BRAZILIAN BIOGAS: CURRENT SCENARIO AND PERSPECTIVES

Jéssica J. Silva[2], Ana Beatriz S. Aguiar[1], Ana Clara Vieira dos Reis[2] & Renata P. Rodriguez[2]*

[1] *Center for Energy Planning (NIPE), University of Campinas (UNICAMP), Campinas, Brazil.*
[2] *Instituto de Ciência e Tecnologia, Universidade Federal de Alfenas, Poços de Caldas, Brasil.*
** Corresponding author's: renata.rodriguez@unifal-mg.edu.br*

ABSTRACT

Biogas plants in Brazil annually produce 1.83 billion cubic meters of biogas, contributing to an expanding sector with a national production capacity of 42.7 billion cubic meters per year. This biogas, generated through biological processes, is gaining prominence as a clean energy source amid increasing demand for sustainable technologies. Renewable energy sources play a crucial role in diversifying the global energy mix, reducing greenhouse gas emissions, and lessening reliance on fossil fuels. This review explores environmental impacts of biogas and biomethane, and the current and future outlook of the Brazilian government initiatives, technical regulations, international perspectives, and economic, environmental, and legislative aspects.

Keywords: Biomethane. RenovaBio. GHG emission. Biogas panorama.

1 INTRODUCTION

Biogas from anaerobic digestion (AD) presents advantages across several aspects, serving as a renewable energy resource while aiding in mitigating greenhouse gas (GHG) emissions and reducing reliance on fossil fuels. Beyond its environmental significance, its substantial energy capacity, coupled with its versatile multifunctionality, positions biogas production as noteworthy within economic and social spheres [1].

Biogas serves as a versatile energy source across various applications, including direct combustion for heat production, electricity generation via fuel cells or microturbines, combined heat and power generation (CHP), and as a fuel for vehicles [1–2]. The utilization of biofuels for electric and thermal energy production represents a promising avenue for either total or partial substitution of non-renewable energy sources, owing to their environmentally sustainable nature and considerable energy potential. Moreover, the utilization of biogas leads to reduced greenhouse gas (GHG) emissions in comparison to those emitted by fossil fuel products [3].

In 2022, data from Brazil revealed a notable 87% increase in biogas production volume in the last decade. With 936 biogas plants, of which 885 are operational, the sector annually generates 2.9 BNm^3 of biogas, indicating a phase of expansion. Predominantly, biogas application in the country is directed towards electricity generation, consuming 86% of the national biogas volume. However, Brazil holds significant untapped potential, boasting a capacity of 84.6 Bm^3/year, of which only 3.4% is currently utilized [4]. In Brazil, biogas production results from three main sectors: agriculture, industry and sanitation. In the sanitation sector, the main substrates are urban solid waste (MSW) deposited in landfill sanitary, segregated MSW at source (organic fraction), fruit waste and vegetables, food waste and supermarket. In agriculture, the substrates for biogas production are mainly animal manure and feed waste. In industry, all effluents as well as other organic waste generated in the processes are sources of substrate. In 2022, the agricultural sector accounted for 78% of operational biogas plants in the country, with the industrial sector and the sanitation sector contributing 12% and 10%, respectively, to the total number of plants. Concerning the volume of biogas produced in these units, the sanitation sector was responsible for 74% of the total volume produced, followed by the industrial (16%) and agricultural (10%) sectors [4].

In this context, the review aims to provide the current scenario and prospects for Brazilian biogas involving government initiative policies, technical regulations, international panorama, and economic, environmental and legislative aspects.

2 ENVIRONMENTAL, AND LEGISLATIVE ASPECTS OF BIOGAS GENERATION IN BRAZIL

Brazil currently exhibits a biogas electricity generation scenario with an installed capacity of 302.62 MW. In contrast, the global potential for energy generation using biogas stands at 20,150 MW, with Germany, USA, and UK emerging as leading producers. Consequently, Brazil's capacity represents only 1.5% of the world's total. However, for biogas to gain prominence within the Brazilian energy sector, political structuring and appropriate business models are imperative, given the gradual evolution of biogas regulation in the country over the years [5-6].

For biogas to gain notoriety in the Brazilian energy sector, political structuring and appropriate business models are necessary since the regulation of biogas in the country has been gradually developing over the years [7]. The adoption of new markets, such as the free electricity market and microgeneration, as well as the development of technology, can reduce energy consumption and the cost of biogas generation. Circular business models do not guarantee the efficient use of resources. Therefore, before implementing these models, it is essential to know the complexity of industrial ecosystems that aim to convert waste into energy. Thus, to implement a model, it is important to customize it according to the local scenario, including aspects such as regulation, institutions, finance, and technology [8].

