Atlas of Energy Efficency

Brazil | 2025

Indicators Report

epe 20+

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Public Value

The Brazilian Energy Research Office (EPE), founded in 2004 and part of Brazil's Ministry of Mines and Energy (MME), plays a key role in supporting energy sector planning through its research and studies. One of its standout initiatives is the Atlas of Energy Efficiency in Brazil, a report published regularly since 2014 that tracks progress in energy efficiency across the country using detailed indicators.

Together with the Methodological Manual for the Atlas of Energy Efficiency, this publication aims to provide transparency and close information gaps about Brazil's energy efficiency advancements, focusing particularly on the residential, industrial, and transportation sectors.

This report features a special chapter...

about the Energy Efficiency Program (PEE), an initiative of the National Electric Energy Agency (ANEEL), the result of cooperation with EPE. In this chapter, the PEE is presented, which aims to promote the efficient use of electricity in Brazil, reducing waste and involving several projects to optimize energy consumption in different sectors.

In addition, the International Energy Agency (IEA) presents an international analysis of energy efficiency policies, providing guidance to policymakers to improve and expand their programs, as well as accelerate energy efficiency gains through new and stronger policies.

AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA

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Objective

Objetivo

The main purpose of this report is to track the Brazilian energy efficiency advances through an indicators analysis. In 2014 the first Energy Efficiency Indicators Report was published, with data up until 2012. Since then, this report is being updated, and in 2020 it started to be called as "Atlas of Energy Efficiency Brazil – Indicators Report". This document complements and updates, in a synthetic way, the first reports, with data up until 2024.

2014

2017

2020

Special chapter

Energy Efficiency Benchmarking: Brazil in the Global Scenario

2021

Special chapters

- Cement sector in Brazil and in the World
- Covid-19 effects

2022

Special chapter

Road freight transport and the comparison of the Brazilian case with selected countries

2023

Special chapter

- Steel sector

Special chapter

- Residential sector

2024

Special chapter

- Industry sector of Ferroalloys and Silicon metal

Definitions

ODEX

The ODEX is an indicator that measures the energy efficiency progress. It can be combined by sector (industrial, residential, services and transport) or for the whole economy. The ODEX is being used by the European Union in the ODYSSEE database program to track efficiency gains (Enerdata, 2020).

The ODEX by sector (e.g. industry) is based on specific consumption indexes by subsector (cement, ceramics, textiles, etc.) and weighted by its share on the total energy consumption. The specific consumption by subsector can be expressed in different units to provide the best energy efficiency proxy, such as consumption per household, consumption per physical production or consumption per transport activity (measured in units such as passenger-kilometre and tonne-kilometre).

For this report, 2005 was taken as the base year (value = 100), essentially due to the data availability for most sectors from that year onwards. A decrease in the ODEX from 100 in 2005 to 80 in any given year, for example, represents a 20% gain in energy efficiency over the analyzed period. In other hand, if the ODEX increases from 100 to 120, means that the energy efficiency declined over the years.

In the case of the global ODEX, the same method is applied with weighted factors, based on the share of each sector on the total final energy consumption, in relation to the total final energy considered for all the evaluated sectors.

For this report purposes, the industrial, residential and transport sectors were considered. Other sectors (energy, services and agriculture) were not included due to the data unavailability in the appropriate format for the indicator calculation.

The Methodological Manual of the Atlas of Energy Efficiency in Brazil provides detailed information about the data and indicators used to prepare this report, including the ODEX. It can be accessed by clicking on **Methodological Manual**

Energy Intensity

Energy intensity refers to the amount of energy required to produce one final product or service. It is the ratio between an energy indicator (ton oil equivalent [toe], Joule, calorie, Btu, among others) and an activity indicator (U$, R$, m^2, ton-kilometers, passenger-kilometers, among others).

Hypothetical examples:

- Industrial Energy intensity: 100 toe/U$ ppp 2010
- Energy intensity of residential building: 0.5 toe/m^2
- Energy intensity of commercial building: 200 KJ/m^2
- Energy intensity in the transport sector: 1,000 toe/tkm

The energy intensity of an economy corresponds to the ratio of Internal Energy Supply divided by the Gross Domestic Product (GDP) of the country. This indicator is typically used to measure a country's energy efficiency. However, it's important to notice that this ratio does not necessarily express energy efficiency. It means that a country with low energy intensity may still be inefficient from an energy perspective. For example, consider the case of a small country with an economy based on the service sector. This country may have lower energy intensity than another large nation with an economy based in industrial production. However, the second country may efficiently use more energy in its industries compared to the first, which utilizes energy for developing a trade and service-based economy.

Thus, the energy intensity should not be analyzed alone. Efficiency gains are only one component of this analysis, which must also consider the **structure** (structural effect) of a country's economy (involvement of intensive-energy industries, developed services sector, etc.) and **activity** changes (activity effect), which are influenced by the country's size (implying in higher transport sector demand, for example).

In this report, the indicator will be established in two ways: from the perspective of total energy supply (TES), identified as Primary Intensity (i), and from the perspective of final energy consumption, denoted as Final Intensity (ii).

I. Total Energy Supply (thousand toe)/GDP (M$[2010])
II. Final Energy Consumption (thousand toe)/GDP (M$[2010])

Final Consumption

This is all the energy that reaches consumption sector for energy and non-energy purposes (raw material, for example). The sources used as input or raw material for transformation into other energy products are not included in this concept. These activities are ranged, according to the Brazilian Energy Balance, as Transformation Centers (examples: water used to generate electricity or oil that will be transformed into gasoline, diesel oil, etc.).

In general, the sectors in this report are ranged according to the Brazilian Energy Balance, except for some intensive-energy sectors, to depict better the energy efficiency progress in Brazil.

Final consumption can be calculated in the following ways:

- **Final consumption =** primary final consumption (+) secondary final consumption, or;
- **Final consumption =** non-energy final consumption (+) final energy consumption

Where:

- **Primary final consumption** is the consumption of primary energy, i.e., consumption from sources coming directly from nature. Examples: natural gas, mineral coal, solar, wind, hydro and sugar cane products, among others
- **Secondary final consumption** is the consumption of secondary energy, i.e., consumption from sources coming from different transformation centers, for a different economy sectors destination. Examples: electricity, gasoline, diesel oil, ethanol, among others.
- **Non-energy final consumption** corresponds to the consumption of sources that, although they have energy content, are used as raw materials for other purposes. Example: use of naphtha for the thermoplastics manufacture.
- **Final energy consumption** is the use of sources by sectors of the economy as energy.

INOVA-E

The INOVA-E digital platform was developed to provide information about innovation in energy in Brazil accessible to a wide range of audiences. In its investment module, the strategic information available on the platform has been arranged into a single database, presenting a relevant overview for understanding the country's investment trends in energy RD&D. This unprecedented overview provided by INOVA-E attempt to support EPE, MME, MCTI, among other government parties, private and civil society organizations, formulating and promoting public policies aimed on Brazilian energy transition. In its most recent update, the platform's RD&D investment module underwent several methodological improvements, which resulted in the expansion of mapped investments and the inclusion of projects in the investment history.

Public investment in R&D - Public investment in R&D are calculated based on expenditure on reimbursable and non-reimbursable R&D projects carried out by public institutions that promote innovation in Brazil. The statistics presented on this platform include the following federal bodies: BNDES, CNEN, CNPq, FINEP; and the state of São Paulo: FAPESP.

Publicly oriented investment in R&D - Publicly oriented investment refers to private investment driven by public policies, being compulsory for companies in the energy sector. These are resources that fall under public programs whose purpose is to induce companies to invest in RD&D. The statistics presented on this platform include R&D projects regulated by the ANEEL and ANP agencies.

For more details, visit:

Energy innovation investments in Brazil overviewing

inova e
BRASIL

Transport Sector

Activity

Activity in the transports sector is internationally represented by the indicators passenger-kilometer and ton-kilometer transported. Passenger-kilometer is a unit that relates the relative work to the passenger displacement over one-kilometer displacement. Similarly, ton-kilometer is the unit that represents the relative work to the displacement of a ton of cargo over one kilometer distance. It is also called as transport momentum.

Intensity of use

Ratio between transport activity and distance traveled. It is expressed in ton-kilometer/kilometer or Passenger-kilometer/kilometer.

Fuel Economy

Ratio of the distance traveled by passengers or cargo and the fuel consumption in volume and expressed as a measure of range.

Usually in kilometers/Liter.

Fuel Consumption

It is the spent fuel amount (volume) to travel a given distance, usually 100 km. It is expressed in Liters/100km.

Energy Efficiency

Ratio of estimated activity (t.km or p.km) to total energy demand (in units with Joule [J], Watt [W] or ton oil equivalent [toe]).

Transport Sector

Light Duty Vehicles (by size)[1]

Automobile

Motor vehicle for passenger transportation, with capacity up to eight people (excluding the driver);

Light Commercial Vehicle

- **Utility Vehicle** – vehicle for freight transportation with GCVW less than 3,500 kg;
- **Medium Duty Passenger Vehicle** – mixed vehicle for passenger transport;
- **SUV** – Mixed vehicle characterized by its versatility of use, even off road.

Heavy Duty Vehicles[2]

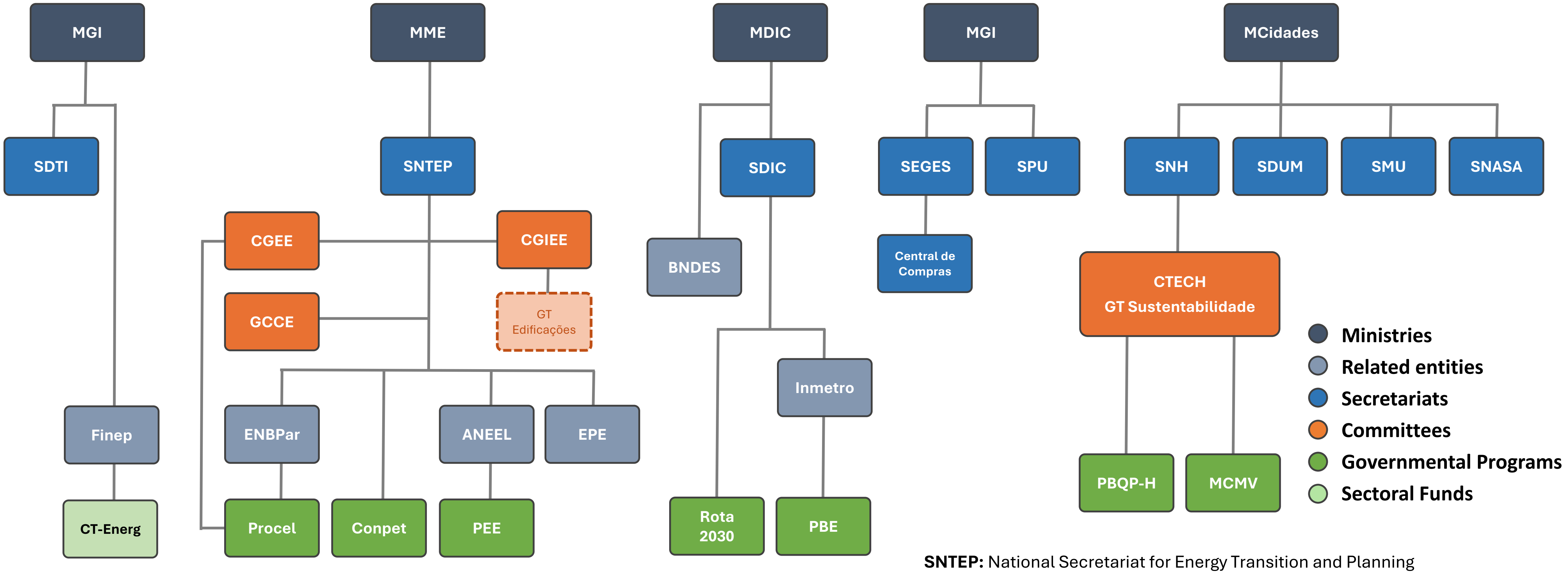
Trucks

- **Semi-light** – 3.5 t. < GCVW < 6 t.
- **Light** – 6 t. ≤ GCVW < 10 t.
- **Medium** – 10 t. ≤ GCVW < 15 t.
- **Semi-heavy** – GCVW ≥ 15 t. e MTC ≤ 45 t.
- **Heavy** – GCVW ≥ 15 t. e MTC > 45 t.

[1] Código Nacional de Trânsito (BRASIL, 1997)
[2] Anfavea (2025)
GCVW – Gross combined vehicle weight; MTC – Maximum Traction Capacity;
PBT – Total Gross Weight; CMT – Maximum Traction Capacity

Introduction

Institutional governance of energy efficiency in Brazil



SNTEP: National Secretariat for Energy Transition and Planning
SDIC: Secretariat for Industrial Development, Innovation, Trading and Services
SPU: Secretariat for the Coordination and Governance of Federal Assets
SNH: National Housing Secretariat
SDUM: National Secretariat for Urban and Metropolitan Development
SMU: National Secretariat for Urban Mobility
SNASA: National Secretariat for Environmental Sanitation

Energy Efficiency Policies Timeline...

1981

Ordinance MIC/GM46
CONSERVE Programme
Industry and imported energy sources substitution

1982

Decree 87079
PME: Energy Mobilization Programme

1984

PBE | INMETRO
PROGRAMA BRASILEIRO DE ETIQUETAGEM

1985

IO[1] 1.877
Establishes PROCEL

1990

Decree 99656
CICE – Internal Commission for Energy Conservation
(withdraw by Decree 10473/2020)

1991

Federal Decree 07/18/1991
Establishes CONPET

1993

Federal Decree 12/08/1993
Efficiency seal

1997

Law 9478
National Energy Policy Council (CNPE) and ANP

2000

Law 9991
PEE ANEEL: Investments in R&D and energy efficiency
ANEEL
AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA

2001

Law 10.295[2]
Energy Efficiency Law
(MEPS - Minimum Energy Performance Standards)

Decree 4.059 and republished by **Decree 9.864/2019**
CGIEE/ Buildings Technical Group

2002

Procel Industry

2003

Procel EDIFICA
Procel SANEAR

2004

Law 10.847
Decree 5.184
Establishes EPE

2005

Conpet Seal

2007

PNE 2030

Notes: (1) IO = Interministerial Ordinance
(2) Three-phase electric motors, compact fluorescent lamps, refrigerators and freezers, gas stoves and ovens, air conditioners, gas water heaters, sodium-vapor and metal-halide lamps, incandescent lamps, distribution transformers, ceiling fans.

... over the years to the present day

2009

Vehicle and Commercial Building Labeling

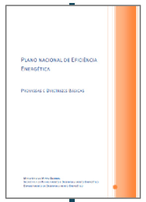
Decree 6996 (withdraw)
Decree 11158/2022 (in force)
Tax reduction (IPI) for products with energy efficiency levels A and B

2010

Residential Label

2011

Ordinance MME 594
NEEP: Energy efficiency targets



2014

NI[1] 02 MPOG
Requirements for Federal Public Buildings and Procurement

Procel Seal for Non-residential Buildings

2016

ProEESA: Energy Efficiency in Water Supply Systems Project

Law 13280
Reallocation of resources from PEE to Procel

Nationally determined contribution (NDC)

2017

Law 13576
National Biofuels Policy (RenovaBio)

Aliança Programme (industry)

2018

Decree 9557
Rota 2030 Programme (transport)

2019

Brasil Mais Produtivo – Eficiência Energética Programme (B+P EE) (industry)

2020

Procel Seal for Residential Buildings

Energy Efficiency Networks for Industry and Public Buildings

2021

Decree 10791
Establishes ENBPAr

PotencializEE Programme (industry)

2022

FGEnergia
Guarantee Fund for Energy Efficiency (BNDES and PROCEL resources)

2023

Energy Efficiency Website (MME)

2024

CGIEE
Res. CGIEE nº 01/2024
Regulatory Agenda CGIEE 2024-2026

Notes: (1) NI = Normative Instruction

Political Integration Viewing

ENDORSEMENT SEAL
Rewards the most efficient products

PROCEL Seal
1985

ENCE
Comparative label that rates energy performance

ENERGY EFFICIENCY LAW
Regulates minimum energy performance standards (MEPS) and the establishment of energy efficiency requirements for buildings

Minimum Energy Standards
Law Nº 10,295/ 2001

Energy Efficiency

Brazilian Labeling Programme
INMETRO (1984)

Implementam as políticas e desenvolvem o mercado

Energy Efficiency Programmes
PEE/ANEEL
PAR PROCEL

Research, Development and Innovation Programme (PDI)
ANEEL

Law nº 9,991/2000 delivers the rules about the investments in RD&D (currently PDI) and EE for the electric utilities. Currently 0.5% of the utilities' Net Operating Revenue (NOR).
After Law No. 13,280/2016, which amends Law No. 9,991/2000, 20% of the EE resources are destined for Procel and 80% for the PEE/ANEEL.

Share of renewables in the Energy Mix

Historically, Brazil stands out for being a country with a high percentage of renewable energy sources in its domestic supply when compared to the rest of the world. In the last 20 years, the share of renewables in the Brazilian energy matrix has remained stable with values above 40%. The oscillations observed between 2011 and 2014 are due to the reduction in the share of renewables in the energy mix due to the drop in hydraulic supply. As of 2015, renewable sources resume a growth trajectory with the expansion of the supply of sugarcane derivatives, wind and biodiesel, reaching 50% in 2024 with the contribution of the favorable hydrological situation.

