BRAZILIAN BIOGAS
OVERVIEW
2021

CIBIOGÁS
ENERGIAS RENOVÁVEIS

Disclaimer Notice:

Citation:

CIBiogás – Centro Internacional de Energias Renováveis - Biogás

Brazilian Biogas Overview 2021. CIBiogás (Brazil) Technical Report nº 001/2022 – Foz do Iguaçu, CIBiogás, 2022.

20p. il. coulor.

1. Overview 2. Energy 3. Biogas 4. Biomethane 5. Sustainable development. I. CIBiogás. II Title.

AUTHORS

Alessandra Freddo
CIBiogás/UNIDO

Felipe Souza Marques
CIBiogás/UNIDO

Karina Cerqueira Navarro Finco
CIBiogás

CONTRIBUTORS

Larissa Caroline Sbalqueiro Carmona
CIBiogás

Natalí Nunes dos Reis da Silva
CIBiogás/UNIDO

Yelva Cristina de Amorim Cubas
CIBiogás

LAYOUT AND GRAPHIC ARTS

Nathalia Alves Santana
CIBiogás

CHIEF EXECUTIVE OFFICER

Rafael Hernando de Aguiar Gonzales

CIBiogás

As the continuous development of the biogas industry has always been our priority, the Brazilian Biogas Overview 2021 is the outcome of studies carried out by researchers who are committed to bring updated information and are interested in highlighting biogas and biomethane initiatives in Brazil.

This report manifests support to the discovering of new ideas that can increase the share of renewable resources in the energy mix and help solve several environmental issues in our country.

Enjoy the reading!

Brazilian Biogas Overview 2021

TABLE OF CONTENTS

METHODOLOGY

Brazilian Biogas Overview 2021 is a report that brings together the main information extracted from the annual survey of Brazilian biogas and biomethane plants, conducted by CIBiogás with the support of companies and institutions linked to the sector. Its purpose is to present the biogas production and energy use across the country, and thus demonstrate its share in the Brazilian energy scenario.

Data was collected from April 2021 to March 2022 and survey results, which are the object of this document, include only biogas plants that started being built and operated or that have energetic applications until December 2021. Plants that started their construction, operation or energetic application in 2022 were not considered. This document covers all 26 Brazilian states and the Federal District.

All information presented in this report comes from CIBiogás' database, which has been built mainly by (1) contacting products and services suppliers as well as biogas plants owners and/or operators; (2) getting access to open source database from the regulatory agencies, such as electricity (ANEEL) and biofuels (ANP); 3) searching for any sort of data in the news websites and social media, such as LinkedIn and Instagram.
Furthermore, researchers and research centres were also consulted, as well as some environmental licenses issued by state environmental agencies. Finally, a registration form - which is available on the Biogasmap website - was also carried out and the answers obtained to compose the database. This methodology is based on the research conducted by Mariani (2018).[1]

Although the database is largely composed by official figures and primary data, sometimes it is necessary to estimate or calculate the biogas production, and CIBiogás does this according to its expertise – taking into account a conservative approach.

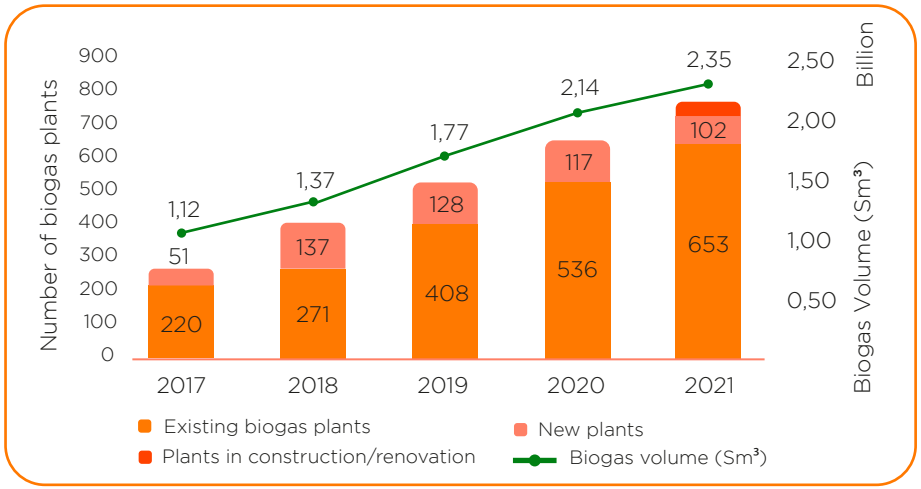
Graphs and tables shown in this report may have changed compared to those published in previous years. This is due to the fact that some data which had been previously **estimated** became **primary data** after contact made directly with the biogas plant. There were also new plants included in this year's survey that started operation before 2021 and had not been considered previously.

[1]MARIANI, Leidiane. Biogás: diagnóstico e propostas de ações para incentivar seu uso no Brasil. 2018. 1 recurso online (144 p.). Tese (doutorado) - Universidade Estadual de Campinas, Faculdade de Engenharia Mecânica, Campinas, SP.

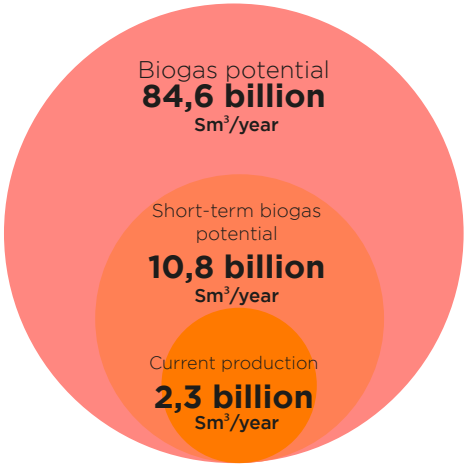
OVERVIEW

This survey shows that the number of plants increased by **16%**, last year in comparison to 2020, and the amount of biogas produced in 2021 was **10%** higher than in the previous year.

