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Biodigesters in Restaurants and Food Courts: A Technical-Economic Study and

Regulatory

Biodigesters in Restaurants and Food Courts: A Technical-Economic and Regulatory Study

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Summary

This article analyzes waste treatment from a technical, economic, and regulatory perspective.

Organic products in mid-sized restaurants and food courts: An examination of the scenario.

Brazilian and foreign companies regarding methods of collection, separation and disposal of waste, as well as

The market for biodigesters for commercial applications. Applied technologies and costs are evaluated.

implementation, financial viability, biogas and biofertilizer production, energy integration and

regulation. The study culminates in market projections and trends for solutions.

Automated and hybrid technologies, pointing to sustainable and economically viable paths for the sector.

Keywords: biodigester, organic waste, biogas, biofertilizer, restaurants, viability

economic regulation.

Abstract

This article analyses, from a technical, economic, and regulatory perspective, the treatment of organic

waste in medium-sized restaurants and food courts. It examines the Brazilian and international

scenarios for methods of waste collection, separation, and disposal, as well as the market for

biodigesters for commercial applications. Applied technologies, implementation costs, financial

viability, biogas and biofertilizer production, energy integration, and regulation are evaluated. The

study culminates in market projections and trends for automated and hybrid solutions, pointing to

sustainable and economically viable paths for the sector.

Keywords: biodigester, organic waste, biogas, biofertilizer, restaurants, economic viability,

regulation.

1. Introduction

Organic waste generated by food establishments represents a fraction

A significant portion of urban solid waste. Its inadequate management — including disposal in

landfills or sewage systems — cause environmental impacts, such as greenhouse gas emissions.

greenhouse effect, contamination of surface and groundwater, and resulting sanitation problems.



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Disposal in landfills or water sources. This article presents a comprehensive study on these practices.

Current separation and cleaning methods, the market performance of biodigesters adapted for restaurants and food courts, and the technical, economic, and legal perspectives applicable to Brazil.

2. Study on the methods of separating and cleaning this organic waste today in Brazil and abroad.

In Brazil, the most common methods for separating and cleaning organic waste are...

Restaurants involve the use of **grease traps**, which are mandatory in service areas.

food, in accordance with ANVISA legislation¹, in addition to grinders (macerators) and separators.

of solids and fats, as primary barriers before discharge into sewage systems. In some

In European countries and the US, advanced practices include **biological selective waste collection systems with refrigerated transport** and decentralized treatment, through composting or biodigestion in

This approach reduces the volume sent to landfills. It promotes the circular economy and...

energy recovery.

3. Current percentage of collection and separation of this waste in Brazil and abroad.

The rate of collection and separation of organic waste is still low in Brazil. Estimates

Studies indicate that only **3%–5%** of municipal organic waste is collected separately for composting or biodigestion.

In contrast, in European Union countries such as Germany and Austria,

This rate could exceed 50%, driven by public policies and infrastructure.

specialized for organic waste. This discrepancy highlights the latent potential in Brazil for

Expand the collection and reuse of these waste materials.

4. Impact of organic waste on nature, sewage, rivers, and the soil layer in landfills.

Organic waste disposed of in landfills or dumped into inadequate systems generates

Methane during anaerobic decomposition – a gas with a global warming potential of approximately 25 times greater.

greater than that of CO₂. In addition, toxic leachates resulting from decomposition can

Contaminating soil and groundwater, affecting water quality and biodiversity. When

Disposed of solid and greasy waste in the sewer system, it causes **blockages** and increases costs.

Maintenance of the sewer system. Deposition in rivers and bodies of water promotes **eutrophication**.

impacting aquatic ecosystems and human health.



5. Companies that collect this waste and generate a market for it.

In Brazil, companies such as **Emaús Ambiental** and Ambev (through the “Troca de Trocento” project) and startups like Compost Group and Óleow are implementing selective collection of organic waste in Restaurants and food courts, transforming them into compost or biogas. Tools Digital tools and apps for collective logistics have facilitated the connection between waste generation points. and composting or digestion units, fostering the creation of a market for waste before discarded.