Figure 1: International comparison of the renewables share in the Total Energy Supply (TES)

Source: EPE (2025b) e IEA (2025)

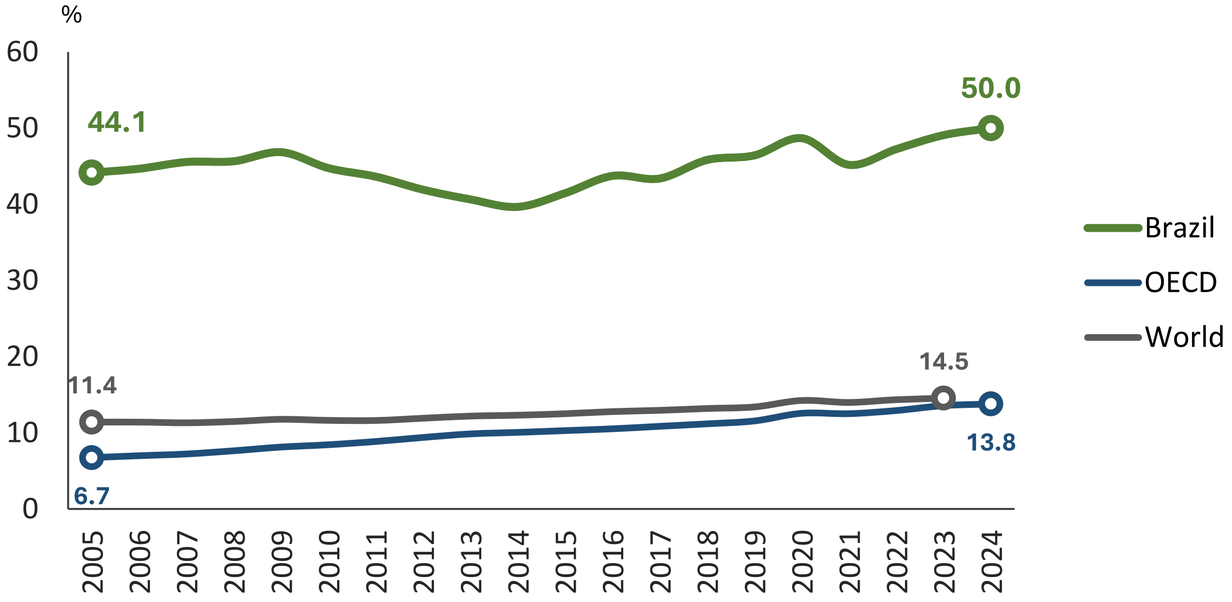
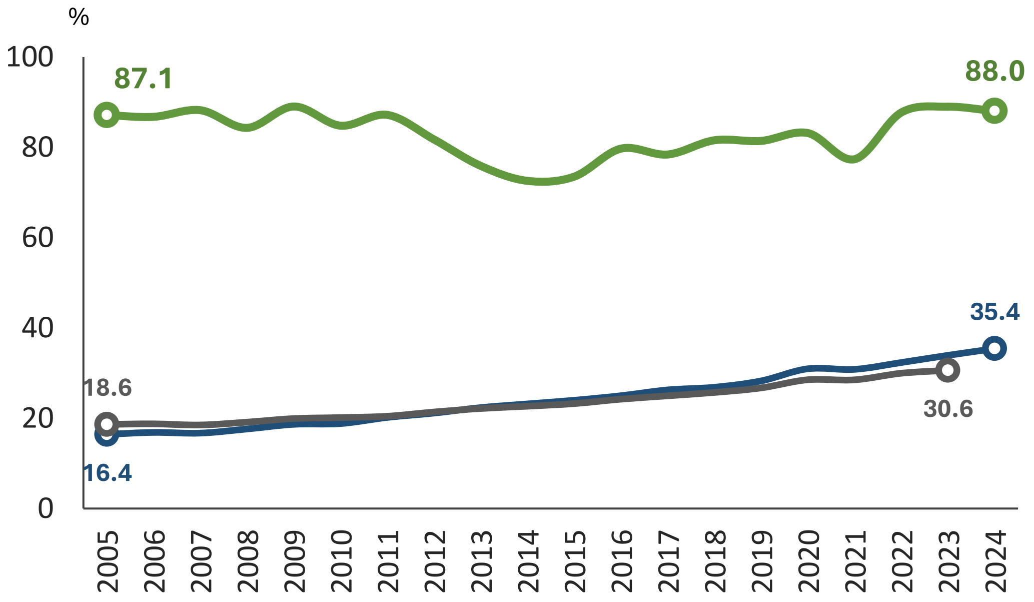


Figure 2: International comparison of the renewables share in Electricity Generation

Source: EPE (2025b) e IEA (2025)



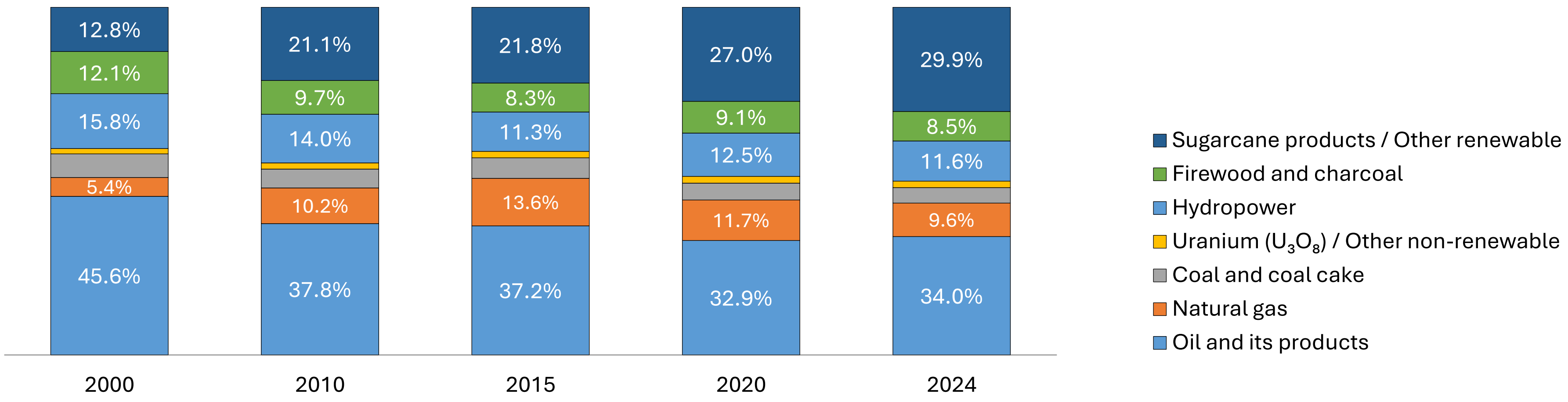
Note: World data presented according to the availability of data from the International Energy Agency.

Evolution of Total Energy Supply (TES) by source

On the side of non-renewable sources, oil and its derivatives continue to be the largest sources. Natural gas increased its share from 5.4% in 2000 to 9.6% in 2024, due to its use in basic thermoelectric plants and extension of the pipeline network, which enabled its use both in industries and in residential, commercial and public buildings.

Figure 3: Total Energy Supply (TES) by source in selected years

Source: EPE (2025a)



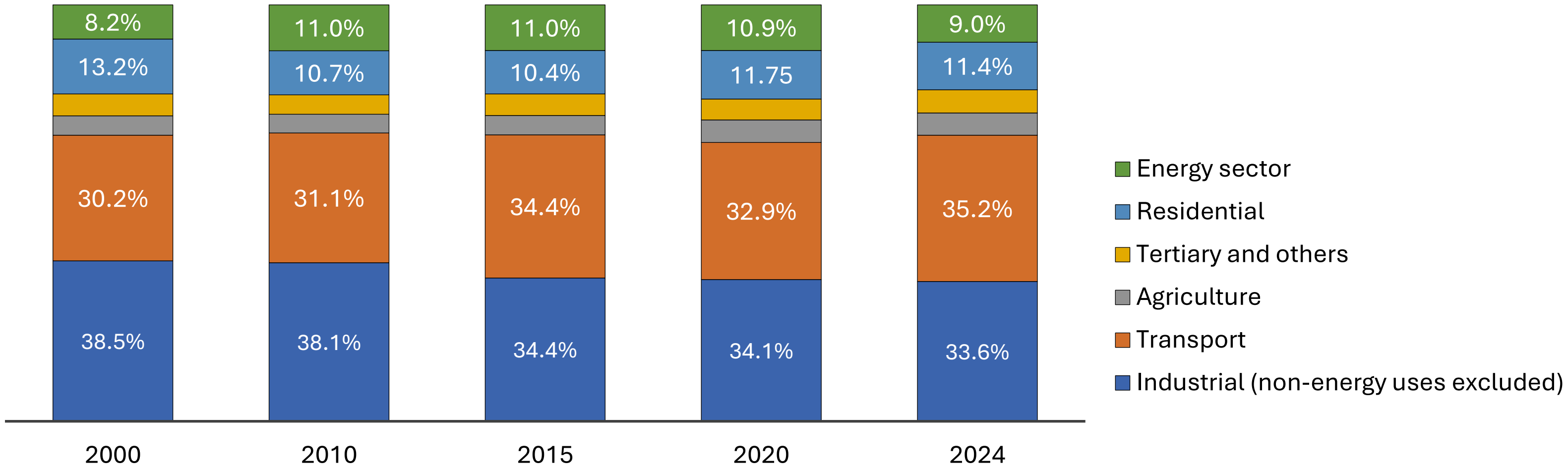
Renewable sources grew at a faster pace due to the expansion of the sugar and alcohol sector and the strong penetration of other renewables, such as wind, solar, black liquor and biodiesel. Wind energy showed increasing participation in the energy matrix, reaching 2.9% of the Domestic Energy Supply in 2024. Black liquor, directly associated with the pulp industry, contributed 3.6% of the TES in 2024. Biodiesel has been favored by the policy of adding it together to fossil diesel. In 2024, the average annual volume of biofuel addition was 13.6% in the composition of total diesel oil in 2024.

Evolution of energy consumption by sector

The main movement observed in this period was the decline in the industry consumption in contrast to the advance of the transport sector, which reached the mark of 35% of participation in 2024. The transportation sector grew at an average rate of 3.0% per year (2000-2024), and more sharply between 2000 and 2015, with a growing participation of the road sector. In 2020, the sector was impacted by the covid-19 pandemic, due to travel restrictions, resuming its recovery trajectory in subsequent years and presenting a share of 35.2% of total energy consumption in 2024.

Figure 4: Energy consumption share by sector in selected years

Source: EPE (2025a)



Between 2005 and 2024, **the segments that stood out** the most in the industry were Pulp and Paper (3.6% per year), Cement (2.6% per year) and Sugar (2.2% per year). It should be noted that the production of cellulose and sugar are energy-intensive and use the co-products black liquor and sugarcane bagasse, respectively, which are renewable.

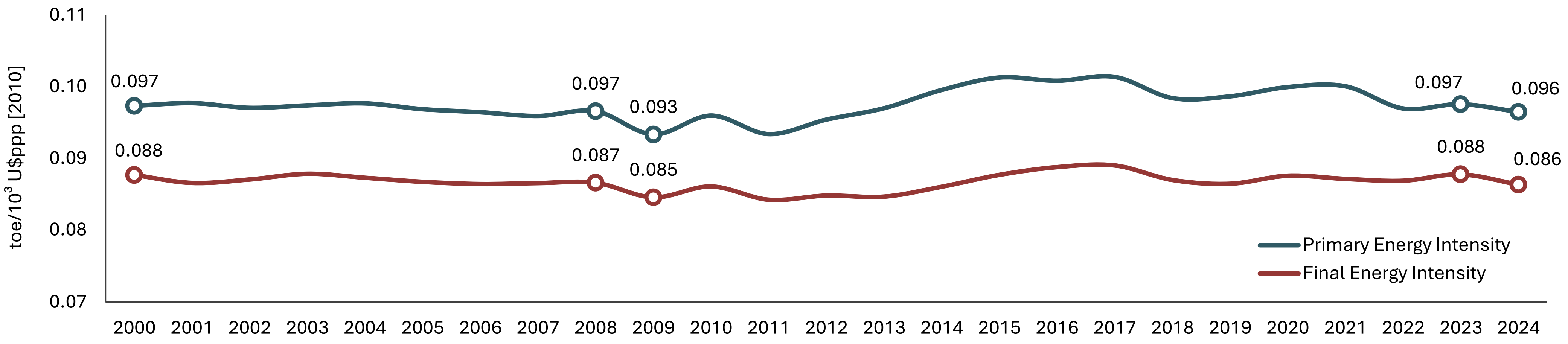
Compared to 2023, the energy-intensive segments of Pulp and Paper, Non-ferrous and Pig Iron and Steel grew 4.6%, 3.2% and 3.0%, respectively. The Sugar sector reduced 3.3%.

Energy Intensity

Between the years 2000 and 2008, the primary energy intensity remained stable at around 0.097 toe/10^3U$ppp [2010]. The final intensity, likewise, stabilized at values close to 0.087 toe/10^3U$ppp [2010]. In 2009, the effects of the international crisis on industry contributed to the reduction of primary energy intensity to 0.093 toe/10^3U$ppp [2010]. More inefficient units with higher intensities were deactivated.

Figure 5: Energy intensity Evolution in Brazil

Source: EPE (2025b)



Between 2010 and 2024, the primary and final intensities remained stable, evolving at average annual rates of 0.04% and 0.02%, respectively. The upward trend in energy intensities may be associated with the growth in the production of energy-intensive products with low added value in the production agenda, in relation to other manufactured products.

Note: Clarifications on Energy Intensity available at Definitions

Brasil is investing in Energy Efficiency

Competitive sectors such as industry depend on energy efficiency in the day-to-day of their production processes, because without it many businesses can be unviable. Technological changes are among the main sources of wealth creation and long-term economic growth.

According to the INOVA-E platform, between 2013 and 2024, Brazil invested almost 6 billion reais in research, development, and demonstration (RD&D) in energy efficiency projects arising from public or publicly oriented investments[1]. Of this amount, more than half came from BNDES, while ANEEL and Finep corresponded to 17% and 20%, respectively.

Figure 6: Evolution of RD&D investments in Energy Efficiency

Source: EPE (2025c)

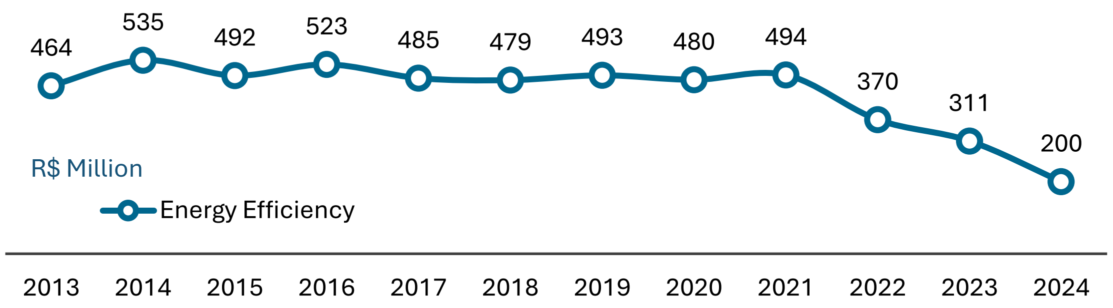
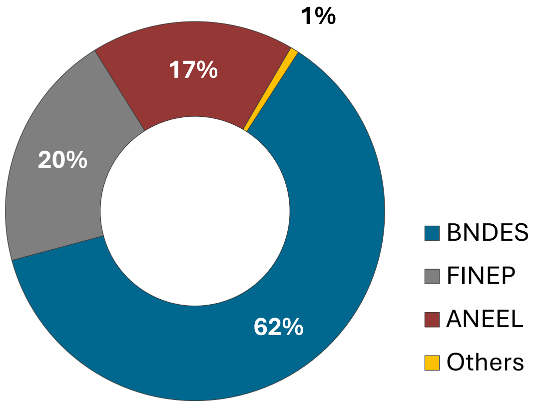


Figure 7: Source of resources (%) of RD&D in Energy Efficiency

Source: EPE (2025c)



inova e BRASIL

INOVA-E data point to an annual average investment of about 443 million reais over twelve years of historical series, considering public and publicly oriented resources in R&D projects in Brazil.

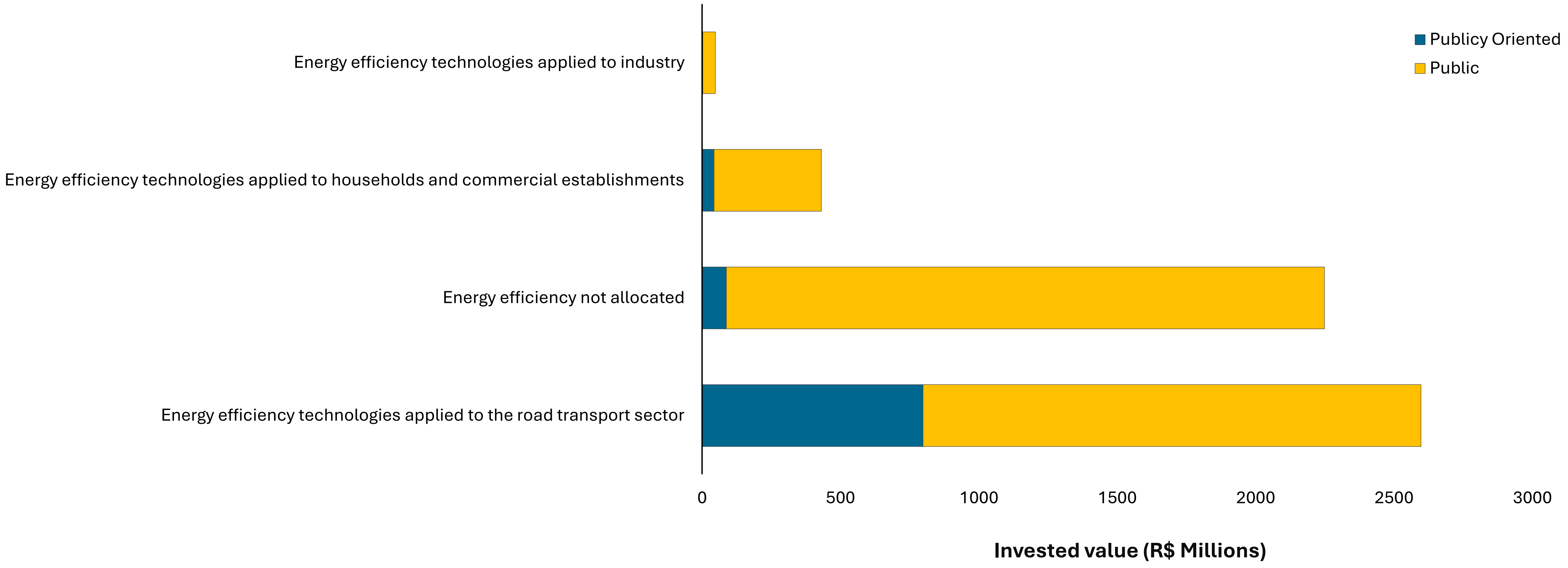
[1] For information on INOVA-E and meaning of the expressions "public investments" or "publicly oriented" access Definitions.

Note: With each update of INOVA-E, the process of selecting and classifying projects is reviewed and improved. Thus, the history values may vary from previous versions. In the latest version, the annual history is updated to constant values for 2024

RD&D Energy Efficiency Investments

Figure 8: Nature and modality of investments, in millions of reais - 2013 to 2024

Source: EPE (2025c)



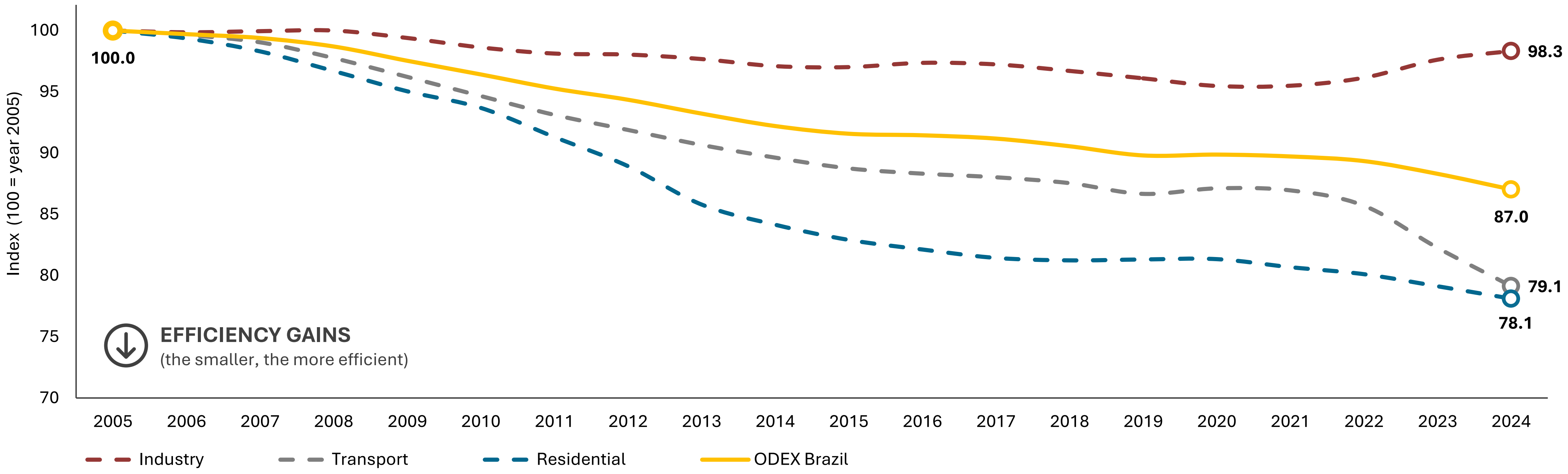
Note: The investments presented in the figure were adapted from the Inova-e tool, which adopts the classification of the International Energy Agency (IEA).