Development of biogas production (Sm³/year) and number of plants in the past 5 years. (Active plants)



Relation between current production and the Brazilian biogas potential - 2021. (Sm³/year)



NUMBER OF PLANTS REGISTERED ON THE BIOGASMAP IN 2021

811 BIOGAS plants nationwide

755 Active BIOGAS plants

+102 new biogas plants in 2021

+16%* PROJECTS GROWTH

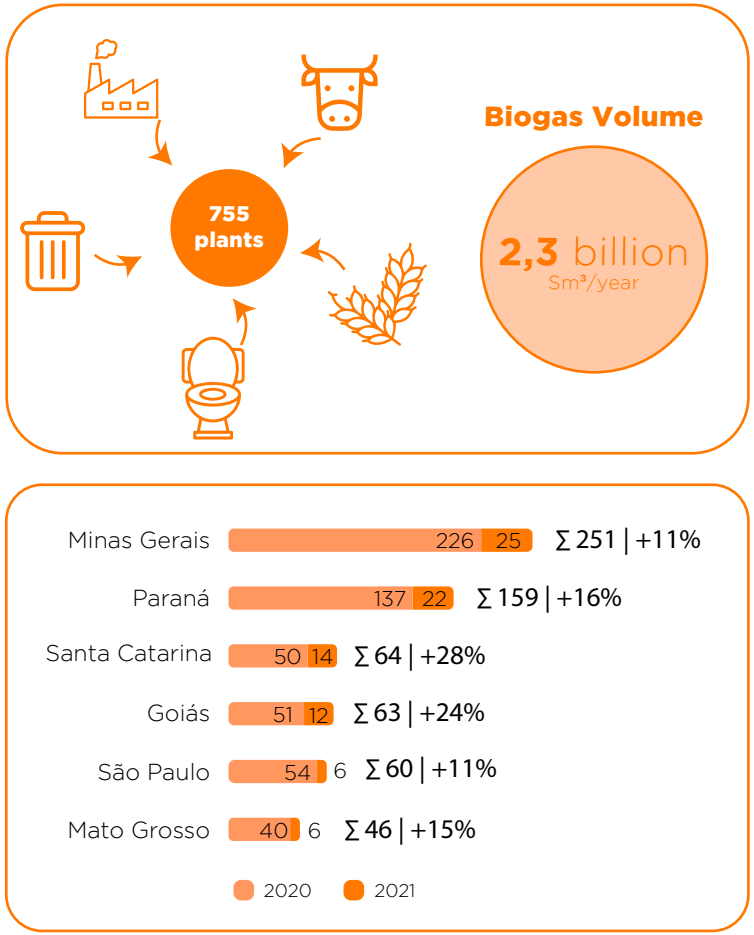
2,3B Sm³/year BIOGÁS in operation

+209M Sm³/year in 2021

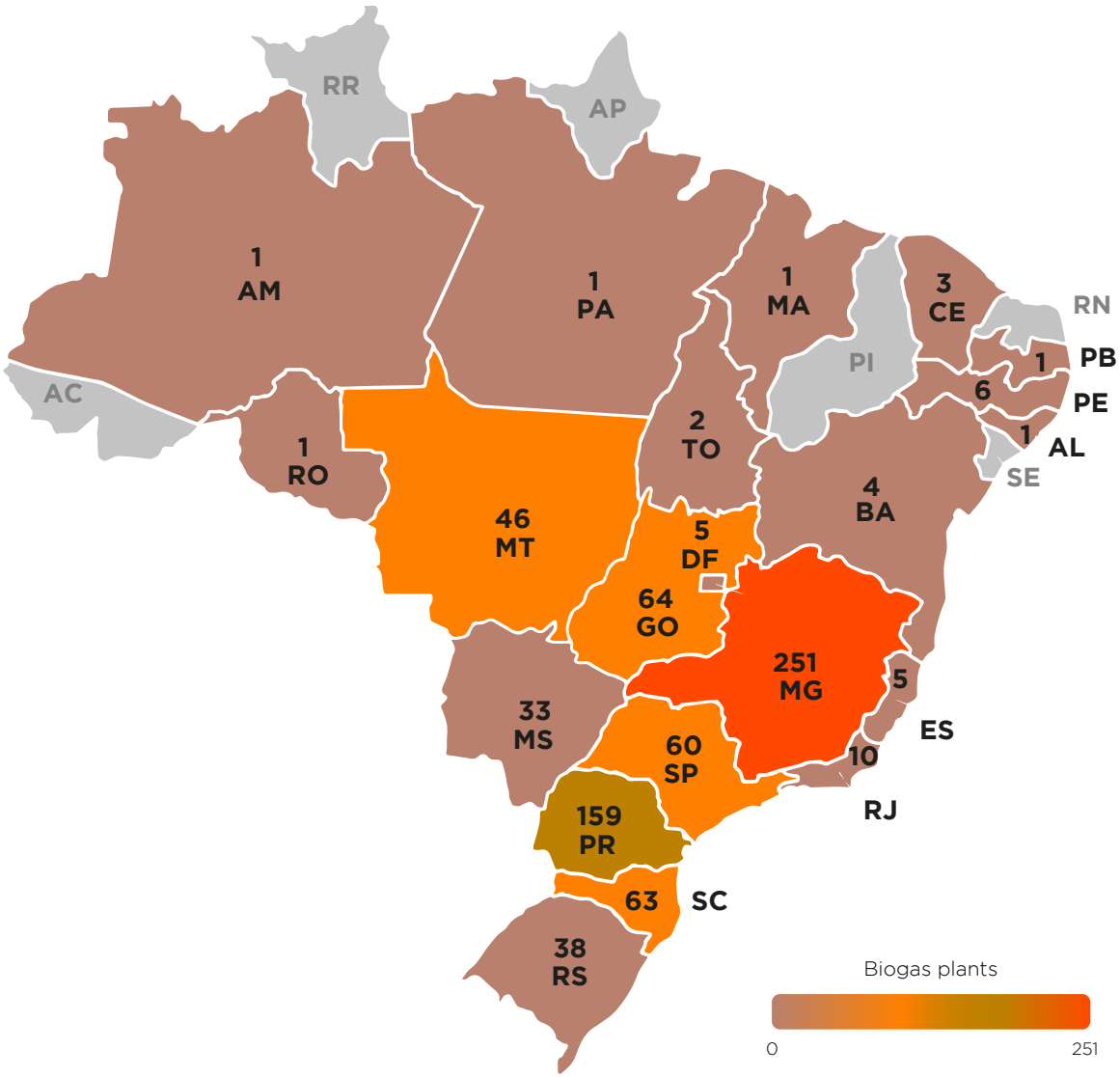
+10%* BIOGAS VOLUME

*compared with 2020 figures.

