices across the value chain.

The easy wins outlined above are grounded in a comprehensive International Policy and Technology Benchmarking exercise. Please refer to the accompanying Excel file, which contains the full detailed benchmarking matrix, including lists of country-by-country policy instruments, regulatory frameworks, financial mechanisms, and technology deployment practices assessed in this study. An exhaustive bibliography document has also been included alongside the Excel file.

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