ODEX

In this report, 2005 was set as the base year (100), covering the industrial, residential, transport sectors and Brazil globally. In the period, all the sectors analyzed showed efficiency gains, with the largest in the residential and transportation sectors, with 21.9% and 20.9%, respectively. The ODEX calculated in 2024 shows that the country, this year, is 13% more energy efficient than in 2005.

Figure 9: ODEX Brazil

Source: Compiled by EPE



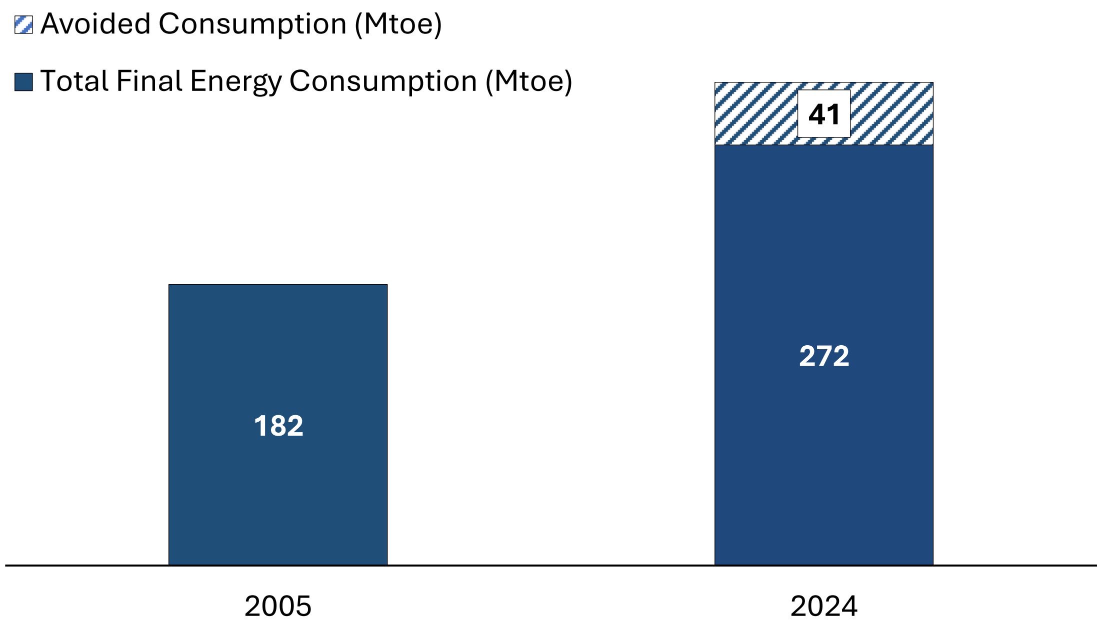
Note: Clarifications on changes in the ODEX history available at Definitions

Avoided consumption based on ODEX

In 2024, assuming that the energy efficiency indicator reduced by 13.0% (ODEX in 2024 = 87.0%), it would be equivalent to avoiding final energy consumption of 41 million toe.

Figure 10: Final Energy Consumption and Avoided Consumption (Mtoe)

Source: Prepared by EPE



The final energy consumption avoided was calculated based on the reduction of the energy efficiency indicator between 2005 and the base year of the report.

The value obtained was based on data from the Brazilian Energy Balance, and this number was extrapolated to calculate its equivalent of 100%[1]*.*

The avoided consumption of 41 Mtoe would correspond, in number, to the final consumption of fossil diesel oil in the transport sector in 2024.

[1]***Consumption avoided***$= \frac{Final\ Consumption_{base\ year}}{ODEX_{base\ year}} - Final\ Consumption_{base\ year}$

Buildings

Evolution in Buildings' consumption: residential, commercial and public sector

Electricity is the main source of energy in the building sector[1]. In 2024, households used 51% electricity, 21% LPG, and 23% firewood in its energy mix. In the commercial and public buildings segment[2], electricity was even more prevalent, reaching 90% of total energy consumption.

Figure 11: Total energy demand in buildings

Source: EPE (2025)

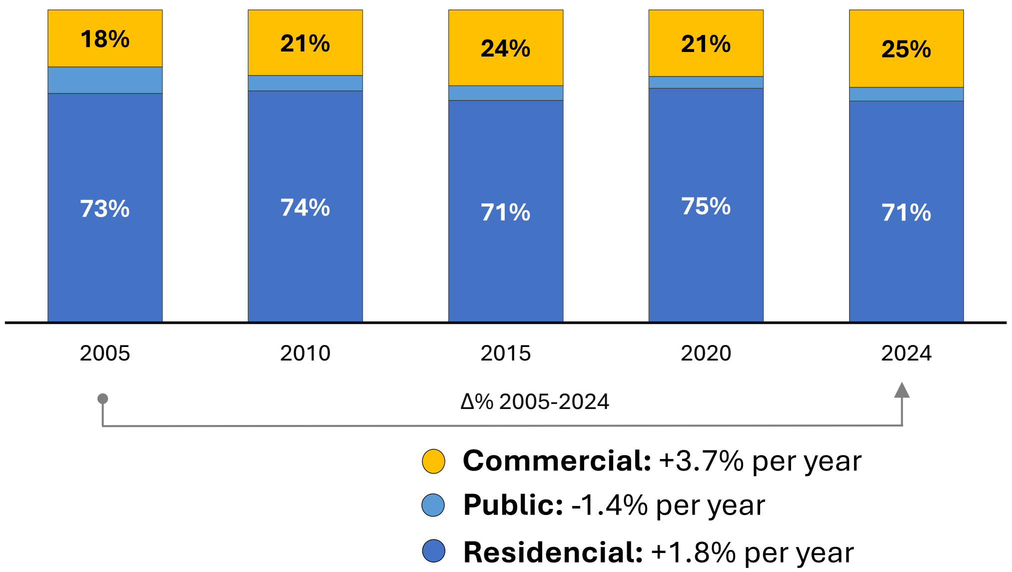
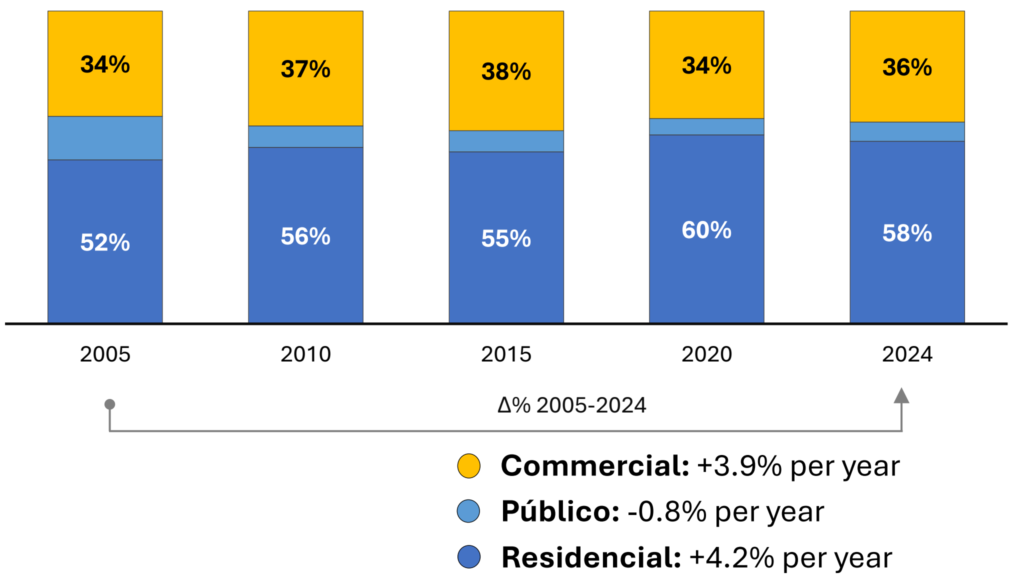


Figure 12: Eletricidade demandada pelas edificações

Source: EPE (2025)

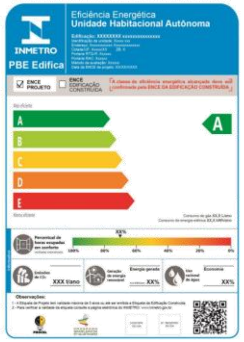


Almost half of the country's electricity consumption is concentrated in buildings. In 2024, consumption reached 314 TWh, which represents 48% of the country's electricity. Given the relevance of buildings in electricity consumption, this segment can be considered with the greatest potential for electrical efficiency.

[1] According to the historical series, electricity has been the main source since 2008.

[2] The public sector accounted for in buildings does not include Public Lighting and Sanitation.

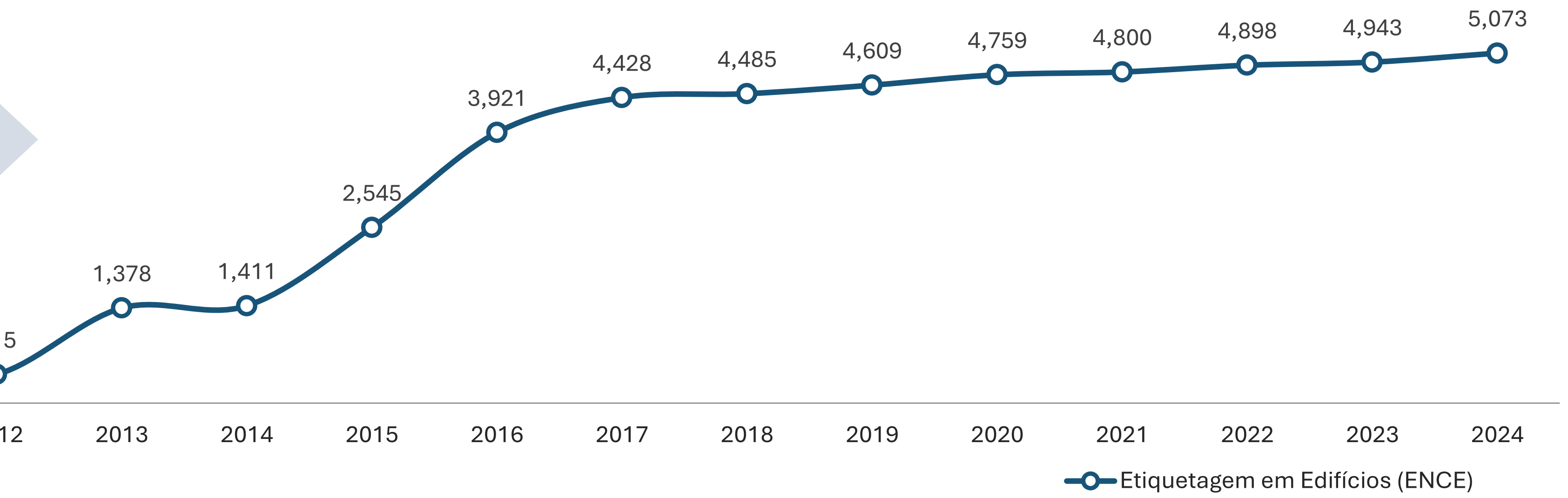
Building Labeling Evolution – Brazilian Labeling Programme (PBE Edifica)



The Energy Efficiency Labeling in Buildings, a voluntary adhesion instrument, allows buildings to be classified between the most efficient with A and the least efficient with E. Commercial, Service and Public Buildings, and Residential Buildings are part of the program. The label can be applied at two times: to the project and the built building.

Figure 13: Evolution of the National Energy Efficiency Label for Buildings - ENCE (number of issued labels)
Source: INMETRO (2025)

In 2024, autonomous housing units were the most labeled, with a share of 80% of the total accumulated in the period.



Building labeling is a voluntary adhesion instrument, as is the Procel Seal in Buildings, which aims to stimulate the market in the acquisition and use of more efficient properties. Due to the importance of the building sector in Brazil, with about 50% of electricity consumption, these policies have great relevance for energy efficiency and environmental comfort.

Note: PBE is the Brazilian Labeling Program. PBE Buildings: https://pbeedifica.com.br/

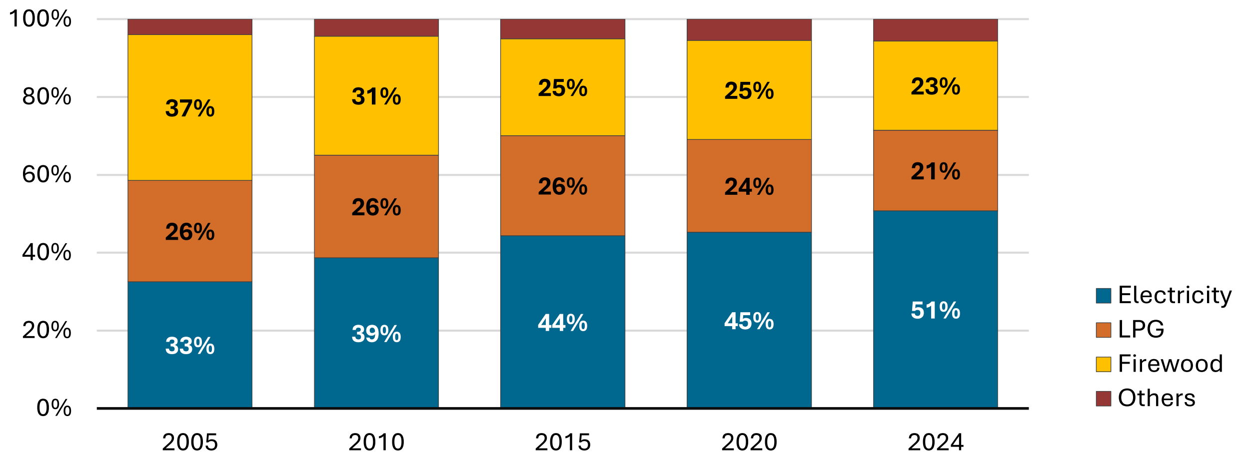
Residential Sector

Evolution of energy consumption in Households by source

Electricity continues to be the most used energy source in Brazilian households, surpassing the 50% share barrier in 2024, with an 18 p.p. increase in energy share from 2005 to 2024. Its use in homes is associated with various energy services, such as air conditioning, conservation, food preparation and cooking, water heating, lighting, domestic services, entertainment, communications, personal beauty and other electrical and electronic equipment.

Figure 14: Evolution of energy consumption in Households by source

Source: EPE (2025)



Liquefied Petroleum Gas (LPG) has a share of 21% in 2024, with its main use being associated with cooking food and heating water for bathing.

Natural Gas (NG) is included in the Other category (Chart) and its end use is associated with the same uses as LPG. Its participation is mainly concentrated in the urban and coastal areas of the country, due to the distribution infrastructure.

In addition to NG, the category Others (6%) adds solar thermal energy, also associated with the heating of water for bathing, as well as swimming pools.

There is a gradual reduction in the consumption of firewood for cooking food between 2005 and 2024. This is due to the improvement of the economic conditions of families and, more recently, the elaboration of public policies for clean cooking and the promotion of the substitution of energy sources are also determining factors in reducing the need to use firewood to cook food.

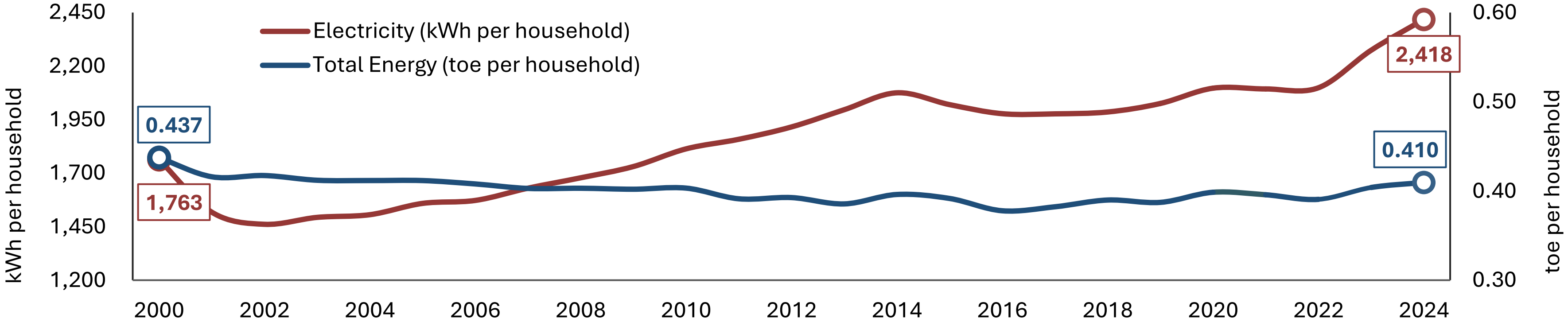
Note: The "p.p." notation refers to percentage points.

Evolution of electricity and energy consumption in households

Energy consumption per household decreased by 6.4% between 2000 and 2024 (down 0.3% per year), while electricity demand grew by 37% (up 1.5% per year) over the same time horizon. The demand for electricity fell abruptly in the early 2000s, as a result of energy rationing in the country, which caused a change in habits and the adoption of energy efficiency measures in Brazilian homes. From this period, until 2014, electricity consumption showed a steady increase. Between 2014 and 2018, effected by a period of economic recession, consumption decreased again, returning to the same levels in 2019. From 2020 to 2022, electricity consumption did not show major variations. In 2023 and 2024 a significant increase was observed. This can be explained by the use of air conditioning equipment, such as air conditioners and fans, due to the constant heat waves that have occurred in the country in the last two years.

Figure 15: Evolution of electricity and energy consumption in households

Source: Compiled by EPE



The demand for electricity per household increased from 2000 to 2024, due to the economic progress of families, the advance of credit for the purchase of household appliances, government policies to expand the general electricity network, especially in rural areas, and housing programs in conjunction with incentives to reduce the Brazilian housing deficit. On the other hand, the total energy consumption per household showed an average annual reduction of 0.3% per year over the period. This was due to the reduction in the mix of less energy-efficient sources (traditional biomass such as firewood and charcoal) and the consequent replacement by more modern sources (LPG, natural gas and electricity). It should be noted that energy consumption per household includes the consumption of solar thermal energy for heating water for bathing, which has been increasing considerably since 2005.

Effects of energy efficiency policies on households

Energy efficiency policies combine regulatory and market instruments through the implementation of minimum energy efficiency indices (or maximum consumption indices), comparative labelling (compulsory or voluntary) and endorsement labels.

These initiatives have been practiced in the country since 1984, with the creation of the Brazilian Labeling Program (PBE), coordinated by INMETRO, which began to prepare comparative labels of equipment energy performance, providing important information to the consumer and stimulating the manufacture of products with better levels of efficiency by the industry.

In 1993, the PROCEL (for electrical equipment) and CONPET (for products that use petroleum and natural gas) seals were created, which began to identify and value the devices with the best energy performance on the market.

Some complementary actions seek to reduce energy demand in homes, such as the Building Performance standard ABNT NBR 15.575, published in 2013, revised in 2021 and ABNT NBR 15.220 published in 2006 and revised in 2022, which specifically deals with the thermal performance of buildings. The labeling standards (PBE Edifica) and endorsement seals (Procel Edifica) of buildings and encouragement of the use of alternative energy generation systems in social interest housing (HIS) are also important actions in the implementation of efficiency policies.

It is estimated that the average annual consumption per **air conditioner** has been reduced by 20.3% between 2005 and 2024 (-1.0% per year), as a result of the regulations on minimum energy efficiency indices initiated by PI MME/MCT/MDIC nº 364/2007, revised by PI n0 323/2011, PI nº 2/2018 and PI nº 234/2020 and PI nº 269/2021.

In the case of **refrigerators**, it is estimated that the average annual consumption per equipment has been reduced by an average of 12.4% between 2005 and 2024 (-0.7% per year), as a result of the regulations on minimum energy efficiency indices initiated in 2007 by PI MME/MCTI/MDIC nº 362/2007, and which was revised by PI nº 326/2011, PI nº 01/2018 and PI nº 332/2021, amended by PI nº 736/2024.