Santa Catarina and Goiás achieved 28% and 24% growth in the number of operational plants, respectively.



Growth in number of operating biogas plants per state (2020-2021).



BRAZILIAN BIOGAS AND BIOMETHANE PLANTS: Current Situation

In 2021, Brazil had 811 biogas plants with energy production (biomethane, electricity, thermal-only), of which 755 were in operation (93%), 44 were in construction (5%), and 12 were undergoing renovation (2%) and should start operating again in 2022. There was a 20% growth compared to figures reported in the previous year (675 plants in total), indicating that the industry continues to grow.

The 755 active plants produced 2.3 billion cubic meters of biogas. More than 22% growth is expected in 2022, given the 56 plants in construction or in renovation. With that, the Brazilian biogas production shall reach at least 2.8 billion cubic meters of biogas in 2022.

KARINA NAVARRO

Four per cent of the facilities are in construction and account for 15% of the biogas volume, suggesting that the new plants tend to be larger.

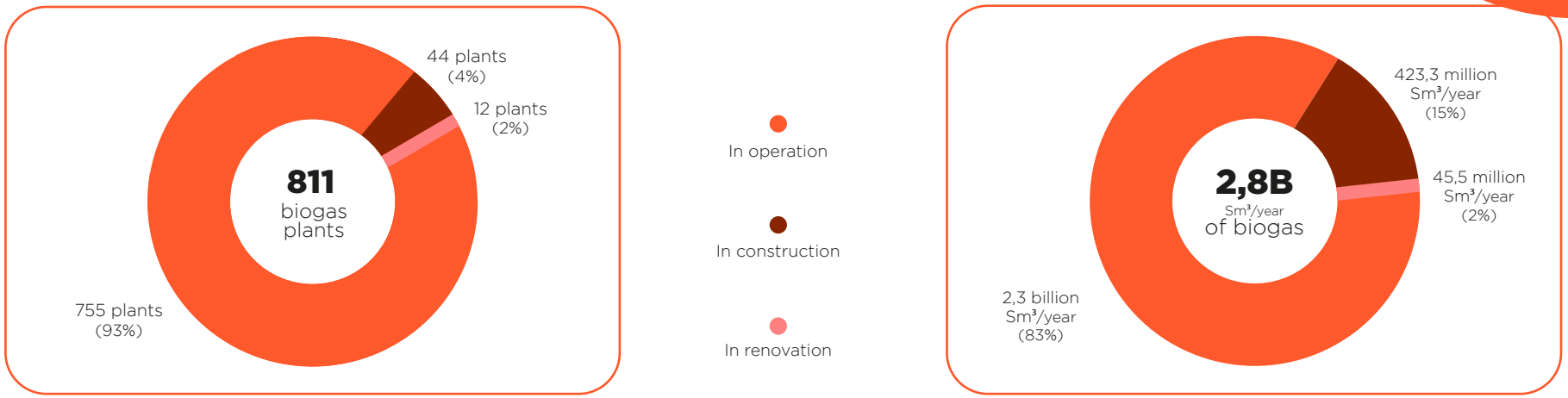


Figure 1 – Percentage of biogas plants in operation, in construction and in renovation - 2021.

Figure 2 – Percentage of biogas production in active, in construction and in renovation plants - 2021.

ANALYSIS OF BIOGAS GROWTH AND POTENTIAL OF PRODUCTION EXPLOITED

Graphics show that the Brazilian biogas sector has been growing continuously year on year, even under the seemingly unfavorable scenario in 2021. Fluctuations in the oil barrel price and the Brazilian currency devaluation (due to the increase in the value of the Dollar) led to a rise in vehicle fuels and liquefied petroleum gas (LPG) prices. Furthermore, the water crisis that led to what's been called "water scarcity flag" in the electricity sector made prices rocket, and the COVID-19 pandemic affected various sectors of the economy.

Despite the pandemic, the biogas industry is still thriving. According to the Brazilian Biogas Association (ABiogás), the domestic goods and services industry has further helped the development of the biogas sector, and that has been helping to reduce the costs of installing biogas and biomethane plants in Brazil.

According to the latest national biogas and biomethane survey carried out by CIBiogás, the number of **operational plants** increased from 653 in 2020[2] to 755 in 2021. That represents a 16% growth at national level. However, when we look at a regional scenario, it is possible to highlight that the states of Goiás and Santa Catarina achieved 28% and 24% growth in the number of operational plants, respectively.

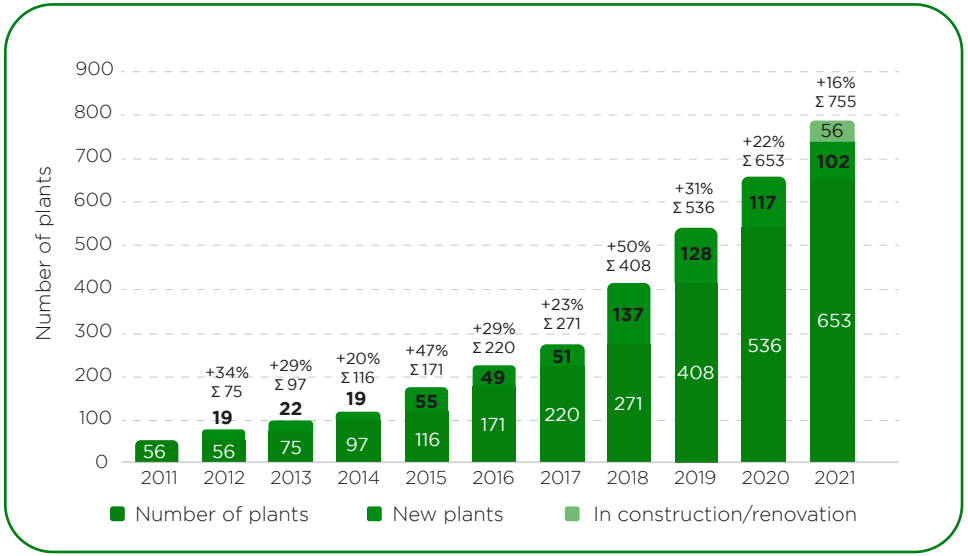


Figure 3: Increase of the number of new biogas plants in Brazil in the last decade. Since 2018 there has been a considerable rise in the number of biogas plants using biogas for energy generation, mainly encouraged by the entry into force of the ANEEL Resolution nº 482/2012, which opened the way for electricity generation from biogas in the distributed micro and mini generation modalities.