The energy yield of biogas and the avoided GHG emissions are related to the sources of organic waste. Depending on the substrate, there will be a viable electrical power between 4.5 and 6.9 GW, corresponding to the supply of more than 180,000 buses, resulting in a reduction of CO_2 emissions by 4.93% per year [7]. Approximately 19.8 MtCO2 $year^{-1}$ could be mitigated in an optimistic scenario, which reflects almost 5% of national emissions.

In terms of legislation, biomethane has more consolidated regulation in the country than biogas since it depends on the development of the natural gas sector, including programs such as RenovaBio, Probiogás, and the Brazilian Association of Biogas and Methane [9]. The new Gas Law (Law 14,134/21) [10], focused on natural gas, cites biomethane as a fuel equivalent to natural gas, making its application clear and accessible. Thus, biomethane can bring a series of benefits to the development of the Brazilian energy market, such as increasing the supply of biofuel in regions not connected to the gas pipeline network; increasing demand and attracting regional investments; increasing the competitiveness of the sector, replacement of fossil fuels in industrial, commercial, and vehicular use (e.g., fleet of trucks and agricultural machinery); mitigation of pollutant emissions; and price predictability [11].

The biomethane produced in the national territory in the current scenario could supply 70% of the average diesel consumption. Furthermore, the development of research focused on biofuels through the creation of research centers could further intensify funding for the construction of biogas and biomethane plants and the free marketing of these products. Biomethane can be produced throughout the year, stored in an accessible and economical way, and can be commonly applied to natural gas [1].

3 BIOGAS INTERNATIONAL PANORAMA

The 26th Conference of the Parties to the United Nations Conference on Climate Change in 2021 focused on critical issues like global decarbonization and reducing methane emissions. During this event, countries committed to limiting global warming to 1.5°C by signing an agreement targeting a 45% reduction in CO^2 emissions by 2030 compared to 2010. Additionally, the conference set a goal for achieving carbon neutrality by 2050. Discussions also emphasized the urgent need for transitioning to clean energy alternatives and decreasing reliance on fossil fuels and coal. Negotiations faced challenges due to resistance from coal-dependent and oil-exporting nations [12]. Countries such as Germany, France, Sweden and China stand out worldwide, which have an installed biogas production capacity of 900GWh, 133 GWh, 78GWh and 500Gwh, respectively.

4 CONCLUSION

This review addressed the Brazilian biogas scenario regarding legislation and environmental aspects. Biogas has great diversity and flexibility for its use as electrical and thermal energy through biomethane. However, the implementation of public and private initiatives aligned with efficient environmental management is important to expand the sector, being fundamental to optimize and enhance it as a source of energy. Furthermore, the consumption of biogas in Brazil is an alternative for energy diversification at an international and national level.

REFERENCES

1 CAPOSCIUTTI, G., BACCIOLI, A., FERRARI, L., DESIDERI, U. 2020. Energies. 13.743-457.
2 FUESS, L.T., ZAIAT, M. 2018. Process Saf Environ Prot. 115.27–37.
3 BÖRJESSON, P., BERGLUND, M. 2007. Biomass Bioenergy. 31. 326–344.
4 CIBIOGÁS (Brasil). 2023. Relatório Técnico nº 001/2023 – Foz do Iguaçu, CIBiogás.
5 CAMPOS, A.F, SILVA, N.F., PEREIRA, M.G., FREITAS, M.A.V. 2017. Renew Sustain Energy Rev. 75.1207–1216.
6 NADALETTI, W.C., CREMONEZ P.A., SOUZA, S.N.M., BARICATTI, R.1. BELLI FILHO, P., SECCO, D. 2015. Renew Sustain Energy Rev 41.277–283.
7 SANTOS, I.F.S., VIEIRA, N.D.B., NÓBREGA, L.G.B., BARROS, R.M., TIAGO FILHO, GL. 2018. Resour Conserv Recycl. 131.54–63.
8 PAVAN, M.C.O., RAMOS, D.S., SOARES, M.Y., CARVALHO, M.M. 2021. J Clean Prod 311.127615.
9 ABBM. 2023. Brazilian Association of biogas and methane. Available at: https://www.abbiogasemetano.org. br/ index.htm.
10 BRAZIL. 2021. Law No. 14,134. Available at: https://www.planalto.gov.br/ccivil_03/_ ato20 19- 2022/ 2021/Lei/L14134. htm.
11 ABIOGÁS 2022. Available at: https://abiogas.org.br/nota-daabiogas-sobre-a-regulamentacao-da-lei-do-gas/.
12 UKGOVERNMENT. 2021. COP26 negotiations explained. Available at: https://ukcop26.orgwp-content/uploads/ 2021/ 11/ COP26-Negotiations- Explained.pdf.

ACKNOWLEDGEMENTS

We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for providing research funding and scholarships (Process: 404494/2021-8, 310412/2022-6, and 405692/2022-6).