Through the policies initiated from Law nº 10,295/2001, known as the Energy Efficiency Law, the regulatory agenda of minimum indices will contribute to the implementation of new regulations for energy efficiency of equipment, appliances and buildings to be extended to other appliances for residential use, expanding the set of equipment evaluated by the policies.

PI = Interministerial Ordinance

Solar Heating Systems (SHS) ingress in households

The transformation of solar energy into thermal energy occurs by the absorption of solar radiation by a system of collectors that is converted into heat and transferred to the water inside, and is then used directly in energy applications and services.

Solar water heating systems (SHS) are composed of solar collectors and a thermal reservoir, where heated water is stored. SAS have complementary heating equipment, which can use electricity or gas and are activated during periods of low solar intensity, such as at night or on cloudy days. The collectors and reservoirs are standardized by the Brazilian Labeling Program (PBE), coordinated by INMETRO.

For consumers, the use of SHS can reduce total energy expenses. For the electricity sector, their use can decrease grid consumption, peak demand during critical periods, and technical losses in the system, helping to postpone new investments in generation, transmission, and distribution. Finally, from an environmental perspective, the use of SHS can contribute to reducing greenhouse gas (GHG) emissions.

Residential solar thermal energy is mainly used to heat water in baths and swimming pools, which can be located inside homes or in leisure areas of buildings. It was estimated that the avoided energy consumption in the country's households was 916 thousand toe in 2024 due to the use of SAS.

Figure 16: Solar Heating Systems (SHS) ingress

Source: Compiled by EPE

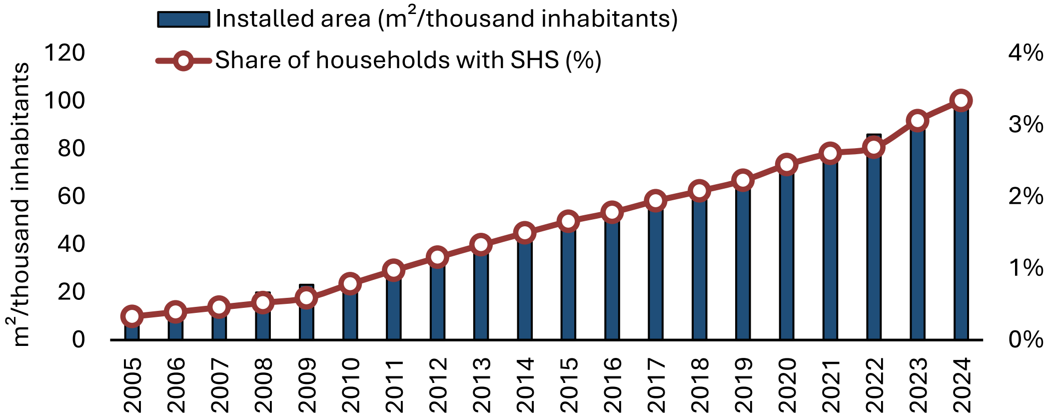
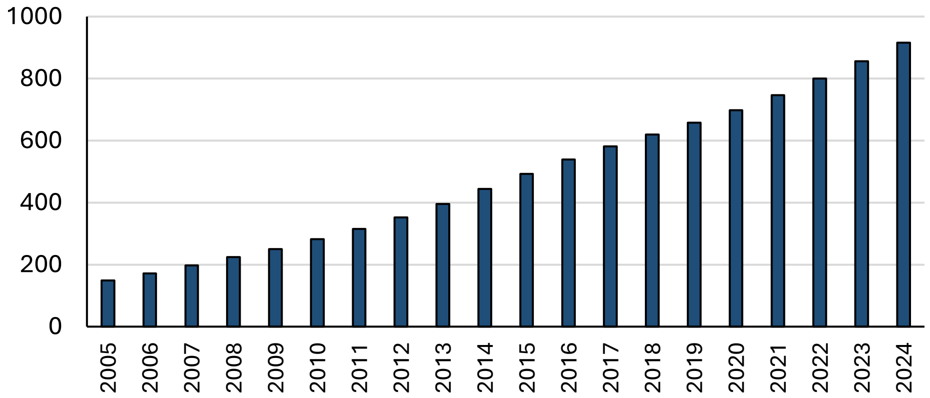


Figure 17: Avoided Residential Energy Consumption (thousand toe)

Source: Compiled by EPE



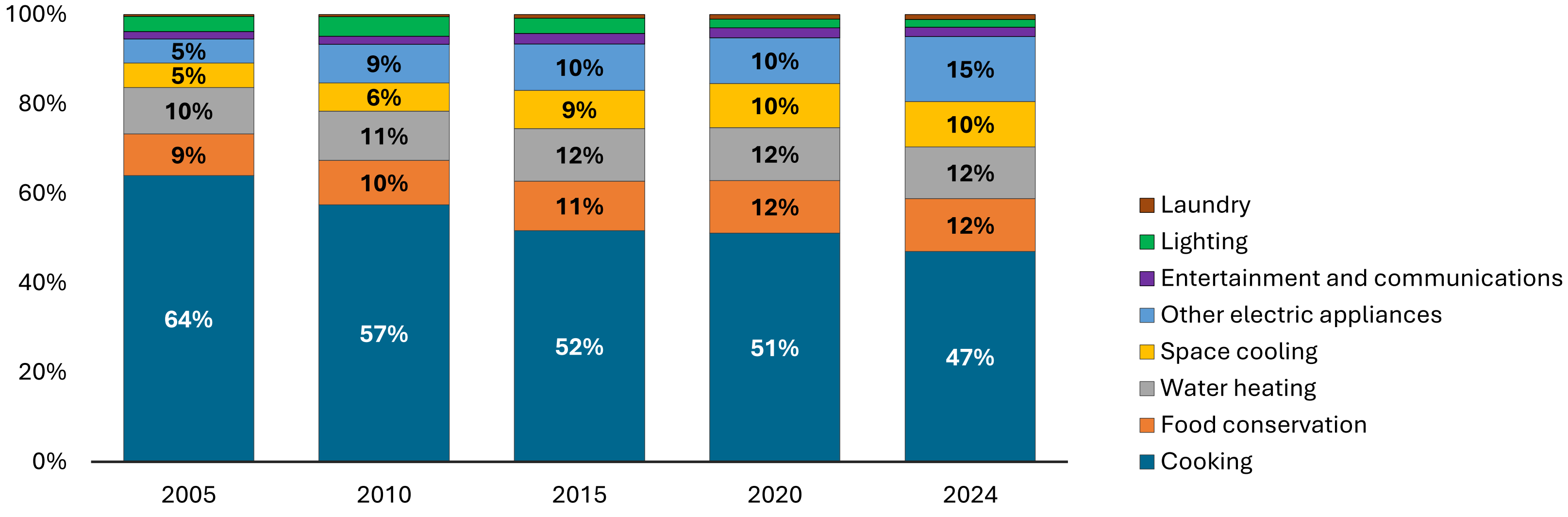
Energy share evolution of the final consumption in the residential buildings

The main end use of energy in Brazilian households is cooking food, followed by food preservation and water heating. The reduction in the energy share of food cooking in the period between 2005 and 2024 can be explained by the energy transition process of the most disadvantaged households that replace the consumption of traditional biomass with more modern and efficient fuels as they progress economically. Lighting, on the other hand, has been losing share over time due to the increasingly widespread use of more efficient lamps, especially compact fluorescent lamps and those with LED technology.

The increase in the share of electrical and electronic equipment can be explained by the increase in their ownership by families, which accompanies a technological and customs transition.

Figure 18: Evolution of the energy share of end uses in the residential energy demand

Source: Compiled by EPE



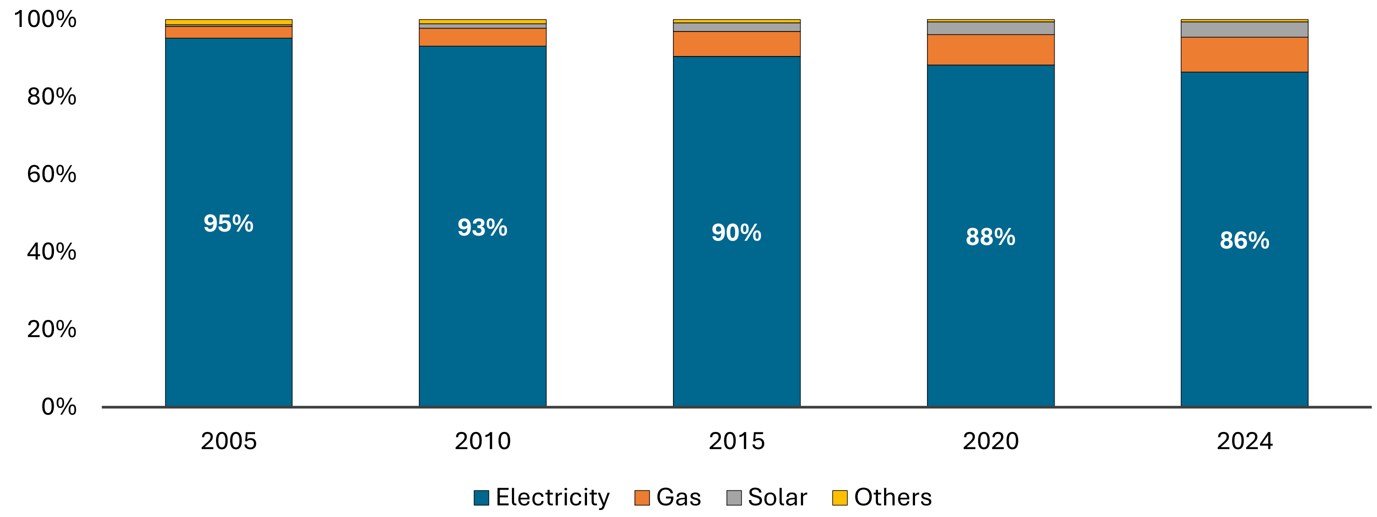
Air conditioning has been gaining share due to the increased use of air conditioners as families have the financial conditions to make the purchase, replacing fans and air circulators, which are relatively cheaper and consume less energy. Induction can also happen due to the presence of warmer days on average over the years.

Heating water houses percentage evolution by energy source

Electricity is the most used source of energy by Brazilian households to heat water through electric showers. It was estimated that the average possession of electric showers in the country was 0.7 equipment/household in 2024 and the share of electricity in the water heating matrix in the sector had a slight drop, reaching 86.4%. In that year, about 3.3% of the households in the country had a solar heating system. In terms of relevance, the share of solar thermal in the residential sector's matrix in water heating reached 4.0% in 2024.

Figure 19: Evolution of the share of households that heat water by energy source

Source: Compiled by EPE



Gas heaters, which can be instantaneous or by accumulation, are an alternative to electric showers, especially in urban areas with gas distribution infrastructure. It was estimated that the share of households that use gas in water heating reached 9% in 2024.

This equipment is standardized by the Brazilian Labeling Program (PBE), coordinated by INMETRO. In addition, there are legislations on minimum efficiency indices in gas heaters, initiated by the publication in 2008 of the Interministerial Ordinance MME/MCT/MDIC Nº 298 and which was revised in 2011 by Interministerial Ordinance Nº 324.

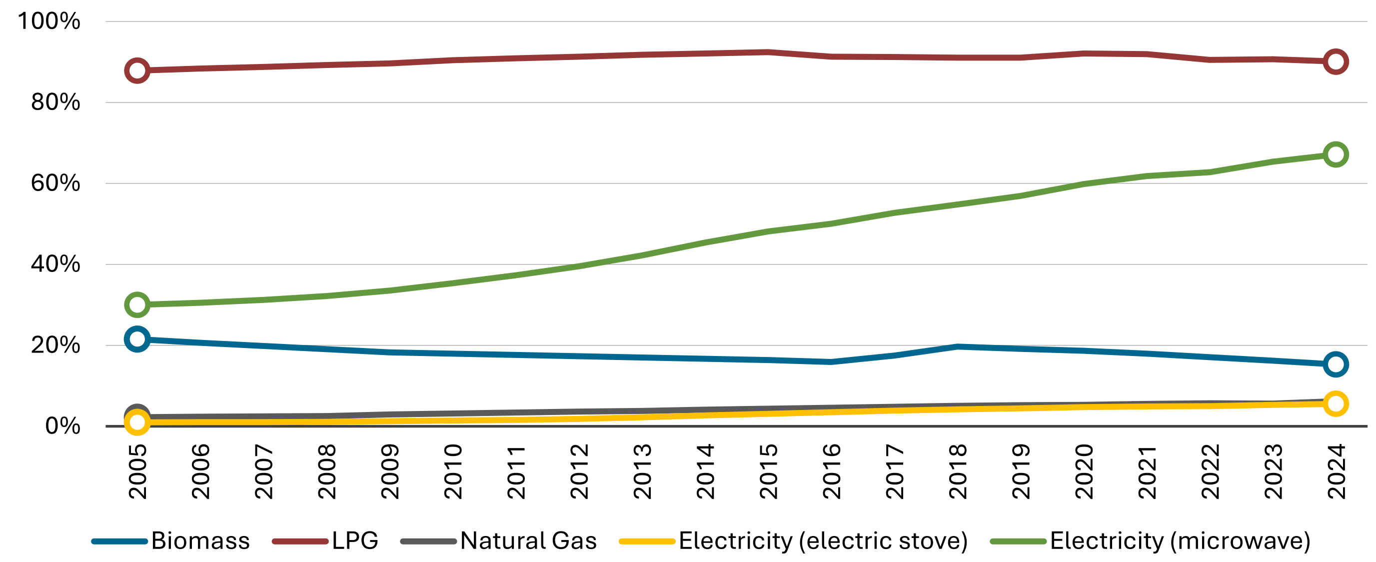
There are regions of the country that are very hot, such as the North and Northeast, which can contribute to the low percentages of households that heat water for bathing, as illustrated by the Survey of Ownership and Habits of Use of Equipment - PPH 2019 (PROCEL/ELETROBRAS). EPE calculations using the data collected in this survey estimate that on average about 35% of Brazilian households did not heat water for bathing in the country in 2019, and in the North (94%) and Northeast (88%) these statistics were much higher.

Percentage evolution of households cooking food by energy source

LPG manages to have a large capillarity in Brazil, reaching 90% of national households in 2024. The use of natural gas is still small (5.6% of national dwellings), basically restricted to urban areas of cities with distribution infrastructure.

Figure 20: Percentage evolution of households that cook food by source in relation to the total number of national households

Source: Compiled by EPE



The use of electricity in food preparation has been growing over time, mainly due to the increase in microwave ownership (0.69 units/household in 2024).

With the evolution of technology and the decrease in cost, the possibilities of people acquiring these types of electrical appliances for domestic use increase, as they are practical and generate good results. This set of equipment includes: ***microwaves, electric ovens and stoves, sandwich makers, grills, toasters, electric air fryers, electric cookers****, among other devices.*

The share of traditional biomass (firewood and charcoal) for cooking food in the country's households fell between 2005 and 2015 due to the progress of the economic situation of the most disadvantaged Brazilian families. Between 2015 and 2020, there was a movement to reverse the situation, mainly due to the worsening of the economic situation, but with a subsequent reduction in the following years until 2024.

Electricity - ending use, ownership and average annual consumption by equipment

Figure 21: Residential electricity consumption by end use

Source: Compiled by EPE

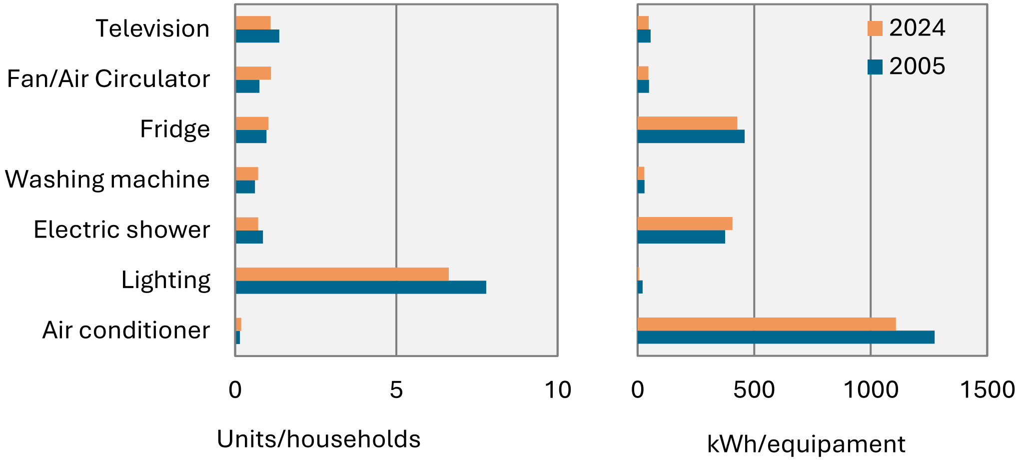
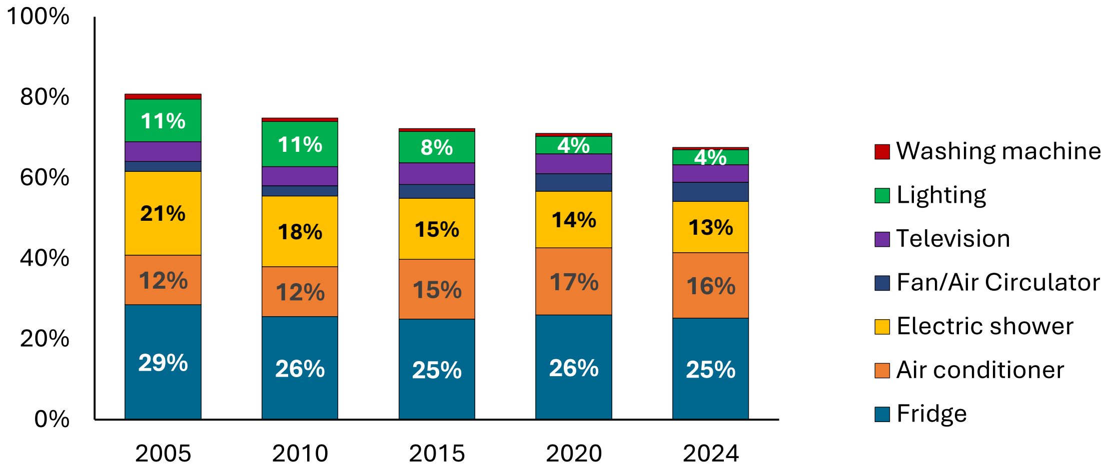


Figure 22: Electricity consumption share by equipment type

Source: Compiled by EPE



Food preservation is the final use with the highest consumption per household in the country, representing an average of 25% of annual residential electricity consumption. This is explained by the fact that refrigerators are in practically all Brazilian homes, are on 24 hours a day every day of the year and have a significant specific consumption.

Despite the low ownership of 0.19 equipment/household of air conditioners in 2024, they have the highest average consumption per appliance, which results in the second position among the most electro-intensive in the same year (about 16% of total residential consumption in the year). Fans and Air Circulators have a possession of a little more than 1.1 equipment/household, being a lower cost solution for environmental air conditioning.

The ownership of electric showers fell between 2005 and 2024. Although the average annual consumption per equipment has increased due to the acquisition of higher power showers, the share of this equipment in annual residential electricity consumption has reduced significantly since 2005, reaching 13% in 2024.