[2]Updated figure compared to what was disclosed in the previous report (638 plants), after including new plants that started operating in 2020.

In terms of biogas production for energetic purposes, there was a 10% increase compared to 2020 figures. The active plants produced 2.1 billion cubic meters in 2020, compared to 2.3 billion cubic meters in 2021.

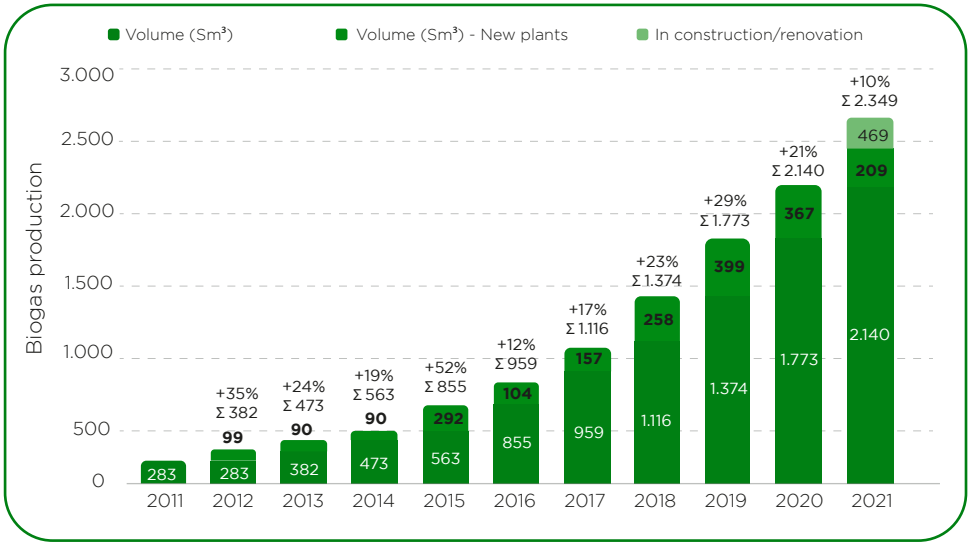
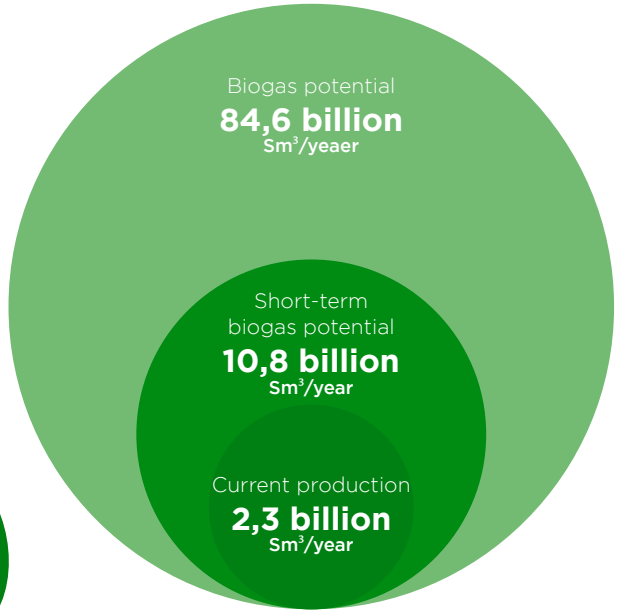


Figura 4: Increase of biogas volume for energy use in Brazil. The graph shows that in 2018, 137 plants (Figure 3) generated 258 million cubic meters of biogas, approximately 1.9 million cubic meters per plant. In 2021, this ratio increased to 2 million cubic meters per plant, and for 2022 it is expected that at least 469 million cubic meters of biogas will be generated by the 56 plants being installed or renovated (8.4 million cubic meters per plant).

According to ABiogás figures, Brazil has the potential to produce 84.6 billion cubic meters of biogas per year, which would be enough to cover 40% of the internal demand for electricity and 70% of diesel consumption (ABIOGÁS, 2021)[3]. Considering the 2.3 billion cubic meters of biogas generated in 2021 by the 755 plants in operation, Brazil is unlocking only 3% of its full potential. When considering the production potential in the short term, taking into account only waste and effluents that do not present obstacles to its immediate access within the agricultural, industrial and sanitation sectors – which is estimated at 10.8 billion cubic meters per year (INSTITUTO I17, 2021)[4] – it appears that 79% of this potential can still be unlocked.

ALESSANDRA FREDDO
In 5 years, biogas production for energy purposes has more than doubled in Brazil!



[3]ABIOGÁS, Associação Brasileira de Biogás e Biometano. ABiogás divulga novo potencial do biogás para o mercado brasileiro. São Paulo: ABiogás, 2021. Disponível em: https://abiogas.org.br/abiogas-divulga-novo-potencial-do-biogas-para-o-mercado-brasileiro-durante-forum-em-sao-paulo/.
[4]Instituto 17. Biogás no Brasil: Potencial Oferta a Curto Prazo. Programa de Energia para o Brasil – BEP (Brasil). Relatório técnico 02-2021. São Paulo/SP: Instituto 17, 2021.

BIOGAS PLANTS IN OPERATION
Feedstock Sources

The types of feedstock used for biogas production in Brazil are divided into three categories, according to their source:

SECTORS	DESCRIPTION	SUBSTRATE
Farming	It mostly includes animal husbandry (poutry, cattle, goats, pigs, etc.)	Animal manure, wastewater from manure management (containing urine, faeces, washing water etc.), leftover feed, carcasses of dead animals not slaughtered etc.
Industry	It includes slaughterhouses, sugar and ethanol, starch mills, breweries, vegetable oil and gelatin industries etc.	Industrial wastewater and other organic waste from the industrial process.
Sanitation	It includes landfills, organic MSW treatment plants and municipal wastewater treatment plants.	Municipal solid waste (MSW) deposited in landfills, Organic MSW (restaurants, supermarkets) and organic household waste, farmers market waste (CEASA in Portuguese), sewage and sewage sludge.