6. Current market for biodigesters in a commercial profile, restaurants

The Brazilian market for biodigesters for commercial use is expanding, with suppliers offering everything from **prefabricated modular solutions** (HomeBiogas, rotomolded tanks) to **medium-sized continuous reactors** (CSTRs, plug-flow), already integrated with treatment systems, Pre-treatment and monitoring. Establishments such as small to medium-sized restaurants and Food courts have been the focus of pilot projects and implementation plans.

7. Most commonly used types for restaurants

The most common types of biodigesters for restaurants include:

- **Modular “plug & play” units** like HomeBiogas: compact systems for small spaces. cubic meters of biodigestion;
- **Prefabricated HDPE tanks:** such as biodigesters combined with septic tanks for small facilities;
- **CSTR reactors** (Continuous Stirred Tank Reactor): continuous mixing tanks, suitable for mixed organic load and constant feeding;
- **Plug-flow / continuous flow reactors:** efficient for waste with moderate solids, but more sensitive to load variation;
- **UASB (Upflow Anaerobic Sludge Blanket):** best suited for liquid effluents, used in Integrated systems focused on the liquid portion of waste.

8. Average purchase costs of a biodigester for use in a restaurant.

The cost of acquiring a biodigester for restaurants varies according to **capacity, Applied technology and level of automation.**



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In the Brazilian market, three main segments can be identified:

- **Compact modular systems (up to 3 m³):** generally range from R\$ 1,500.00 to R\$ 5,000.00.
Made from high-density polyethylene (HDPE) and suitable for small kitchens or Restaurants with low waste volume.
- **Medium-sized systems (5 to 15 m³, with simple pre-treatment):** range between R\$ 15,000.00 and R\$ 80,000.00, including pump, mixer and basic safety elements.
- **Complete commercial systems (20 to 100 m³, with temperature control, agitation and (gas purification):** prices range from R\$100,000.00 to over R\$500,000.00, depending due to the complexity of the project and the energy integration.

These prices include only the equipment and basic installation; they do not include other costs. including civil works, licensing, and training of the operational team.

9. Financial viability of a biodigester for a medium-sized restaurant

Viability depends on three main factors:

1. **Cost savings with LPG replacement:** restaurants that spend more than R\$ 4,000.00/month on Gas tends to get a faster return.
2. **Reduction of waste collection costs: depending on the municipality, waste disposal Organic waste sent to landfills is subject to a fee; on-site digestion reduces this cost.**
3. **Sale or use of biofertilizer:** can generate extra income or reduce acquisition costs.

Fertilizers for growing your own vegetable gardens.

Studies indicate a *payback period* of between **2 and 5 years** for well-designed medium-sized systems. considering the replacement of 30% to 50% of LPG and savings in transportation and disposal of waste.

10. Technology and design parameters (biodigesters currently used in the market restaurants)

In Brazil, two technological formats predominate for restaurants:

- **CSTR (Continuous Stirred Tank Reactor)** in mesophilic regime (35–37 °C), with a time of hydraulic retention time (HRT) of 20 to 30 days and organic loading rate (OLR) of 3 to 6 kg of solids. volatiles/m³.day.
- **Horizontal plug-flow**, suitable for more solid waste, with a HRT (Human Resource Transfer) between 30 and 40 days.

Comparing conventional systems with **automated models** (pH, temperature sensors, pressure and level), it is observed:



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- **Greater operational stability** in automated systems;
- **Ability to operate with higher OLRs** due to real-time control;
- **Reduced need for human intervention**, lowering the risk of operational failures.

11. Biogas installation for hybrid operation with LPG.

The integration of biogas and LPG is technically feasible and widely used in several countries. Asians and Europeans. In Brazil, this installation must comply with ABNT technical standards (NBR 15526) and NBR 13523), using:

- **Automatic gas mixer** (blending) to ensure proper pressure and composition;
- **Non-return valves** to prevent flame backflow;
- **Biogas reservoirs with desulfurization** to remove H₂S, preventing corrosion and odor.

The hybrid system allows for automatic switching between LPG and biogas, maintaining operation. continuous during peak hours.

12. Estimated biogas/methane production

Biogas production can be estimated in two ways:

- **Via BMP (Biochemical Methane Potential) assay:** a laboratory analysis that measures the amount of methane generated per kg of volatile solids (VS).
- **Based on typical values from the literature:** for food waste, the range is 0.45–0.60 m³ CH₄/kg VS, corresponding to ~0.8–1.1 m³ of biogas/kg VS.