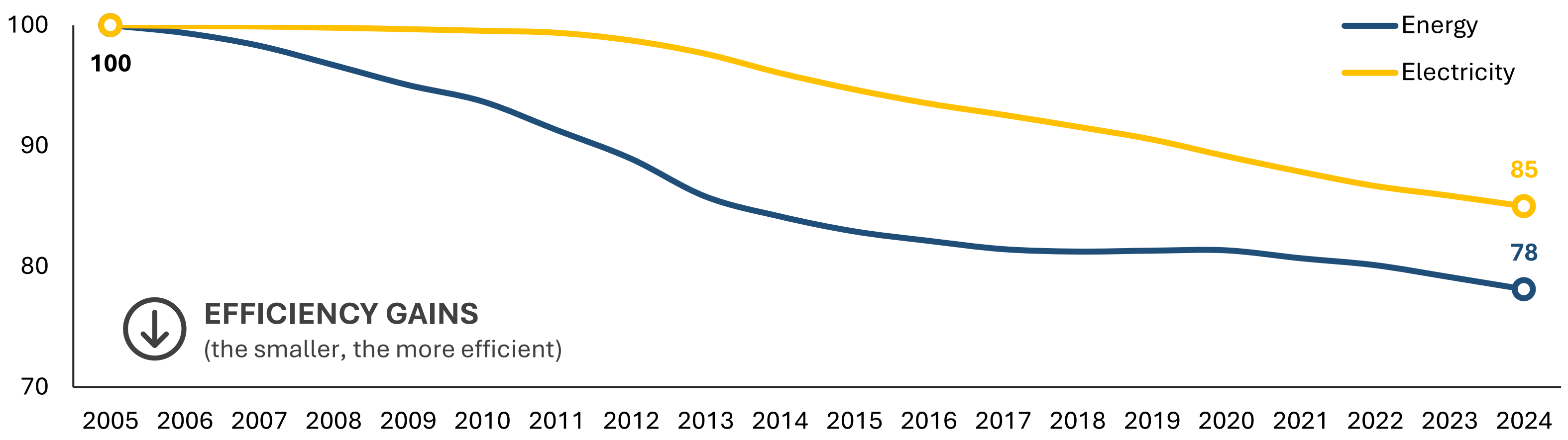
The penetration of more efficient equipment, replacing older ones, tends to reduce the average consumption of the existing stock in the country.

Residential ODEX

ODEX is an indicator used to evaluate the energy efficiency gain in a period. This measure for households aggregates the consumption trend of the different end uses (in the case of energy), or the main electrical equipment (in the case of electricity), based on their weights in total consumption.

Figure 23: Residential ODEX evolution calculated for total energy and electricity

Source: Compiled by EPE



Energy efficiency trend in the Brazilian residential sector between 2005 and 2024.

While the ODEX calculated for electricity fell by 15% (0.8% per year) between 2005 and 2024, the retraction of the ODEX for energy was 21.9% (1.2% per year). It is observed that in recent years, the decline of the indicator is more significant for electricity, suggesting the importance of this source in the conservation of residential energy in the country.

For electricity, there is a reduction in the average specific consumption of the national stock of equipment, due to the first purchase or replacement of obsolete or end-of-life appliances with more efficient appliances. In turn, when considering the other energy sources, it is possible to observe that there was a stabilization of the ODEX between 2017 and 2020, which can be explained by a slight intensification of the use of biomass for cooking due to the increase in budget restrictions and the increase in the weight of LPG in household expenses, especially for low-income families.

Note: The Residential ODEX methodology has been updated to isolate the ownership effect and specific equipment consumption and, consequently, to highlight energy efficiency gains by equipment. The facilities considered in the calculation of the electrical ODEX are light bulbs, fridges, washing machines, TVs, electric showers, air conditioning and fans. In the energy ODEX, in addition to the electrical equipment energy consumption considered, different energy sources consumption are considered for heating water and cooking food.

Residential ODEX

Figure 24: Specific consumption index by energy service in the residential sector (index number 2005 = 100)

Source: Compiled by EPE

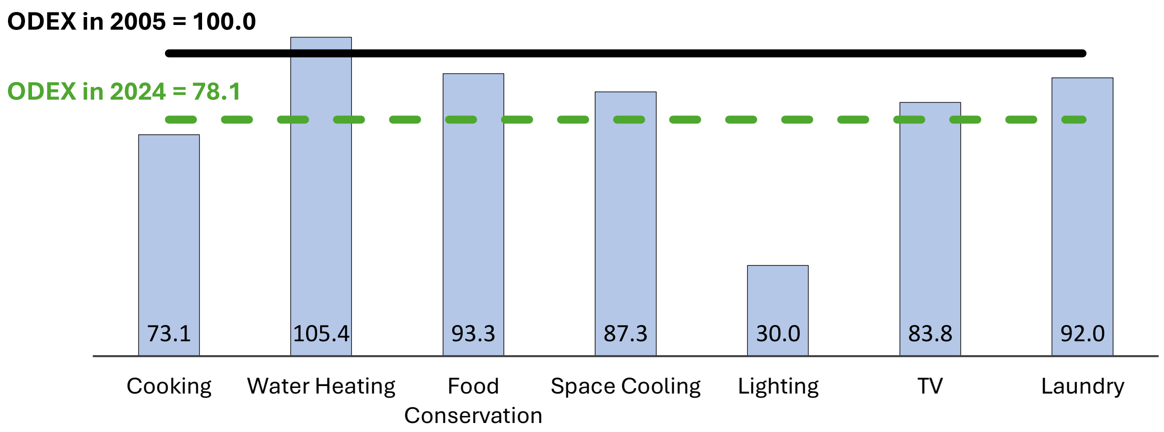
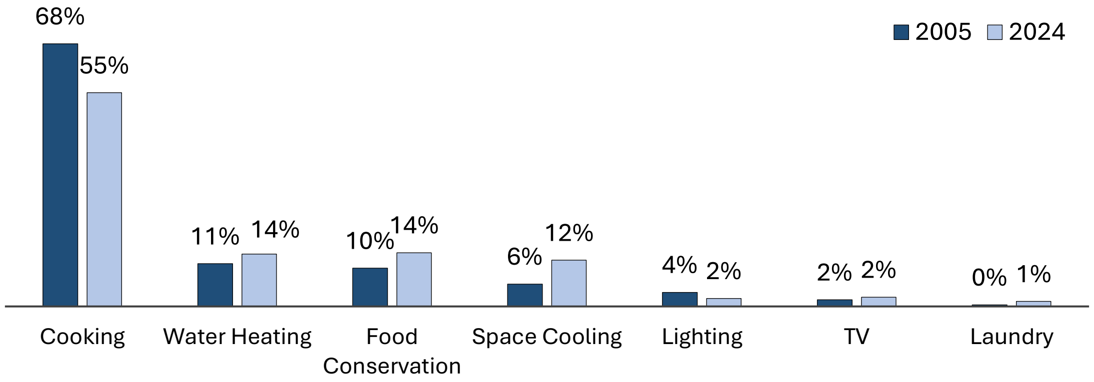


Figure 25: Share of energy services in residential consumption

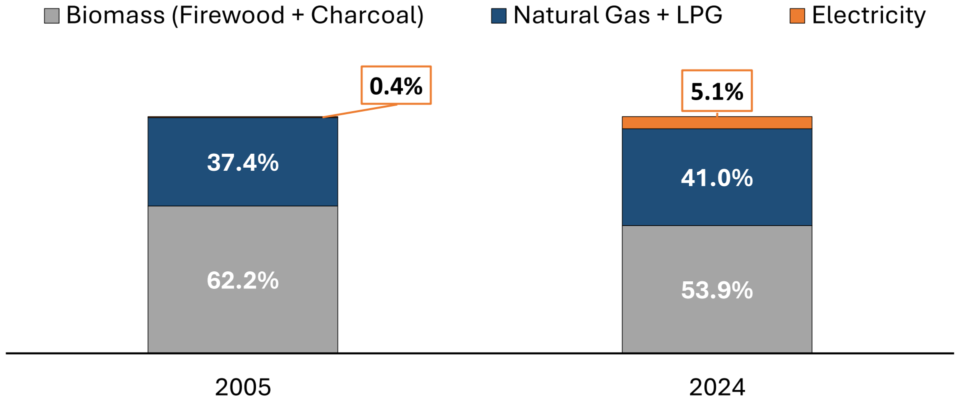
Source: Compiled by EPE



Food cooking accounts for more than half of residential energy consumption, and its consumption per household fell by 27% between 2005 and 2024. This drop is influenced by the lower share of households using firewood in inefficient stoves and the increase in the use of electricity in microwaves and electric stoves.

Figure 26: Share of each energetic in cooking segment

Source: Compiled by EPE



An increase in the ODEX index for Water Heating is noticed. This can be explained by the increase in the number of households in the country that heat water for bathing, as well as a greater specific power of electric showers, which does not mean that there has been a loss of energy efficiency, but rather the fulfillment of a repressed demand by a portion of the population that did not use hot water in showers.

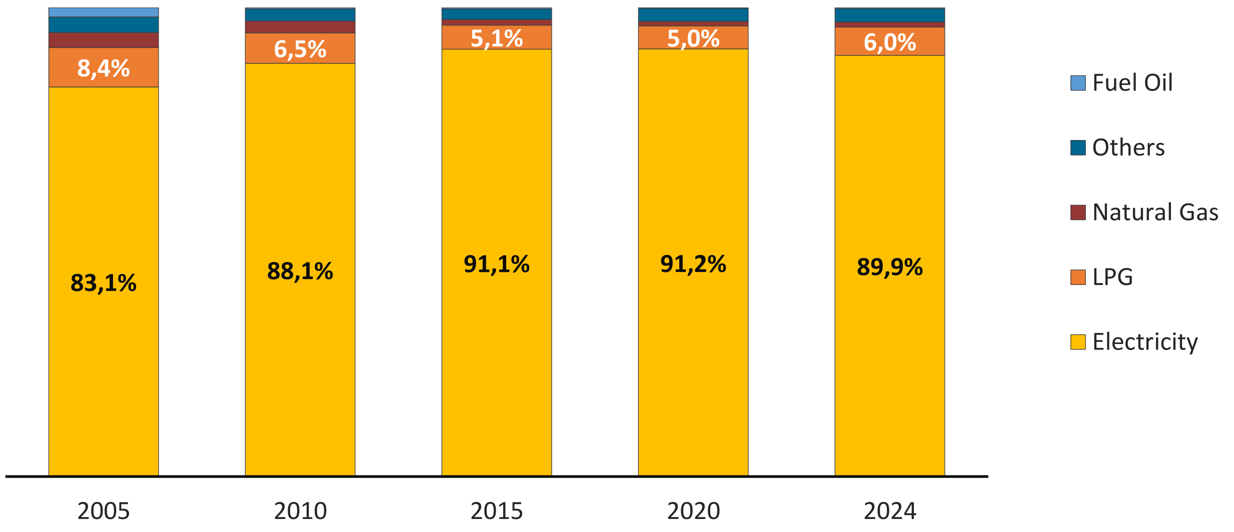
Services Sector
(commercial and public services)

Overview: final energy consumption evolution by source in the services sector[1]

Electricity is the predominant source of final energy consumption in the sector with a 90% share, LPG (6.0%) and natural gas (1.1%). It should be noted that the final consumption data does not include the use of natural gas for electricity generation, according to the National Energy Balance (BEN) methodology.

Figure 27: Final energy consumption by source in services sector

Source: EPE (2025)



Electricity is the main source of the sector. Which can be associated with several factors such as: the availability of electricity, the increase in the possession of electrical equipment in establishments, the automation of processes and equipment, the replacement of equipment for the use of LPG and natural gas by electricity, such as in ovens and stoves, among other factors.

Electricity is the main source in this sector, and showed an average annual growth of 3% in the period (2006-2024). Electricity from photovoltaic solar sources grew 8.3% and has a share of 1.3% in the energy consumption of the services sector.

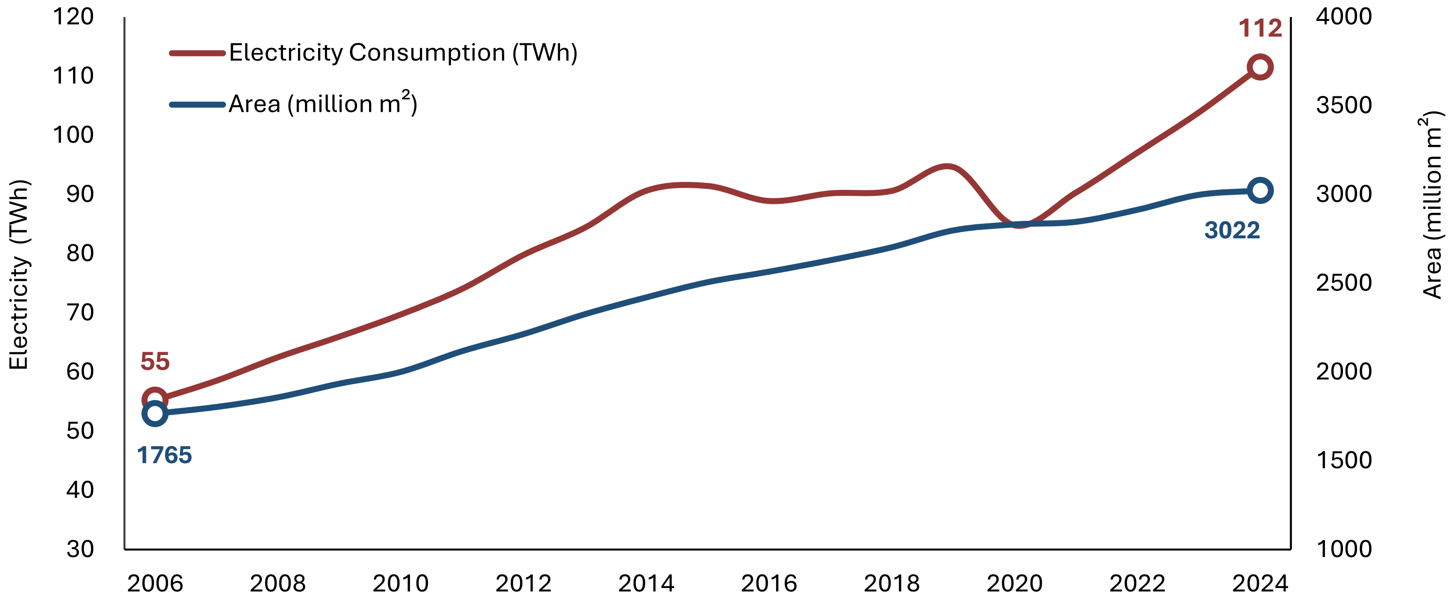
[1] Commercial and public sectors according to the classification of the Brazilian Energy Balance

Analysis: Commercial Sector

The electricity consumption of the commercial sector, in 2024, had an increase by 7.4%, when compared to the previous year, while the built area increased by 0.8%. Analyzing the period 2006-2024, there is a growing increase in the area of commercial establishments with an average annual rate of 3%, while in the same period the sector's electricity consumption shows an increase of 4% per year. As air conditioning has a great impact on the sector, it is observed that the growth data of central equipment (RT[1]) is 27% and the revenue of the entire sector grew by about 20%, compared to the previous year, with a strong impact due to the high average temperatures.

Figure 28: Electricity consumption evolution and commercial sector area

Source: Compiled by EPE



Electricity consumption had a growth rate of 7.4% in 2024, compared to the previous year. This increase is partly justified by the increase in temperature, increase in area and the growth rate of revenue, according to ABRAVA (January 2024). The GDP of Civil Construction, in 2024, had an increase of 4.3 (IBGE), the increase may be partly due to the resumption of the Minha Casa, Minha Vida Program and the national economy (CBIC).

[1] RT = refrigeration ton

Sectorial Indexes: commercial and public buildings consumption evolution per area

General trend:

Both indicators show moderate growth between 2006 and 2014, reaching a peak in 2014 and stability until 2019, culminating in a drop in the year of the Covid-19 pandemic and a partial resumption in the years 2021 to 2024.

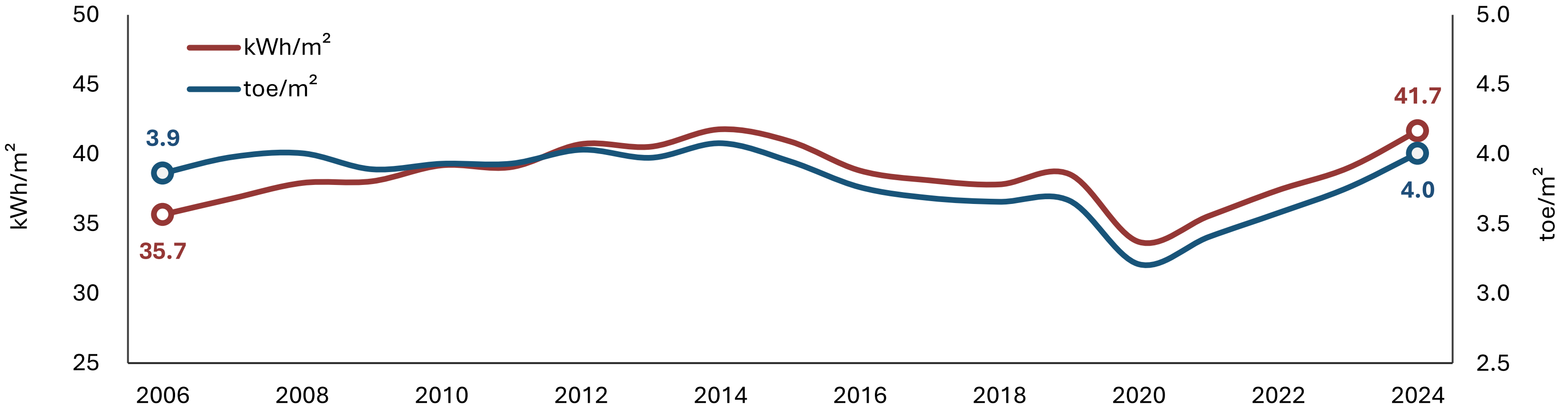
The recent growth after 2021 shows that, despite technological advances and equipment efficiency, the increase in demand for comfort and electrification has again increased consumption per area.

Highlight:

The period from 2021 to 2024: resumption with significant growth, suggesting resumption of activities and increased use of electrical equipment and air conditioning.

Figure 29: Specific consumption[1] per square meter

Source: Compiled by EPE



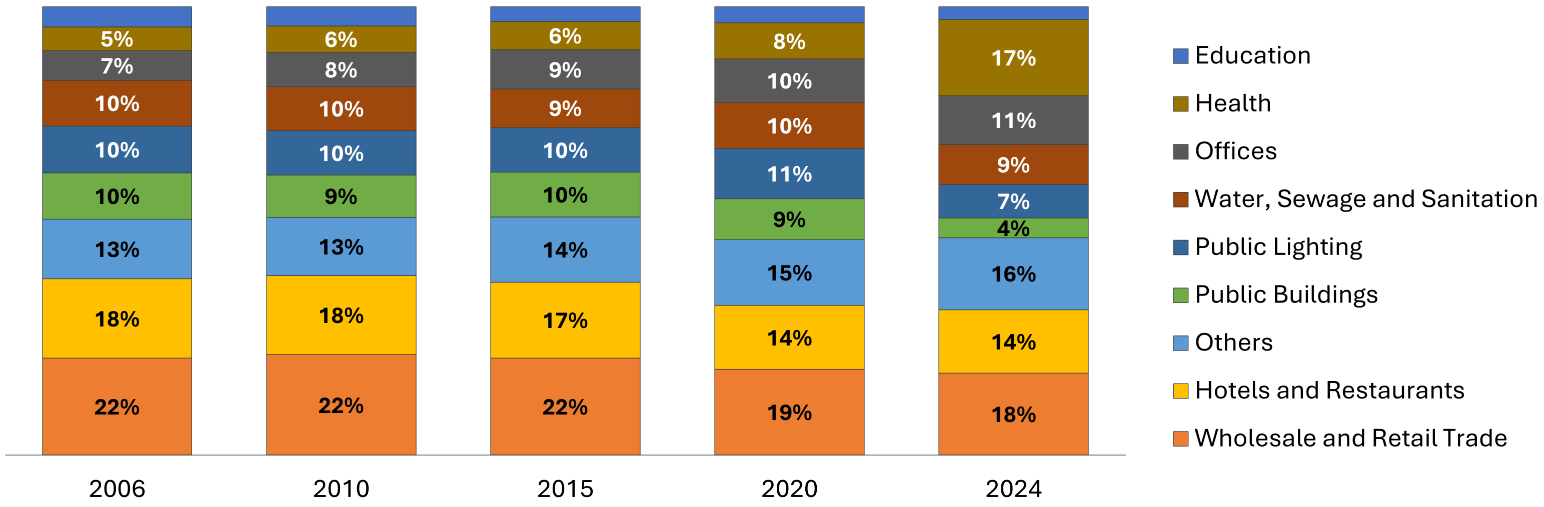
Data	Δ% 24/23
Electricity Consumption	8%
Energy Consumption	8%
Area (million m^2)	1%

[1] Does not include consumption in the following segments: public lighting, water, sewage and sanitation. Consumption in toe considers all energy sources.