In 2021, the farming sector accounted for 80% of the operational biogas plants in Brazil. Meanwhile, the industrial and the sanitation sectors contributed 11% and 9%, respectively, to the increase in the number of plants. As for the volume of biogas, the sanitation sector accounted for 74% of the biogas produced, followed by the industrial (16%) and farming (10%) sectors.

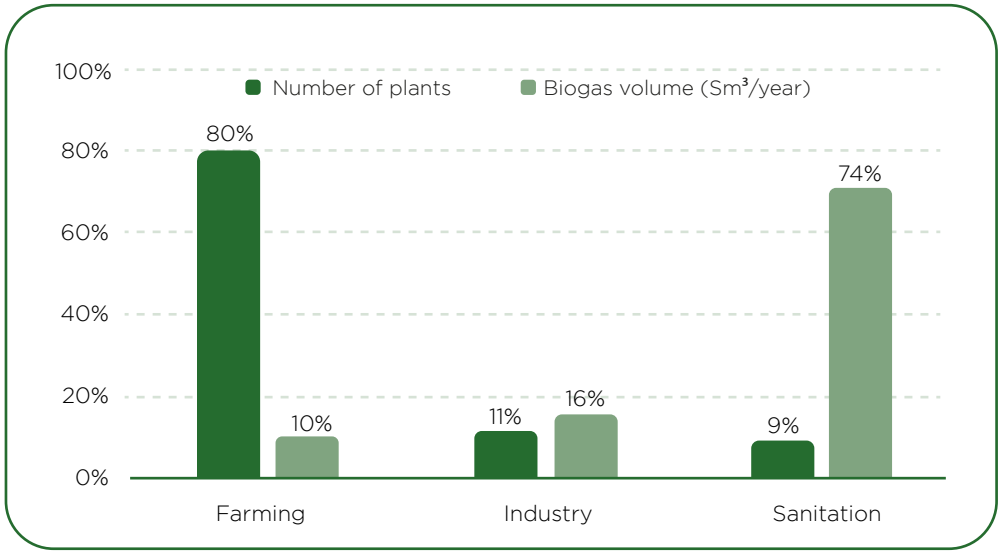


Figure 5 – Ratio between number of plants and biogas volume, per feedstock type.

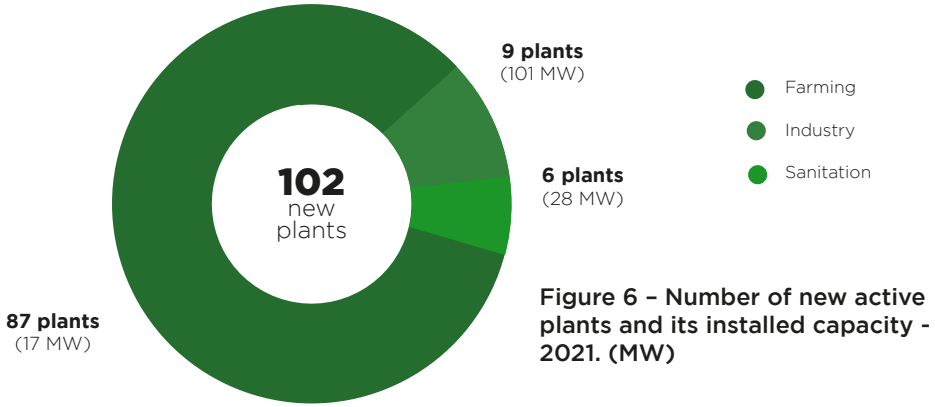


Figure 6 – Number of new active plants and its installed capacity - 2021. (MW)

BIOGAS PLANTS IN OPERATION
Size Range and Volume

Biogas plants are divided into different size ranges in this report and classified as small, medium and large, according to their annual output.

CLASSIFICATION	BIOGAS PRODUCTION RANGE ($Sm^3.year^{-1}$)
Small size	< 500.000 to 1.000.000
Medium size	1.000.001 to 5.000.000
Large size	5.000.001 to > 125.000.001

According to the figures, in 2021, Brazil was home to 595 small, 109 medium, and 51 large size operational biogas plants.

PLANT SIZE RANGE	NUMBER OF PLANTS		BIOGAS PRODUCTION ($Sm^3.year^{-1}$)	
Small	595	79%	178.337.233	8%
Medium	109	14%	236.662.439	10%
Large	51	7%	1.934.105.489	82%
TOTAL	**755**		**2.349.105.161**	

The graphic below demonstrates that 79% of the operational biogas plants are small scale plants and produce 8% of the total biogas volume. On the other hand, large plants account for 82% of the Brazilian biogas production and 7% of the number of operational plants. Medium-sized plants represent 14% of the units in operation and produce 10% of the total biogas volume.

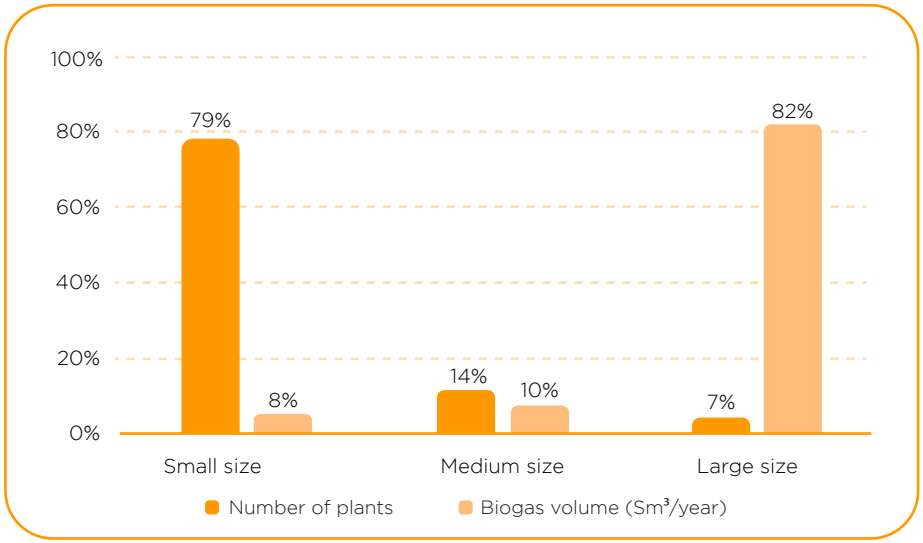


Figure 7 – Ratio between number of plants and biogas volume, per size range.