Practical example:

A restaurant that generates **120 kg/day** of organic waste with 20% total solids and 80% VS would produce:

- VS/day = 120 × 0.2 × 0.8 = 19.2 kg VS/day;
- CH₄/day = 19.2 × 0.5 m³/kg = **9.6 m³ CH₄/day** (~96 kWh/day of thermal energy).

13. Biofertilizer production estimate

During the anaerobic digestion process, organic matter is decomposed, generating biogas. and a nutrient-rich liquid effluent, the **digestate**. In food waste biodigesters, the The typical ratio between treated waste and biofertilizer produced is **0.8 to 1.0 liter of biofertilizer per kg of wet residue**.

Practical example for a medium-sized restaurant:



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- Daily waste: 120 kg.
- Daily production of biofertilizer: ~100 to 120 liters;
- Annual production: 36,000 to 43,800 liters.

Digestate is a source of **nitrogen, phosphorus, potassium, and micronutrients**, and can be applied directly in the soil or after stabilization processes.

14. Biofertilizer market and comparison with 100% natural, pesticide-free fertilizers

The Brazilian biofertilizer market is growing, driven by organic farming and... pressure for sustainable practices.

Key differences:

- **Biodigester biofertilizer:** resulting from anaerobic decomposition, with high bioavailability. It provides nutrients and acts faster in the soil.
- **Traditional organic fertilizer:** obtained through aerobic composting, with the release of nutrients slower.

According to the **Food and Agriculture Organization of the United Nations (FAO)**, the use of biofertilizers can increase vegetable productivity by up to **25%** compared to... traditional organic fertilizers

15. Cost-benefit analysis of biofertilizer production

The cost of producing biofertilizer is practically zero after the biodigester is implemented. considering that the raw material is waste that would already have a disposal cost. The market value of liquid biofertilizers in Brazil ranges from **R\$ 0.80 to R\$ 3.00 per liter**. Thus, for a restaurant that produces 36,000 liters/year, the potential revenue (or savings, if applicable) (for internal use) can range from **R\$ 28,800.00 to R\$ 108,000.00 per year**.

16. Cost of waste shredding logistics

The pre-treatment stage of waste is fundamental to increasing the efficiency of biodigester. Equipment such as industrial shredders and pulpers have an acquisition cost of **Between R\$2,000.00 and R\$15,000.00** for commercial applications.

The operational cost involves:

- Electrical consumption (~1 to 3 kWh per ton of shredded material);
- Labor for operation;



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- Preventive maintenance.

For restaurants that already use similar equipment in their kitchens, the additional impact is... minimum.

17. Biogas purification/conditioning

Raw biogas contains impurities such as H_2S , CO_2 , and water vapor, which can harm the equipment and reduce efficiency.

Typical purification steps:

- **Desulfurization:** use of iron or activated carbon filters to remove H_2S ;
- **Drying:** condensers or silica gel for moisture removal;
- **Upgrading biomethane:** removing CO_2 to raise the CH_4 content above 96%, making it equivalent to natural gas.

Compact restaurant systems cost between **R\$ 5,000.00 and R\$ 25,000.00**, depending on... automation.

18. Energy integration (partial replacement of LPG)

Biogas has a lower calorific value ($\sim 5.5 \text{ kWh/m}^3$) compared to LPG ($\sim 12.8 \text{ kWh/m}^3$).
kWh/kg). Thus, to replace 30% of the LPG consumption of an average restaurant (which consumes
If the energy produced were 400 kg/month, approximately **650 m³ of biogas would be needed per month**.

Advantages:

- Reduction of operational costs;
- Lower CO_2 emissions;
- Partial independence from gas suppliers.

19. Economic feasibility analysis (CAPEX/OPEX, LPG savings, payback)

CAPEX (initial investment):

- Medium-sized biodigester: R\$ 60,000.00;
- Purification system: R\$ 10,000.00;
- Construction and installation: R\$ 15,000.00;
- Estimated total: R\$85,000.00.

OPEX (operating costs):



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Annual maintenance: ~R\$ 3,000.00.