Energy Consumption in services segment by sector 2006-2024

In the period 2006-2024, the healthcare segment was the one with the highest growth rate, with 10% per year, when compared to the other segments. The Wholesale and Retail Trade segment holds the largest share of consumption with 18% and followed by the Hotels and Restaurants segment with 14% of the total. Nearly half of total energy consumption is concentrated in three segments: Wholesale & Retail, Hotels & Restaurants, and Healthcare.

Figure 30: Final energy consumption in services segment by sector
Source: Compiled by EPE, a partir de EPE (2015)



Share of Energy Consumption	
Wholesale and Retail Trade	18%
Hotels & Restaurants	14%
Healthcare	17%
Total of the main sectors	49%

The service sector has great diversity, both in its characteristics and in the usage profiles. Despite this, the distribution of energy consumption among the different segments over the analyzed period reveals a certain homogeneity. Among the highlights, there is a reduction in consumption in public buildings and, on the other hand, an increase in the healthcare segment. In the annual comparison, energy consumption in 2024 registered a growth of 6.6% compared to 2023.

[1] Others category includes condominiums, public places (theaters, clubs, museums, churches, galleries, etc.) and information (cinemas, radio, TV, telephony, etc.).

E-commerce share in traditional retail trade sector

In 2024, the share of e-commerce in traditional retail reached 9.03%. Part of the retraction in the share of energy consumption in the retail trade can be explained by the increase in sales on the internet. About 50% of internet sales are concentrated in three states, São Paulo (32%), Minas Gerais (11.8%) and Rio de Janeiro (9%).

Figure 31: Profile of online buyers (revenue share).
Source: ABComm (2025)

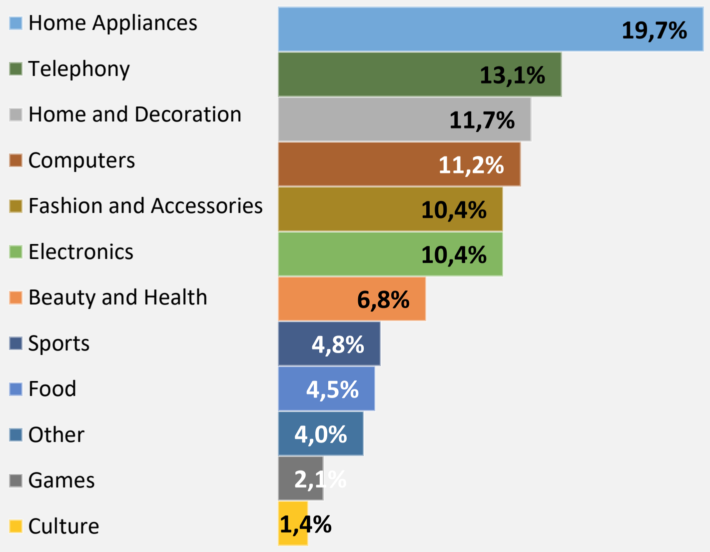


Figure 32: E-Commerce geoChartal region profile
Source: ABComm (2025)

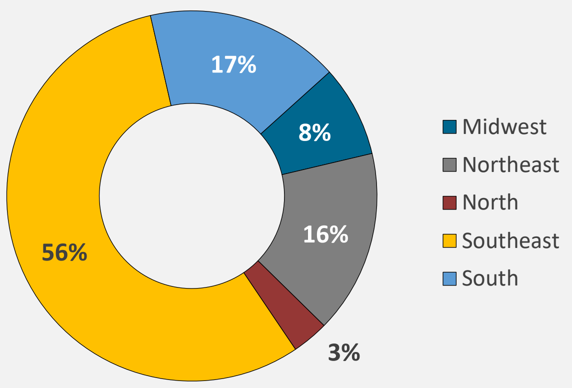


Figure 33: Share (%) of E-commerce in Traditional Retail– 2010 - 2024
Source: ABComm (2025)

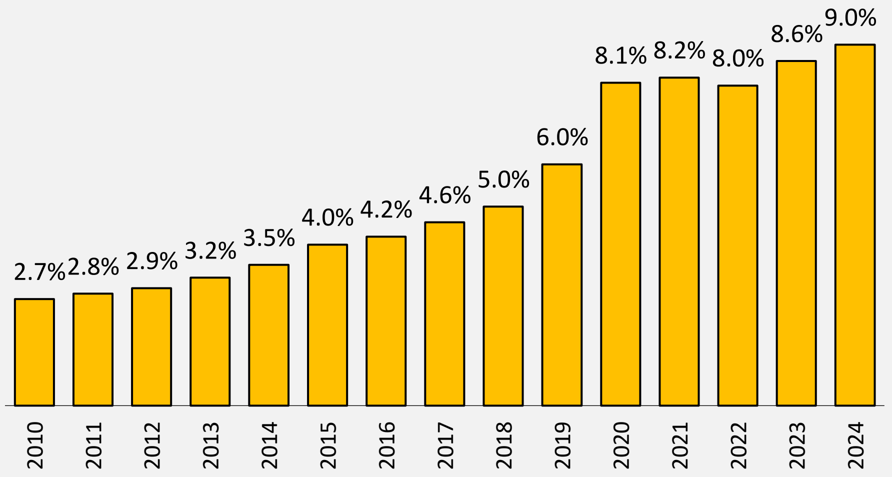
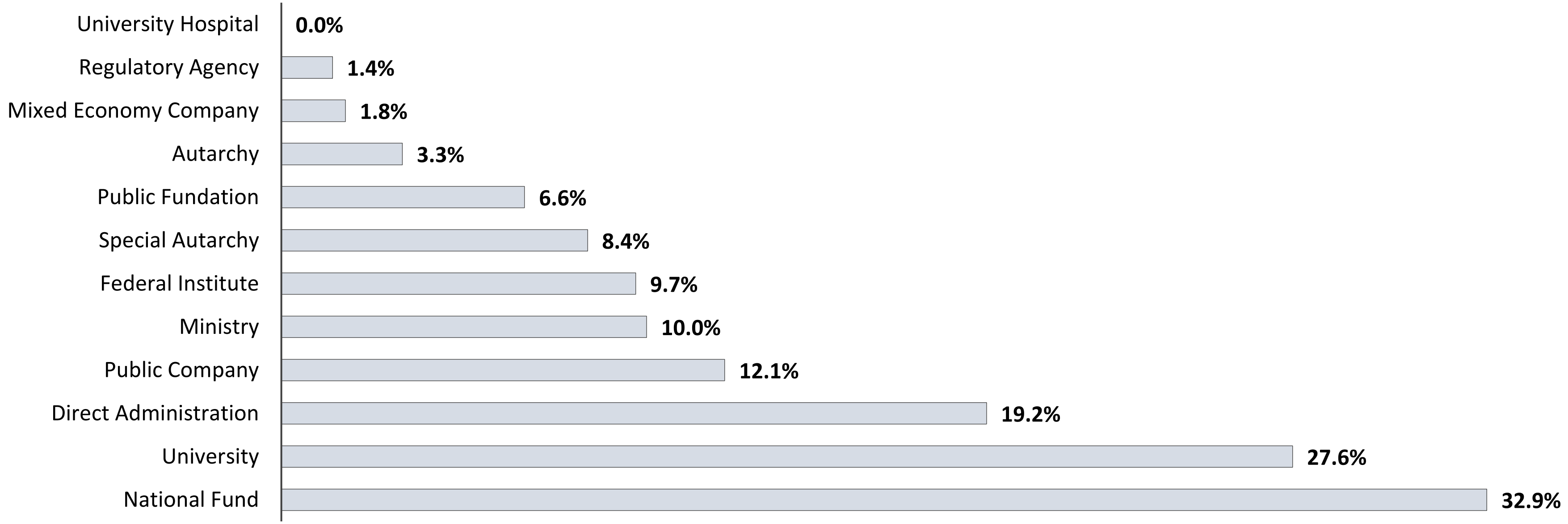


Figure 33 shows the growing increase in the share of e-commerce over the internet, led by the Southeast region with a 56% share of sales (Figure 32). In Figure 31, it can be seen that household appliances and telephony are the ones with the largest share in online sales.

Electricity spends profile in the federal public administration

The Administrative Costing Panel provides information on electricity expenses. Figure 34 shows the distribution by organ. This data helps to visualize the largest expenses, making it possible to direct policies, as well as prioritize actions for energy efficiency.

Figure 34: Distribution of Electricity Spending – 2024 1st semester
Source: MGISP (2025)



It is observed that about 80% of the expenditure on electricity is concentrated in three segments: National Fund[1] (33%), Universities (28%) and Direct Administration (19%). With the profile of electricity expenses, it is possible to identify the segments with the greatest potential for efficiency.

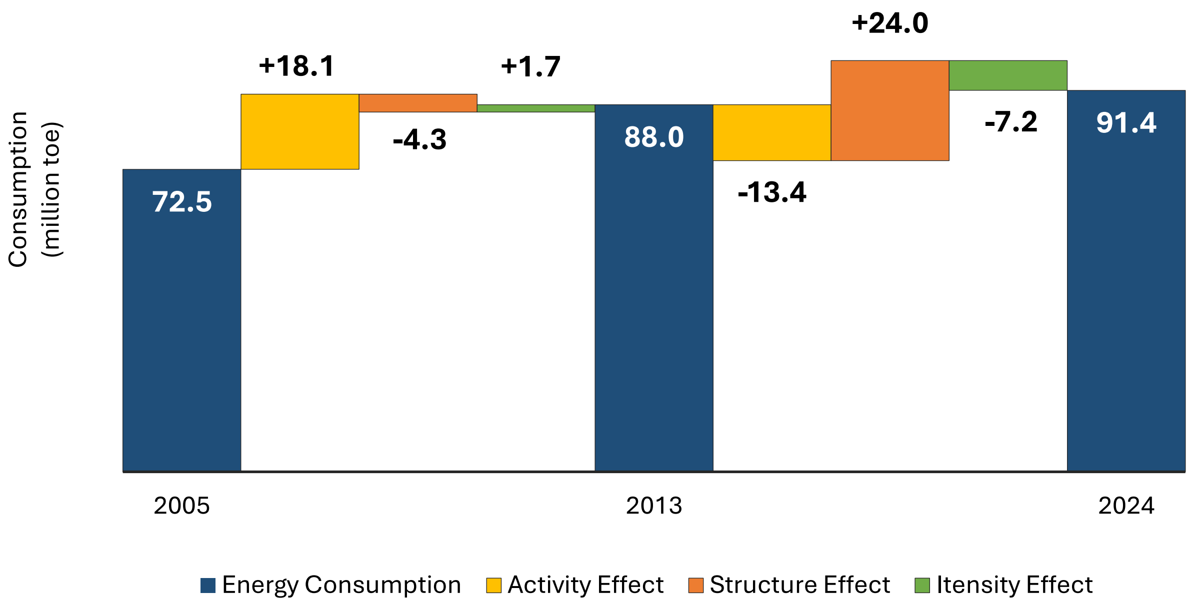
[1] National funds include, for example: the National Health Fund, the Education Development Fund, the Indian Fund, the Arts Fund, the Anti-Drugs Fund, the Culture Fund, the Civil Aviation Fund, etc.

Industrial Sector

Energy consumption effects sectioning: what is behind the increase in industrial energy intensity?

Figure 35: Breakdown[1] of changes in industrial energy consumption

Source: Compiled by EPE, from EPE (2025) and IBGE (2025)



The three main effects that compose the industrial consumption variation are: added value (changes in the activity level), the industrial segments relative share (i.e. the structure of industry) and each segment intensity (the ratio between energy consumption and added value for each segment).

Between 2005 and 2013, there was a significant **increase in industrial activity**, associated with a reduction in the structural effect and intensity effect. The industries that grew the most during this period were cement, sugar, pulp and paper, and mining.

Between 2013 and 2023, there was a **decline in economic activity**, with a drop in the value-added of mining, other industries, and the chemical industry, as well as in the physical production of cement and steel. The **change in industrial structure** was marked by an increase in the participation of energy-intensive segments above the industry average, such as pulp and paper, cement, steel and sugar.

>> More details about decomposition in the section Definitions

In the context of growth, practically all industrial segments stood out without significant structural changes in the economy, while in the second period, where industrial activity shrank and the added value of industry as a whole was reduced, there is a tendency to change in the structure of energy consumption of certain sectors, mainly linked to the demand for steel, sugar and cellulose in the international scenario.

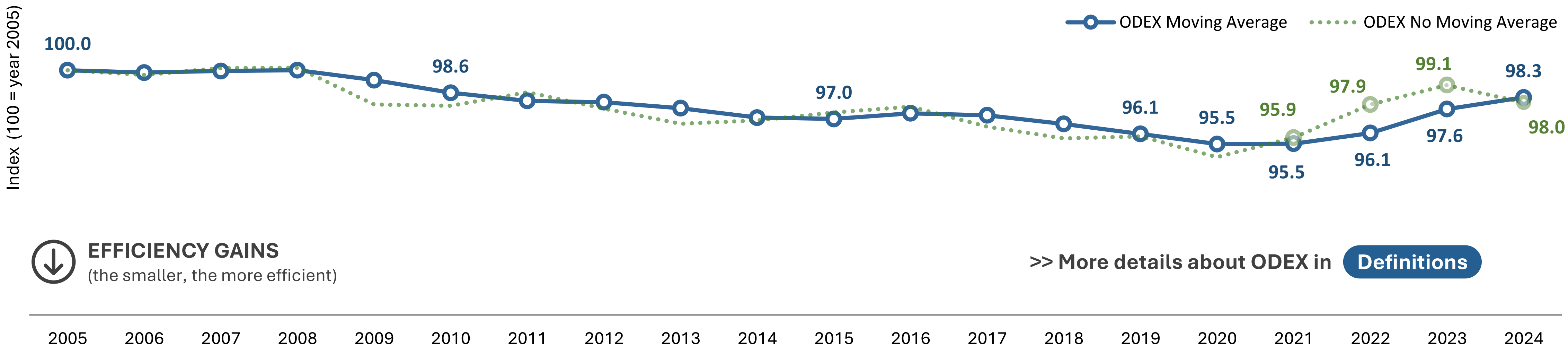
[1] Decomposition of the variation in industrial energy consumption into activity, structure and intensity effects, according to the LMDI I method ("logarithmic mean Divisia index method I") with additive decomposition (Ang & Liu, 2001).

Energy consumption ODEX in the industrial sector

To calculate the ODEX, the variation in specific consumption based on physical production for the steel, pulp and paper, cement and sugar segments**, which represent about 60% of the energy consumption in the industry** was considered. In the segments of other food, textile, chemical, ceramics, iron alloys, other metallurgy, mining and other industries, the calculation is made based on the variation in energy intensity. In both cases, the variations are weighted by the weight of each segment in the final energy consumption of the sector.

Figure 36: Industrial ODEX

Source: Compiled by EPE



The industrial ODEX has remained relatively stable throughout the period. From 2021 onwards, there is a relative increase in this indicator. However, there was a **reduction in the growth rate of ODEX between 2021 and 2024**, when compared to the period of 2021 and 2023. The ODEX without the moving average indicates that there was **a positive evolution** in relation to the previous year, largely due to the internal structure effect related to some energy-intensive segments.

[1] For details regarding the calculation of ODEX, go to: Manual Metodológico do Atlas de Eficiência Energética

Particularities of some segments contributed to the increase in the industrial ODEX

In 2024, there was a growth in **steel routes** characterized by lower specific consumption, such as the **Electric Arc Furnace**, which grew by 12%, against an overall increase in the sector of 5.4%. In addition, there was a drop in the production of **pig iron** of 3.6%. The steel mix in 2024, compared to the previous year, had a reduction in its specific consumption, contributing to the drop in the industry's ODEX, which does not mean that the technological routes individually became more or less efficient.

In the Non-ferrous and Other Metallurgy, the production of primary aluminum grew by 26% in 2023**,** largely due to the **resumption of Alumar's operations**[1]. The primary aluminium production activity is electro-intensive and accounts for a significant part of the group's electricity consumption. In 2024, with the stabilization of the sector's structure, the growth of aluminum production slowed to 8% compared to the previous year, contributing to the reduction of the ODEX of this segment in 2024.

In the Cement segment, there is an effort that the sector has undertaken with the aim of reducing greenhouse gas (GHG) emissions, including the use of alternative fuels, such as tires, industrial waste, municipal solid waste, and "other renewable sources" such as charcoal, wood, agricultural waste, biodiesel and other biomass. These movements eventually cause an increase in specific energy consumption in the segment, as was seen throughout 2024. **In other words, the reduction of emissions was prioritized to the detriment of the overall energy efficiency of the segment.**

> Segments that have technological routes and differentiated products are influenced by the internal structure effect. For example, the specific consumption for the production of recycled paper is much lower than the specific consumption for the production of pulp. Similarly, the production of crude steel from scrap (Electric Arc), requires less energy per ton of steel when compared to integrated steel plants.

[1] More details are highlighted in the following EPE publication:
Boletim Trimestral do Consumo de Eletricidade – Ano IV – Número 16 – 4º trimestre de 2023

Timeline: Energy efficiency policies and programs

Main energy efficiency policy Highlights linked to industrial sector

Source: EPE.

1984

Labeling Brazilian Programme
[INMETRO/MDIC]

- Three-phase electric induction engines up to 250CV
- Pumps and motor pumps up to 25CV

1985

PROCEL²
[ENBPar/MME]

1991

CONPET
[MME]

2000

Law Nº 9.991 | EE Programme, R&D and Procel
[ANEEL]

- R$93 million in 42 PEE/ANEEL industry projects (2009-2018), saving 135 MWh/year
- Priority Project Calling No. 2/2015: replacement of electric engines
- R$492 million from P&D/ANEEL in efficiency

2001

Law Nº 10.295 | Minimum Energy Performance Standards
[MME/MCTIC/MDIC]

- Three-phase electric induction engines up to 500 hp
- Technical Group of refurbished engines

2011

NEEP National Energy Efficiency Plan
[MME]

2016

Law n° 13.280/2016 changed Law 9.991/2000, allocating 20% of energy efficiency resources to Procel

2020

RedEE Indústria
[MME/ GIZ/ Ahk São Paulo]

2021

PotencializEE Transformative Investments for Industrial Energy Efficiency Programme
[MME/GIZ]

2022

FGEnergia Guarantee Fund for Energy Efficiency
[BNDES and PROCEL]

1st PAR

- Alliance Programme
- More Productive Brazil EE Programme
- Structuring through indicators and standardizing

2nd PAR

- Alliance 2.0 Programme
- Digital EE
- Compressed Air Systems EE Programme
- Methodology for Thermal and Motor Systems
- Study on motor systems
- Evaluation of the Lamotriz network
- Impact of motor repair on efficiency

3rd PAR

- Application of solar thermal systems
- Engine repair communication plan
- Engine repair laboratory

4th PAR

- Promoting energy management
- Malmquist Index and Data Envelopment Analysis
- Regulatory impact analysis (RIA) for compulsory certification of distribution transformers
- RIA for improving the motor repair service
- Implementation of the Lamotriz Network Business Plan
- Computer tool for analyzing pumping systems

5th PAR

- Expansion of the PotencializEE program
- Promotion of Energy Management in Industry
- Standard for establishing the performance levels of three-phase electric motors
- Laboratory of Energy and Hydraulic Efficiency in Irrigation
- Market surveillance for reconditioned three-phase electric motors

[1] Non-exhaustive list
[2] Law No. 13,280/2016 amended Law 9,991/2000, allocating 20% of energy efficiency resources to Procel.