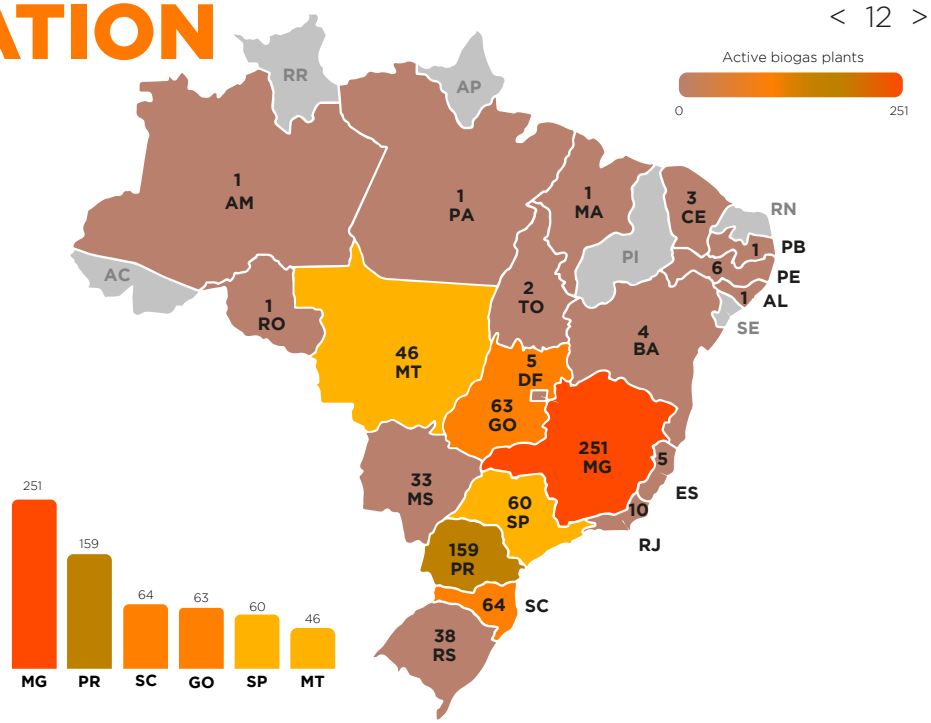
BIOGAS PLANTS IN OPERATION
Location

In 2021, the 6 states with the more biogas plants in operation were Minas Gerais, Paraná, Goiás, Santa Catarina, São Paulo and Mato Grosso.

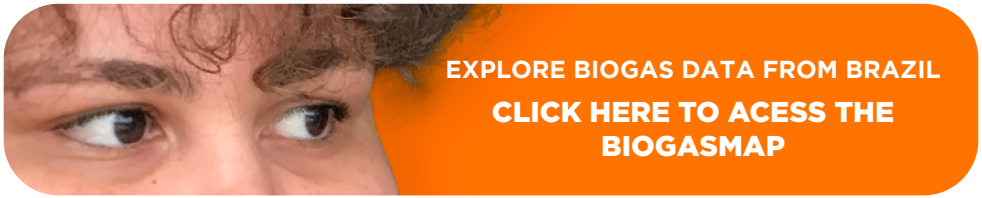
Minas Gerais remained ahead in terms of number of plants. According to the latest survey, the state has 251 plants in operation, or 33% of the national total. However, in terms of biogas volume and its energy equivalent, these units account for 9% of the total volume produced, corresponding to 210 million Sm^3/year. In relation to 2020, the state had an 11% growth in the volume of biogas produced.

Paraná occupies the second position in number of plants, with 159 in operation, which correspond to 21% of the total natiowide. In terms of biogas volume, the state produced the equivalent of 253 million Sm^3/year in 2021.

Santa Catarina and Goiás accounted for 64 and 63 biogas plants, respectively. In Santa Catarina, there was a 46% increase in volume of biogas produced, while Goiás recorded a 37% increase in production compared to the previous year. This is mainly due to the implantation of large units in the agricultural and sanitation sectors.



In 2021 the first biogas plants that generated energy use were located in the states of Alagoas and Rondônia, as shown in the BiogasMap. The states of Acre, Amapá, Piauí, Rio Grande do Norte, Roraima and Sergipe, on the other hand, do not have any biogas plants that make any type of energy use.

