ENERGY RESIDUES AND THE BRAZILIAN INDUSTRY

Analysis of how industry can benefit from waste generation in Brazil

Elaboration: epe

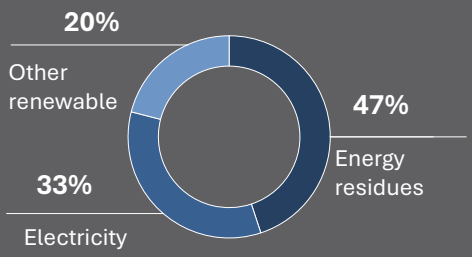
Hundreds of millions of tonnes of waste are generated annually in Brazil. The country, which has one of the largest populations in the world, generated approximately **64 million tonnes** of municipal solid waste in 2022 (*Ministério das Cidades – SNA, 2024*). In addition, Brazil's high agricultural production results in the generation of around **450 million tonnes of residues** as co-products (Embrapa, 2020).
In general, waste generation does not receive adequate treatment and is often disposed of in sanitary landfills or, in worse scenarios, in open dumps.
The challenge of waste generation may find an ally in the industrial sector. Given the trends of growing energy consumption alongside the need to reduce greenhouse gas (GHG) emissions, Brazilian industry could benefit from this large flow of materials.

THE ENERGY CONSUMPTION OF THE BRAZILIAN INDUSTRY

The Brazilian industrial sector accounts for **32%** of national final energy consumpion, second only to the transport sector, at 33%.

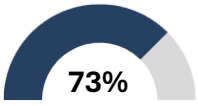
64% of this consumption comes from renewable sources and electricity.

Of these renewable sources, approximately **45%** consist of energy residues, such as sugarcane bagasse and black liquor.



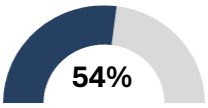
Fonte: EPE, 2025

Use of residues in industrial sectors



Food and beverage

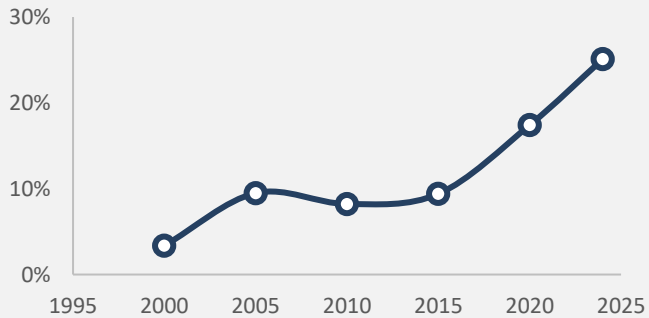
The food sector has a high share of energy residues in its energy mix. With residues accounting for around 73% of total energy use, the sector stands out for its use of sugarcane bagasse as an energy source, mainly associated with sugar production.



Pulp and paper

The pulp and paper industry also stands out for its use of residues. Black liquor, a co-product of pulp production, is used both as fertilizer and as an energy source, accounting for more than half of the sector's energy demand.

Cement



In 1999, CONAMA (the National Council for the Environment) established guidelines for the environmental licensing of co-processing (cement manufacturing with waste combustion). Since then, the use of residues in the cement sector has been increasing (SNIC, 2019).

Currently, around 25% of this segment's energy consumption comes from alternative fuels, which are mostly composed of residues (EPE, 2025).

Key sector regulations (in portuguese): ABCP

Forms of residue use

REFUSE-DERIVED FUELS (RDF) are fuels produced from solid waste (such as municipal, agricultural, or industrial waste) through processing techniques that allow these residues to be used in kilns, boilers, or thermal treatment units without compromising product quality or causing additional environmental damage.

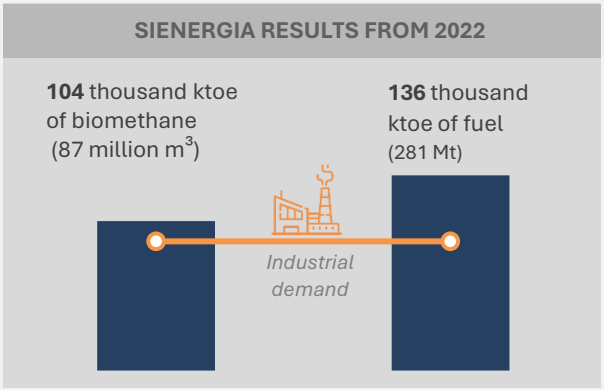
Another solid fuel that can be produced from residues is **CHARCOAL**. It can be obtained through the pyrolysis of biomass, resulting in an energy source with a higher calorific value. This process also generates syngas, which can be used in the production of ammonia and in other industrial processes.

BIOGAS is a gaseous fuel generated from the biological decomposition of organic waste (EPE & CIBiogás, 2023). After purification, **BIOMETHANE** is obtained, a gas composed predominantly of CH_4 (>90%). It is particularly relevant for the industrial sector as a substitute for natural gas, as it can be used as an energy source at various stages or even as a feedstock in industrial processes.

Use potential

SIEnergia is a tool developed by EPE that maps the potential of residues in Brazil. In its new version, it also allows the mapping of the costs of using residues as an energy source in the steel industry, cement plants, and thermoelectric power plants. For more details about SIEnergia, click here.

The tool also includes an economic feasibility simulator. It considers residues from the nine main agricultural crops in the country, the road network, and associated costs (logistics, biofuel production, residue collection in the field, and revenues).
To learn more about this module, visit our Github page.



Both energy sources are sufficient to meet the entire energy demand of the industrial sector.

Industry as a driver of waste consumption

To produce one tonne of steel, around 0.8 tonnes of mineral coal are consumed, resulting in the emission of nearly 2 tCO_2 (WorldSteel, 2024). In general terms, biomass can be used at all stages of the steelmaking process. The use of residues, in the form of biochar or biogas, can be implemented through injection into blast furnaces. Biomethane can also be used as a fuel in technologies such as Direct Reduction, substituting natural gas.

The cement industry stands out for its use of residues due to the characteristics of its energy consumption. High temperatures above 1,400 °C, long residence times, and the destruction of organic components are features that allow the sector to use a high share of residues in its kilns. According to SNIC, its **Roadmap** projects that the use of these residues will increase to **55% by 2050**.

Bridging supply potential and demand requires overcoming a number of challenges.

First, for residues to be used as an energy source, they must meet specific quality standards. Variations in composition and high ash content are examples of challenges to producing a standardized product that meets the requirements for application in specific processes.

In addition, logistical costs can render projects unfeasible, especially when residues are geographically dispersed, increasing collection and transportation costs. Factors such as high moisture content and low calorific value further exacerbate this situation, making the production of an intermediate fuel, such as pellets, an essential strategy to ensure economic viability.

Some already approved policies can help incentivize the use of residues as an energy source. One example is the Future Fuels Law, which aims to increase the share of biofuels in the energy mix and may boost these alternatives. In addition, the carbon market, established by Law No. 15,042/2024, can enhance their competitiveness relative to fossil fuels.

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