The Industry profile

The use of petroleum products loses share due to the **reduction in the use of fuel oil** in all segments, and **lower share of petroleum coke** in the cement industry. Charcoal also loses share due to the reduction in its use in the steel sector, even though it is more used by the iron alloys sector. Black liquor gains share, following the pulp industry, which uses this co-product in its processes.

Figure 37: Industry share by segment

Source: EPE (2025)

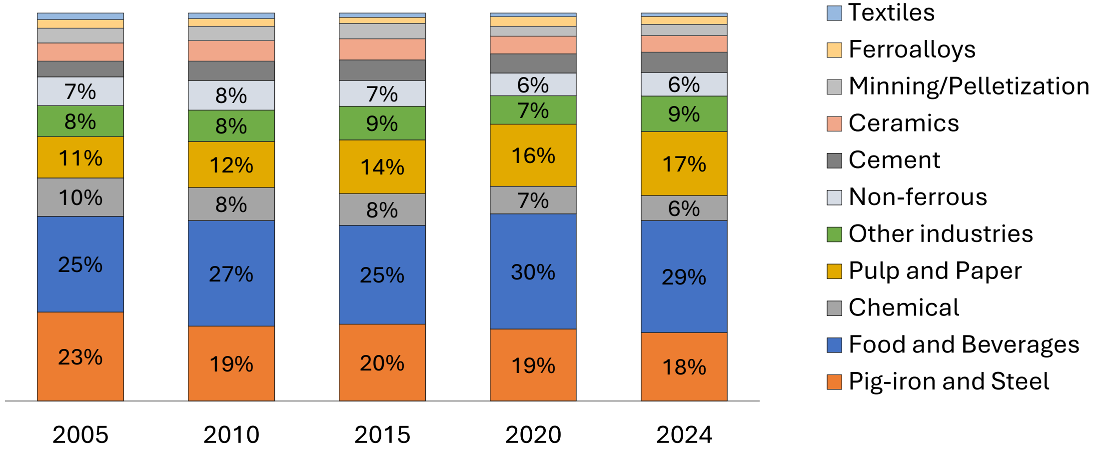
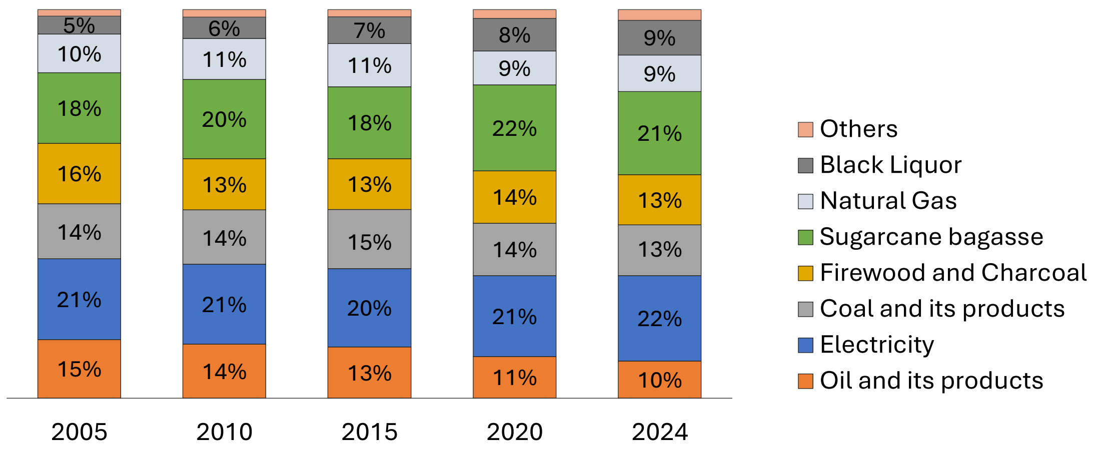


Figure 38: Industrial energy mix

Source: EPE (2025)



In 2024, the **food and beverage, steel (pig iron), and pulp and paper industries** were the most representative in terms of energy consumption. Electricity is the most relevant source and has been gaining a slight share.

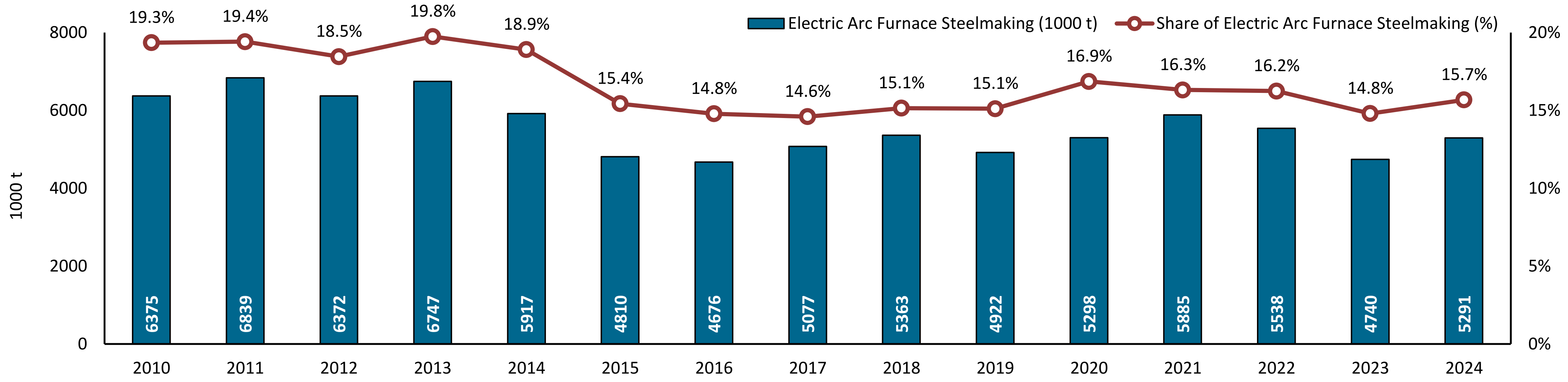
Overview
of industry selected branches

Steel industry: participation of technological routes (arc electric furnace)

The figure below shows the evolution of the physical production of crude steel compared to the share of the arc electric in the total national steel production. Steel refining in the arc electric furnace is carried out using a portion of scrap, which makes the technology less energy-intensive, compared to other technological routes.

Figure 39: Physical production and participation of the arc electric in the national steel industry.

Source: Compiled by EPE



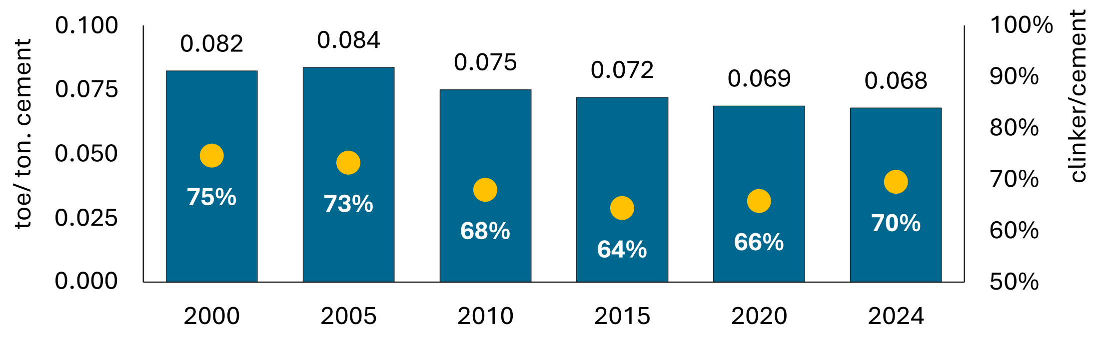
It is observed that there was a **recovery in the share of arc electric furnace in 2024**, contributing to the reduction of the segment's specific consumption this year.

Cement: specific consumption and clinker content

The cement industry in Brazil has a modern and efficient industrial park, which is constantly being updated. More than 99% of production is carried out in dry kilns (the most efficient), around 40% of the industrial park is less than 15 years old and more than 70% of its kilns are equipped with 4 to 6-stage preheater towers and pre-calciners (EPE, 2021)[1]. Modern grate coolers equip 80% of Brazilian kilns and approximately 50% of raw material mills are vertical, which are considered to have the lowest electricity consumption.

Figure 40: Specific energy consumption in the cement industry

Source: Compiled by EPE, from EPE (2025).



Regulation advances, cement chemistry researches, new cements development, among other things, would enable progress to make the cement additions incorporation, replacing clinker, which currently stands at 3%, reducing greenhouse gas emissions associated with calcination and energy use.

Figure 41: Variation index in the specific consumption of cement (clinker and cement)

Source: Compiled by EPE, from EPE (2025).

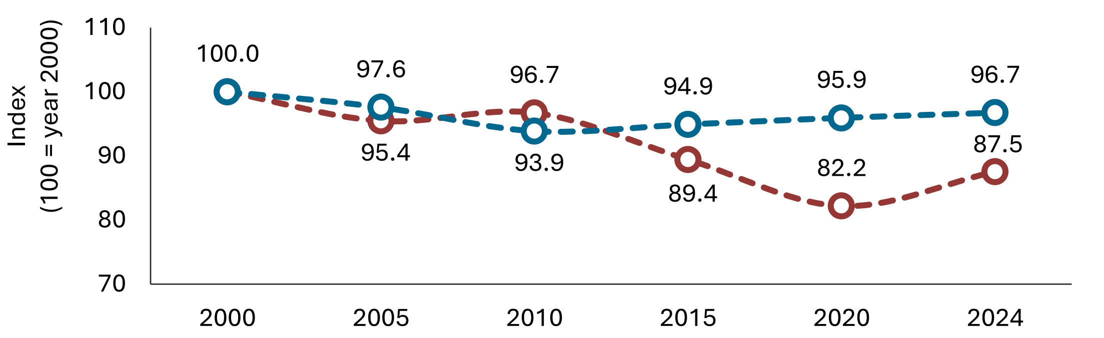


Figure 41 shows the specific thermal and electrical consumption for clinker and cement production, respectively. Electricity is consumed mainly in cement production (grinding) and fuel in clinker production (kiln).

The specific thermal consumption of clinker fell by 12,5% over the entire scenario, while the specific electrical consumption of cement fell by 3,3%.

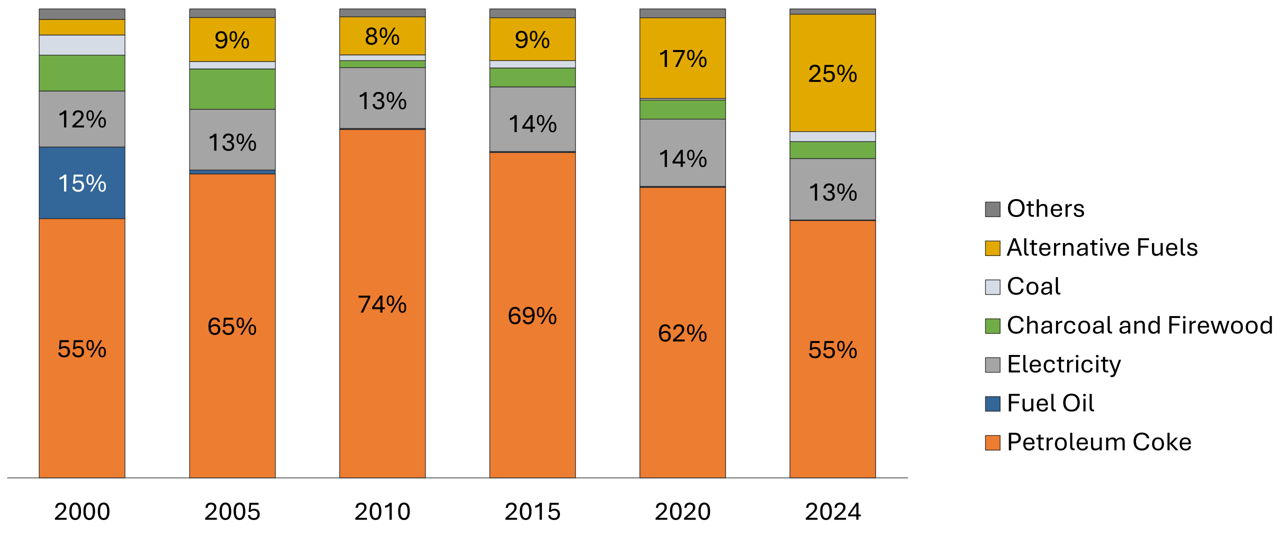
[1] Data from the Cement Technological Roadmap, available at: LINK

Cement: energy matrix and co-processing

The cement industry's energy matrix has changed over time. During the oil crises there was a momentary migration from fuel oil to coal (mineral and vegetable). In the 2000s, the sector switched to imported petroleum coke instead of fuel oil. Currently, petroleum coke is the main source, due to its low price and guaranteed supply.

Figure 42: Final energy consumption by source in the cement industry

Source: EPE (2024a).



Since the 2000s, a new energy revolution becomes more important: alternative fuels, characterized by the wasting co-processing and the biomass use.

Co-processing has several environmental benefits, as it provides an appropriate destination for waste and reduces GHG emissions (since most of this waste has a lower emission factor than traditional fossil fuels).

This energy transition has demanded - and will demand even more - investment from the sector in adapting the production process, as well as improvements in monitoring and control (EPE, 2021).

The share of alternative fuels has been gaining representativeness in replacing petroleum coke, reaching 25% of consumption in 2024.

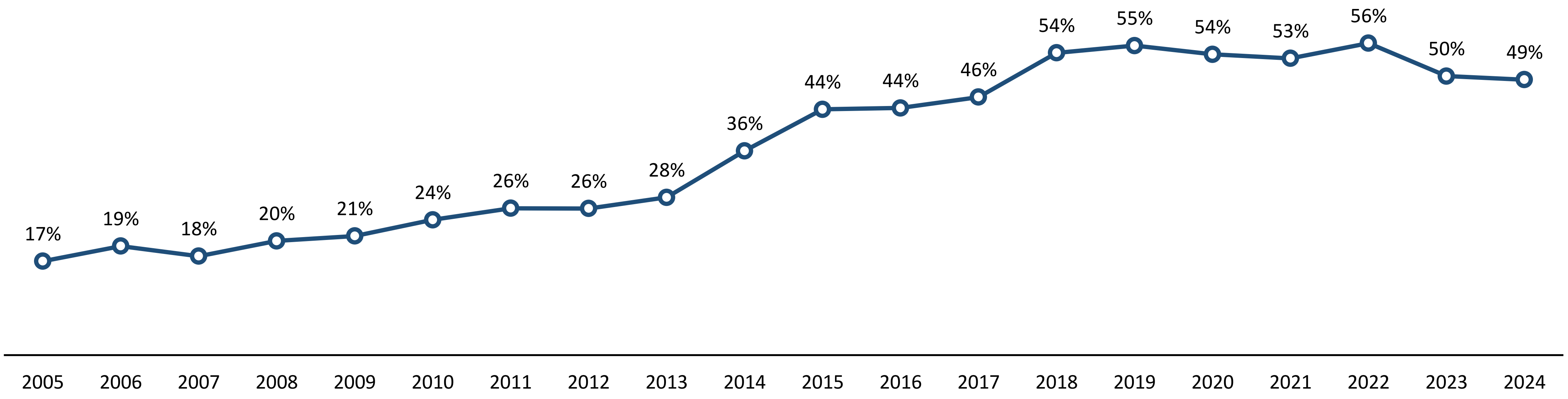
Note: "Others" includes natural gas, firewood, diesel oil and LPG

Aluminum: Share of aluminum scrap in total national production

In 2024, Brazil recycled 97.3% of aluminum beverage cans, equivalent to 33.9 billion units[1], approximately 160 cans per person per year. The share of recovered aluminium scrap reached 49% of the total national production (primary and secondary aluminium), remaining above the world average.

Figure 43: Share of recovered scrap in total aluminium (%)

Source: Compiled by EPE, from ABAL (2025).



Recycling is a strategy for the circular economy, with several socio-environmental benefits. The **electrical consumption** of secondary (recycled) aluminum is lower than that of primary aluminum, which is electro-intensive. According to the World Economic Forum (2021), **more than 90% of current aluminum emissions** are associated with primary production. But secondary, or recycled, aluminum consumes only 5% of the energy needed for primary production.

[1] Data obtained from: LINK

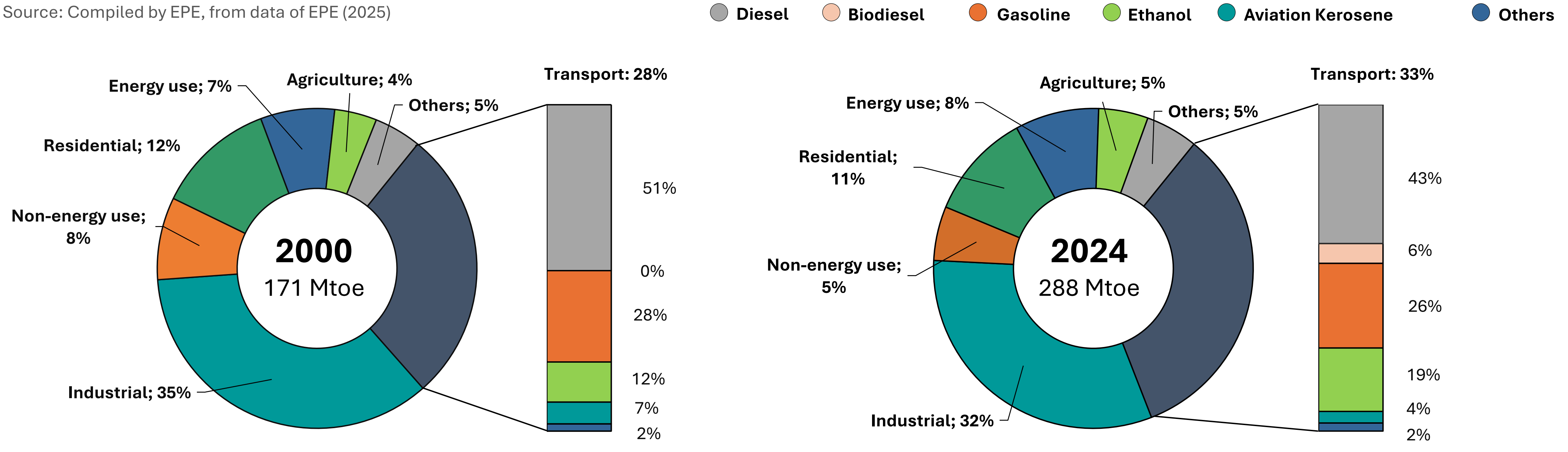
Transport Sector

Energy consumption in the transport sector

The sector's activity grew above the GDP, with an increase equivalent to 4.8% for passengers and 4.2% for cargo compared to 2023. In the case of cargo transportation, the activity has shown successive increases since 2016, reaching a level 30% above the 2019 level in 2024. This scenario reinforces the centrality of the transport sector in the consumption of energy resources in the country, as well as the importance of increasing efficiency as a strategy to assist in the energy transition.