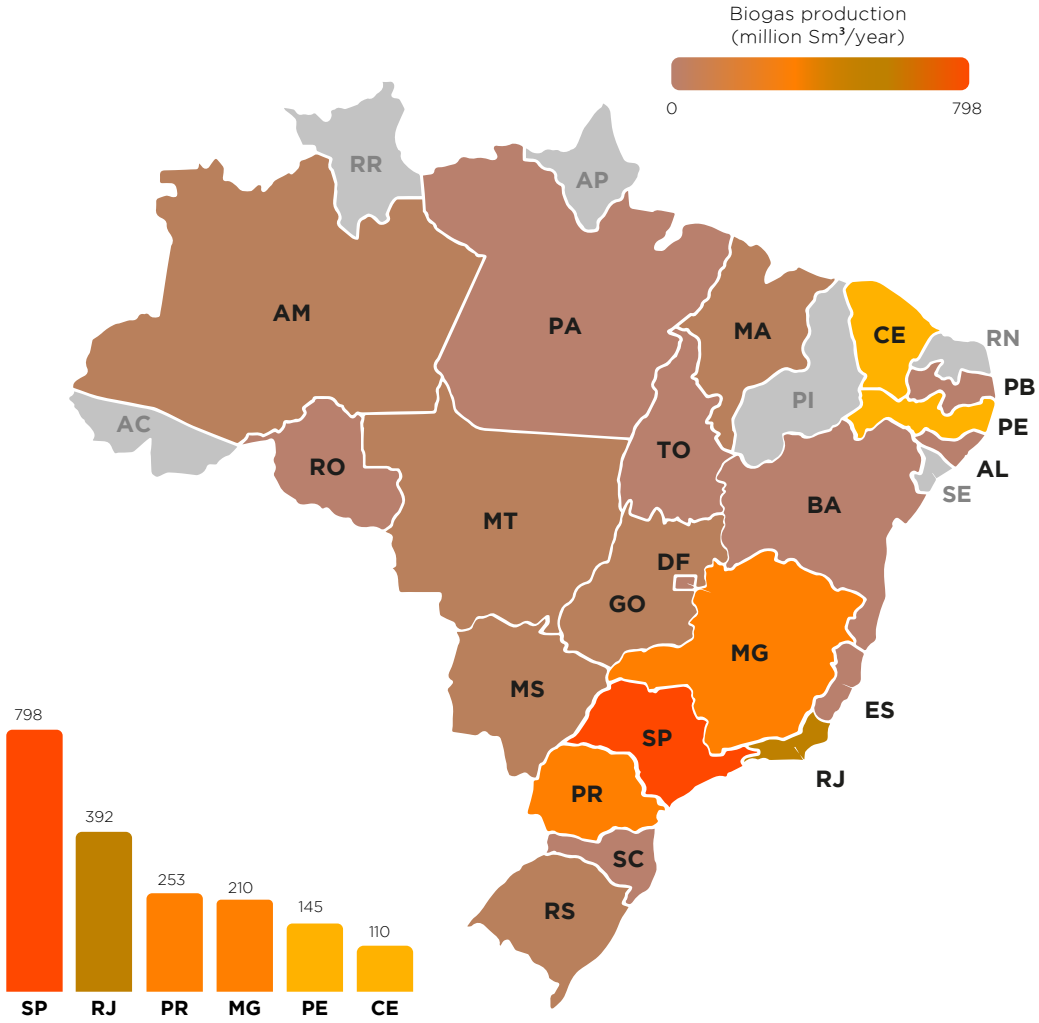


Regarding **biogas volume** and its energy equivalence, the 6 states with highest production are São Paulo, Rio de Janeiro, Paraná, Minas Gerais, Pernambuco and Ceará.

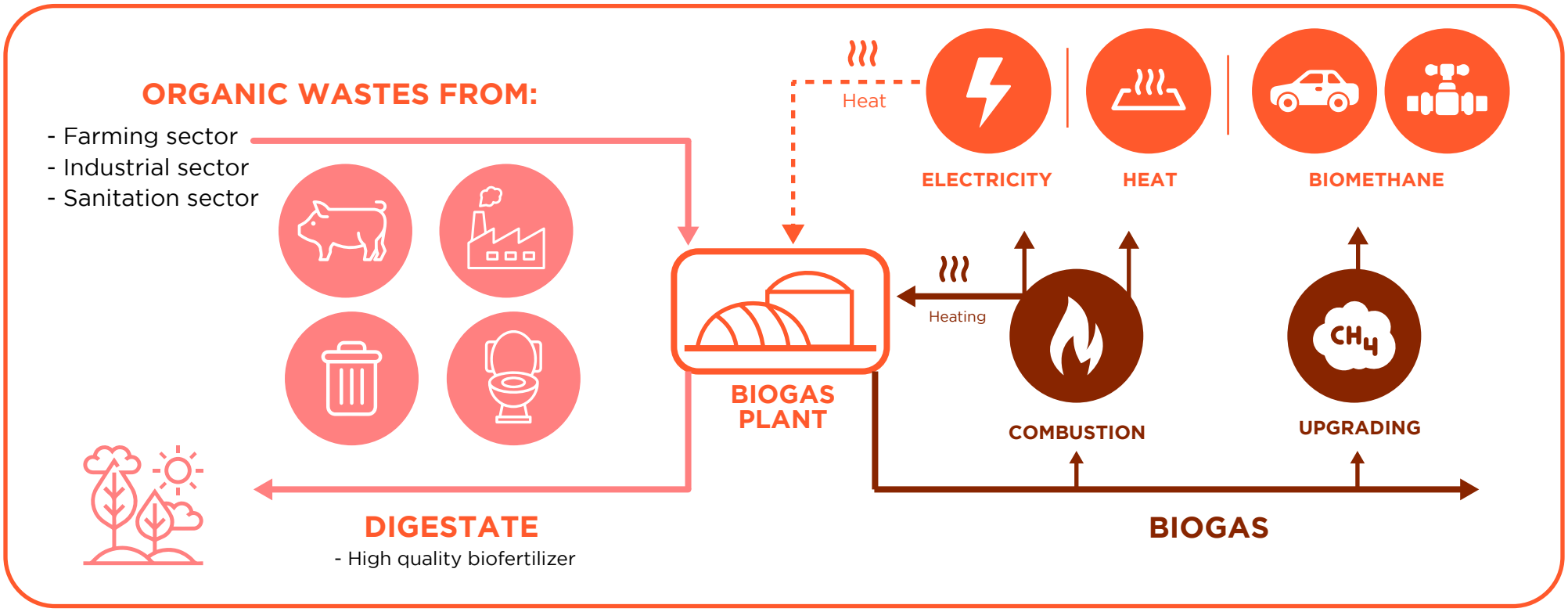
São Paulo is ahead of the other states with more than double the production of Rio de Janeiro, which comes in second. This is due to the fact that São Paulo has more large-scale plants, which mainly use feedstock from industry and the sanitation sector. In terms of number of plants, the state has 60 units in operation (8 of the national total%) and contributes to the production of 34% of the country's biogas volume, equivalent to 798 million cubic meters per year.

Rio de Janeiro, with only 10 plants in operation, was responsible for 17% of the biogas produced in 2021; 90% of the biogas plants in the state are from the sanitation sector. These are large scale biomethane and electricity generation plants.