- Energy for operation: ~R\$ 1,200.00/year.

Estimated savings:

- LPG: ~R\$ 18,000.00/year;
- Waste collection: ~R\$ 6,000.00/year;
- Biofertilizer: up to R\$ 50,000.00/year (if commercialized).

Payback

Between **2 and 3 years**, depending on the efficiency and market of the biofertilizer.

20. Applicable regulations and standards (Brazil)

In Brazil, the operation of biodigesters in restaurants must comply with environmental regulations, sanitary and safety measures.

Key legislation:

- **Federal Law No. 12.305/2010** – National Solid Waste Policy (PNRS) – defines principles of organic waste management;
- **CONAMA Resolutions No. 275/2001 and 358/2005** – regulate the disposal and treatment of waste;
- **ANVISA Resolution RDC 216/2004** – establishes good practices for food services.

Compliance with these standards ensures operational safety, legal viability, and incentives. inspectors in some municipalities.

21. Standards and laws for biogas storage

Biogas storage must comply with ABNT technical standards:

- **NBR 15526:2013** – specifies biogas storage and packaging;
- **NBR 13523:2015** – defines safety requirements for pressurized reservoirs;
- Use of vented tanks, pressure relief valves, and gas sensors to prevent accidents.

22. Standards and laws governing the sale of biogas



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The commercialization of biogas or biomethane is subject to energy and gas regulations:

- **ANEEL – Resolution 482/2012** and complementary regulations for microgeneration of energy;
- Supply contracts must guarantee the quality, pressure, and purity of the biogas, in accordance with... ABNT NBR 15526.

23. Standards and laws governing the logistics process of organic waste

- **Mandatory selective collection** of organic waste in commercial establishments;
- Safe transportation, with enclosed and sanitized vehicles;
- Registration and traceability of waste disposal, in accordance with **the PNRS (National Solid Waste Policy) and municipal regulations.**

24. Standards and laws for installing a biodigester

- Environmental licensing with municipal or state agencies;
- Engineering project approved by technical staff, including tank sizing, piping and safety systems;
- Environmental impact assessment (when applicable);
- Compliance with ABNT standards for construction and operation (tanks, valves, ventilation).

25. Market projections and trends

The biodigester market in Brazil and worldwide is experiencing continuous growth. driven by:

- Sustainability and circular economy policies;
- Tax incentives and energy efficiency programs;
- Growing awareness among consumers and businesses;
- Technological advances, such as automation and remote monitoring, which increase efficiency and They reduce operational costs;
- Integration with hybrid energy systems (LPG + biogas) in restaurants and food courts. food.

Studies indicate that, by 2030, Brazil could multiply the number of installed systems. in commercial establishments, the rate increases 5 to 7 times, especially in large urban centers.

References



Year VI, v.1 2026 | Submission: 03/26/2026 | Accepted: 03/28/2026 | Publication: 03/30/2026

BRAZIL. National Health Surveillance Agency (ANVISA). *RDC No. 216, of September 15, 2016.*

2004. Establishes the Technical Regulation of Good Practices for Food Services. Brasília, DF, 2004.

BRAZIL. Law No. 12,305, of August 2, 2010. Establishes the National Solid Waste Policy.

Official Gazette of the Union, Brasília, DF, 2010.

BRAZIL. National Council for the Environment (CONAMA). *Resolution No. 275/2001.* Provides for Solid waste management. Brasília, DF, 2001.

BRAZIL. National Council for the Environment (CONAMA). *Resolution No. 358/2005.* Provides for Treatment and final disposal of solid waste. Brasília, DF, 2005.

EUROSTAT. *Municipal waste statistics—statistics explained.* Luxembourg: Eurostat, 2022.

GIZ BRASIL. *PROBIOGÁS: biogas and biomethane market in Brazil.* Brasília, DF, 2019.

FAO. *Biogas and biofertilizer production from organic waste: global review.* Rome: Food and Agriculture Organization, 2018.

ABNT. *NBR 15526: Biogas storage – Design and operation requirements.* Rio de Janeiro, 2013.

ABNT. *NBR 13523: Biogas systems – Safety and installation.* Rio de Janeiro, 2015.

HOME BIOGAS. *Modular biodigester systems: technical manual.* Israel, 2021.