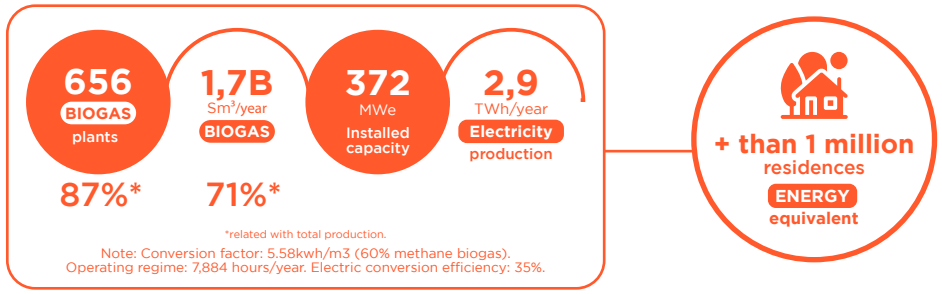
Pernambuco also stands out in the ranking, occupying the 6th position among the states producing more biogas nationwide. It has 6 biogas plants, all in the sanitation sector, which generate 145 million cubic meters per year. In Ceará, there are 3 biogas plants, which produce 110 million Sm^3/year.



BIOGAS PLANTS IN OPERATION
Energy Application



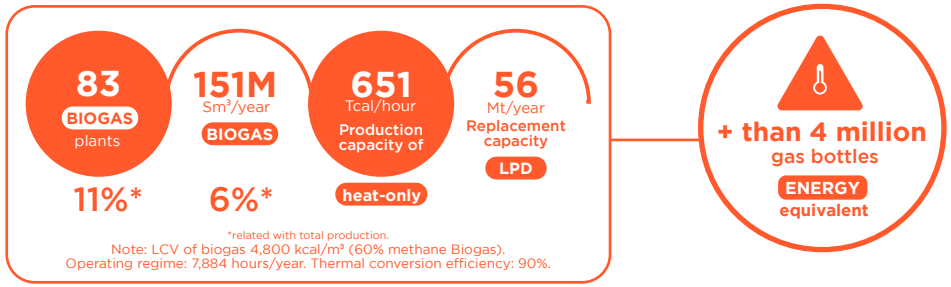
ELECTRICAL ENERGY



The figure above demonstrates that biogas for electricity production is the most common application in Brazil. In 2021, there were 656 operational biogas plants generating electricity, which corresponds to 87% of the total number in the country. 71% of the biogas was produced to generate electricity.

These plants are usually connected to the grid in the regulated contracting environment (ACR, in Portuguese) or free contracting environment (ACL, in Portuguese), although some operate off-grid. Most plants are linked to the energy compensation system (net metering) because the connecting process is simpler than other options available in the market. Furthermore, some plants operate off-grid and do not have registration in the ANEEL's database. The off-grid production for self-consumption is harder to identify and map.

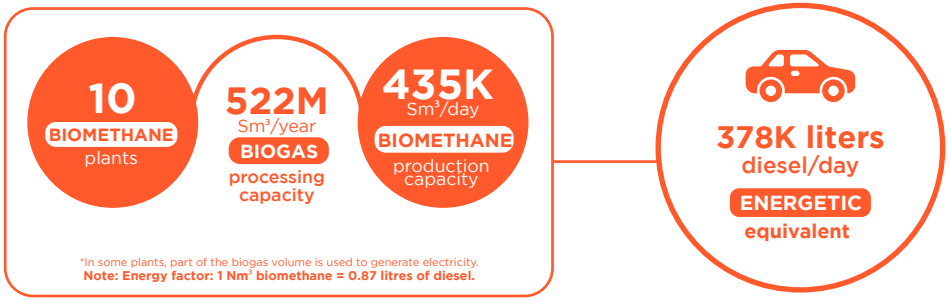
THERMAL ENERGY



11% of the active plants in Brazil use biogas for thermal-only purposes in the most diverse segments. Some examples are: burning biogas in boilers to produce steam, drying grains to make animal feed, heating poultry farms and drying sewage sludge. These plants correspond to about 7% of the biogas produced in 2021. Units that use biogas to produce mechanical energy to drive turbines, for example, total 6 plants, or 1% of the national total. In terms of volume, these plants correspond to 0.3% of the biogas produced in 2021.

The ANEEL database, one of the sources of the data used to produce this report, covers only those plants granted an electricity generation license, which means that only authorized and already registered connections are available for consultation. That is one of the reasons why it is hard to find information regarding plants that are not connected to the grid or those off-grid, which in turn requires a more direct collaboration of product suppliers, service providers and other partners to obtain data.

BIOMETHANE



In 2021, there were 10 biomethane (biogas upgrading) plants in Brazil. They include research projects, self-consumption plants and gas-to-grid plants. That represents 1% of the total number of operational plants. However, they account for 23% of the overall biogas volume produced. According to the Brazilian National Agency of Petroleum Natural Gas and Biofuels (ANP, in Portuguese), 4 units had the authorization to produce and deliver biomethane, and 2 were about to be granted authorization. ANP regulates biomethane production for trading and grid injection. In 2021, Rondônia and Alagoas states reported their first biogas plants with energy recovery.

In 2021, Rondônia and Alagoas states reported their first biogas plants with energy recovery.

BIOGAS PLANTS IN OPERATION
Energy Application

ACKNOWLEDGMENTS

This report was put together thanks to efforts undertaken by International Center for Renewable Energies, CIBiogás and United Nations Industrial Development Organization – UNIDO. Special thank you to the support given by the following companies, institutions and projects: ANEEL, ANP, ASJA Brasil, Biokohler, COPACOL, ENC Energy, Energies Assessoria Energética, Grupo Carapreta, Itaipu Binacional, Master Biodigestores, Paraná Ambiental, Secretaria de Estado de Meio Ambiente Desenvolvimento Econômico Produção e Agricultura Familiar – SEMAGRO do Mato Grosso do Sul, Soll_Pag Energia Solar e Biogás e Veolia. We would also like to thank dozens of farmers, researchers, biogas plant operators, consultants and associations, companies, government bodies and research centers for providing us with valuable information. The results of this report would not have been obtained without your availability and support.

Hey!

It’s not over yet.

Take a look at the BIOGASCLUB

A business club that aims to strengthen the business chain and promote technological development and innovation in the biogas sector.

Take a look at the BIOGASMAP

A tool that ais to gather data on operational biogas plants.

Leave us comments and suggestions here.

CIBIOGÁS

ENERGIAS RENOVÁVEIS