Figure 44: Final consumption of the transport sector in Brazil

Source: Compiled by EPE, from data of EPE (2025)



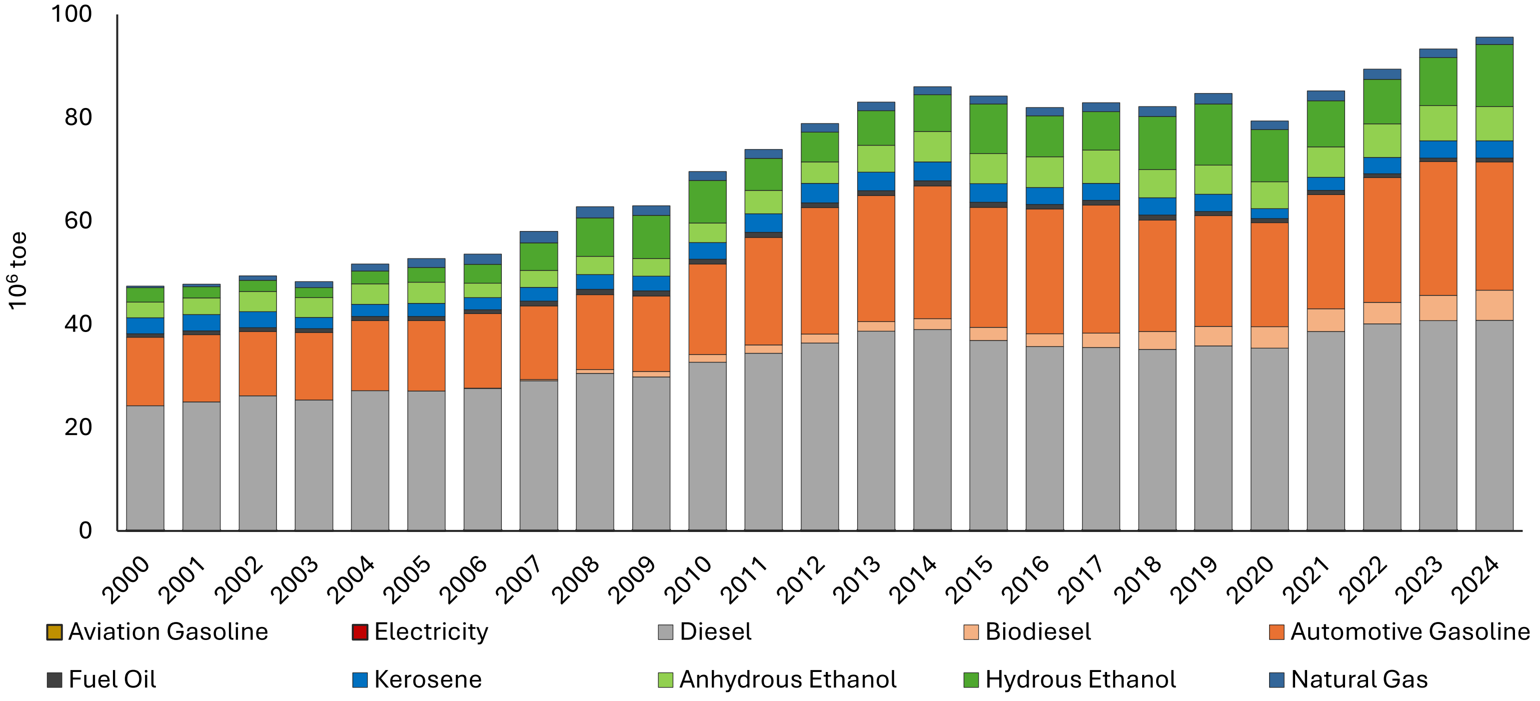
In 2024, national energy consumption increased by 1.9% compared to 2023, a rate lower than the increase in GDP, of 3.4%. However, energy demand for transportation grew 2.7% in 2024, accounting for 46.3% of the expansion of final energy consumption.

Transport Sector's energy consumption share evolution

In 2024, the sector showed an increase of 2.5 million tons of oil equivalent (toe) compared to the previous year. Biofuels stood out in this trend, with hydrous ethanol and biodiesel showing growth of 30.1% and 19.3% in consumption compared to 2023, respectively. At the same time, the consumption of gasoline C retracted 3.9% despite the growth of the individual transportation activity by 4.7% in the same period, reinforcing the increase in the penetration of hydrous ethanol. Fossil diesel consumption grew 0.6% in 2024, causing most of the activity to have its demand supplied by the expansion of biodiesel.

Figure 45: Consumption of the transport sector by energy source (10^6 toe)

Source: EPE (2025)



In general, this scenario shows that, although energy consumption in transport has grown significantly, the penetration of renewable energy sources in the sector has limited the demand for fossil sources.

Passenger transport

In 2024, passenger transport recorded a drop in total energy intensity of 2.0% compared to the previous year, which represents a maintenance of the recovery trend from the level before the Covid-19 pandemic, however, with the intensity still being 0.3% above the level of 2019.

Figure 46: Energy intensity by mode [toe/(10^6 p.km)]

Source: Compiled by EPE

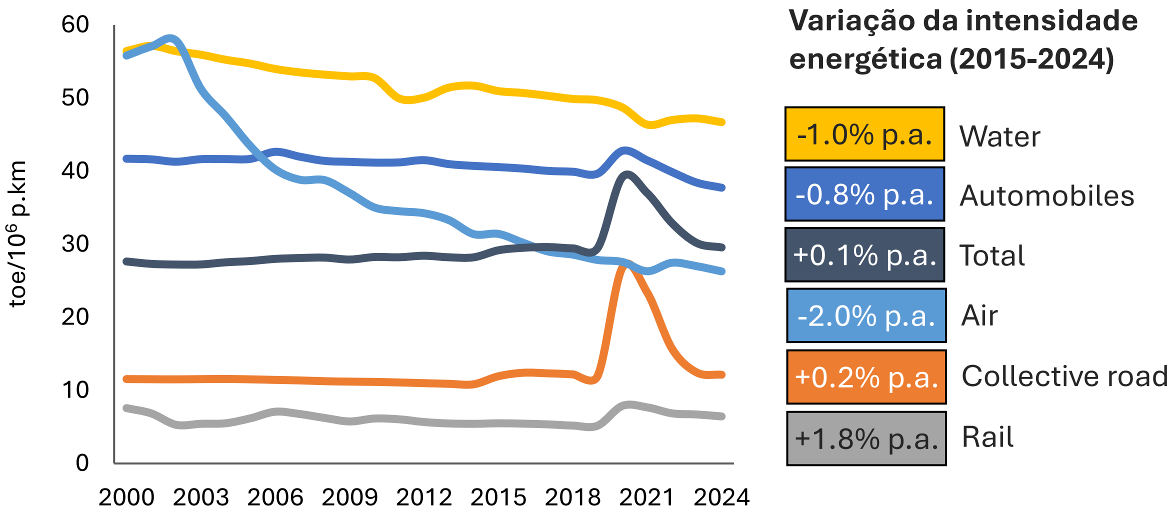
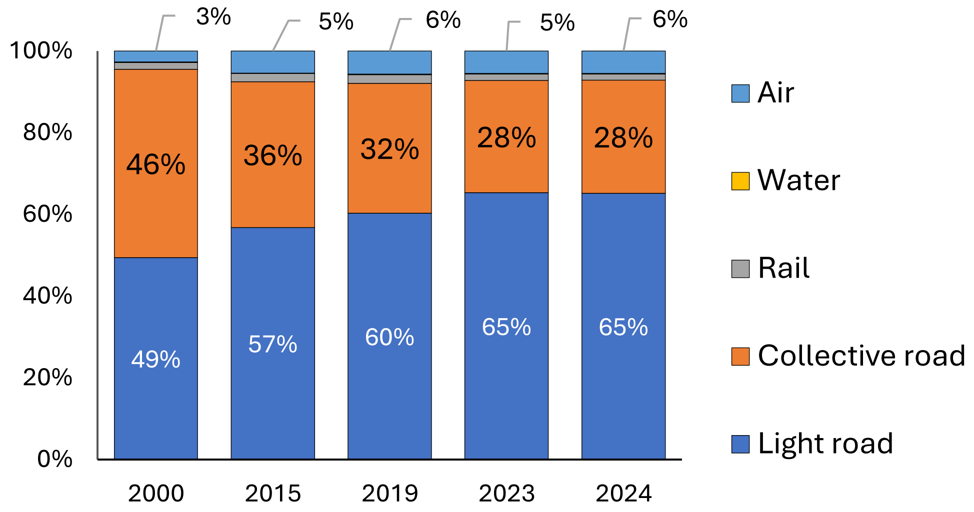


Figure 47: Activity by mode [p.km]

Source: Compiled by EPE



Regarding the activity, public road transport has been falling since 2015, which was intensified during the Covid-19 pandemic due to social distancing measures. Similarly, the metro-rail and air modes suffered a strong negative impact in that period. In the same period, individual road transport showed a significant growth trajectory.

Note: the "p.km" unit refers to passenger-kilometer.

Road transport energy consumption evolution

Between 2015 and 2024, the total energy demand of road transport showed a moderate growth trend. For cargo transportation, it was driven by the consumption of diesel by the truck fleet, while for passenger transportation, the growth in demand for hydrous ethanol and diesel oil for light vehicles for individual use stands out.

The higher penetration of hydrous ethanol caused a relative stagnation in the increase in demand for gasoline C, contributing to the mitigation of greenhouse gas emissions associated with Otto Cycle fuels. Since 2015, the demand for Otto Cycle fuels has grown by 1.2% per year, reaching 45 million toe in 2024.

The consumption of diesel fuel for individual transport has shown significant growth compared to 2015 due to the increase in popularity of light diesel vehicles. These factors have encouraged higher-income consumers to prefer more robust vehicles, many of which have diesel traction.

Figure 48a: Energy consumption by mode and source
Source: Compiled by EPE

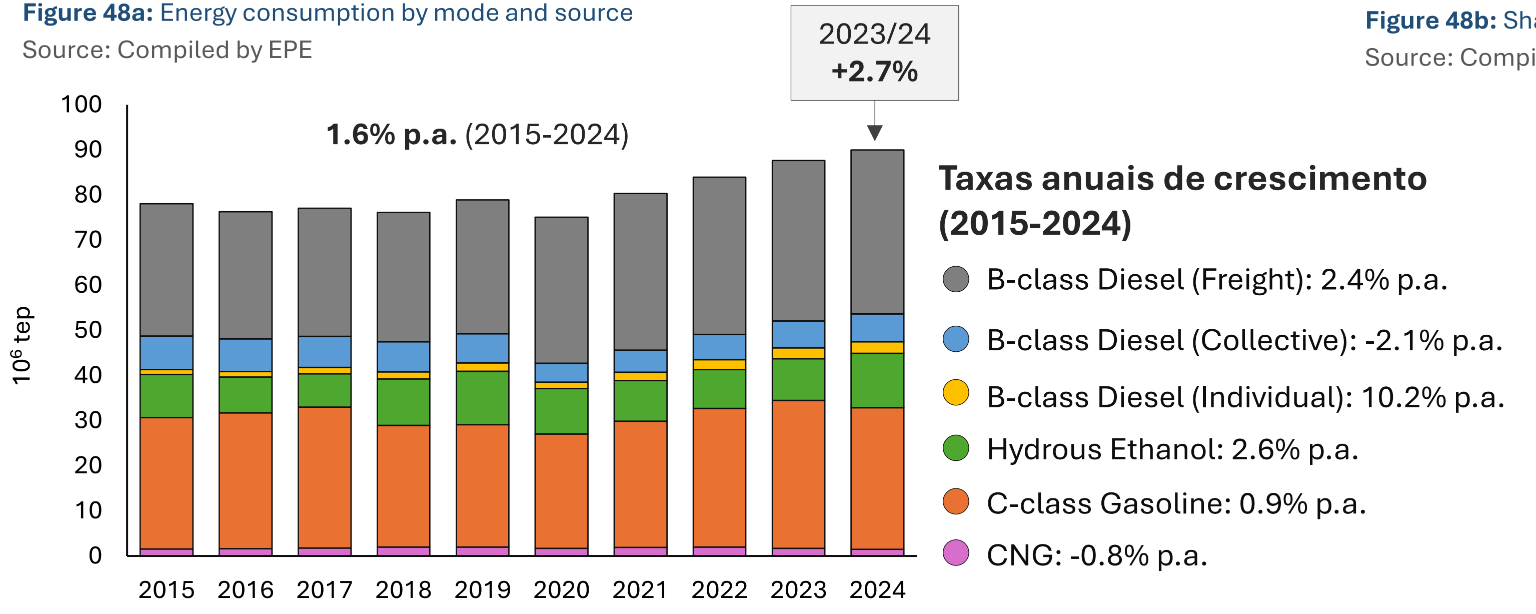
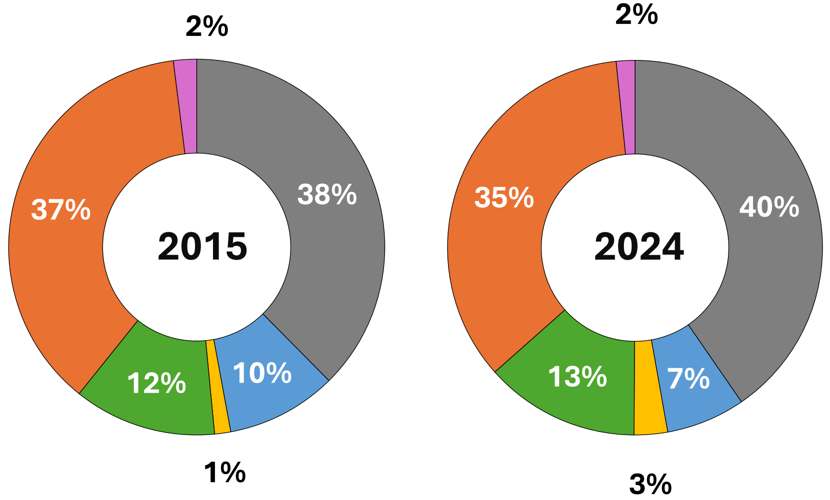


Figure 48b: Share of energy sources in the transport sector for selected years
Source: Compiled by EPE



Public road passenger transport

In the period from 2015 to 2019, the average energy intensity of the bus fleet remained stable, with the drop in activity in the period having been accompanied by a reduction in energy consumption. In 2020, however, there was a 124% growth in energy intensity due to the significant drop in activity. This trend was more pronounced for highway buses, which showed a 79% reduction in activity compared to the previous year, against 62% for urban buses.

The reduction in energy consumption was, however, limited to 36% compared to 2019, so that, due to the need to maintain essential transport services, many buses had to be kept in operation even under low demand, particularly within urban perimeters.

In 2024, the sector appears to have established itself at a new level of activity and energy consumption, while energy intensity has returned to its pre-pandemic level.

Figure 49: Consumption of diesel fuel in buses and energy intensity of the sector

Source: Compiled by EPE

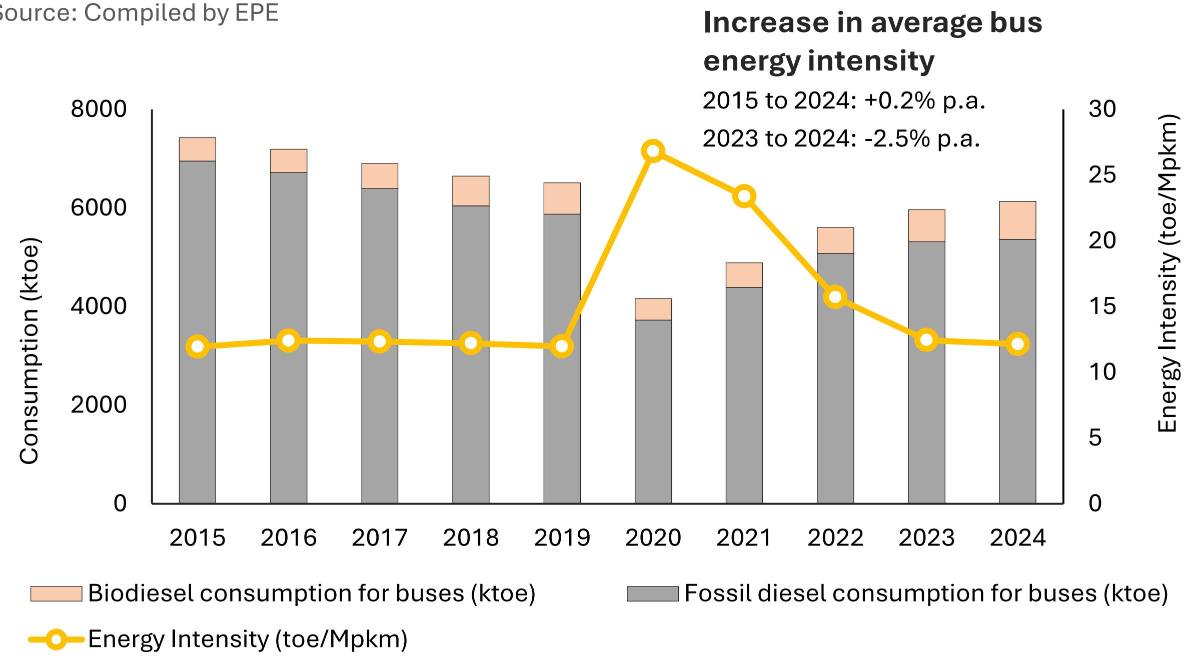
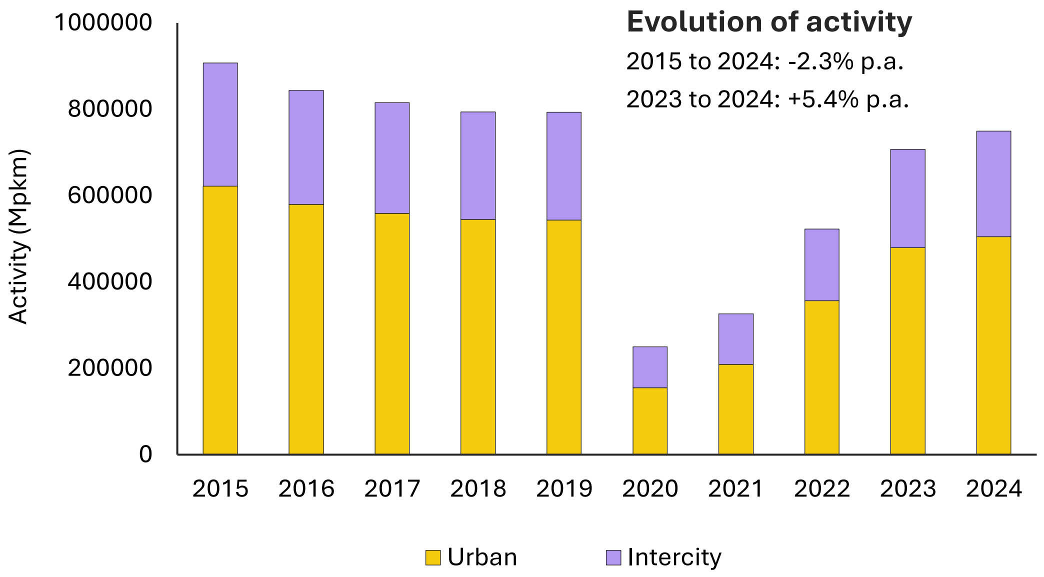


Figure 50: Public road transport activity

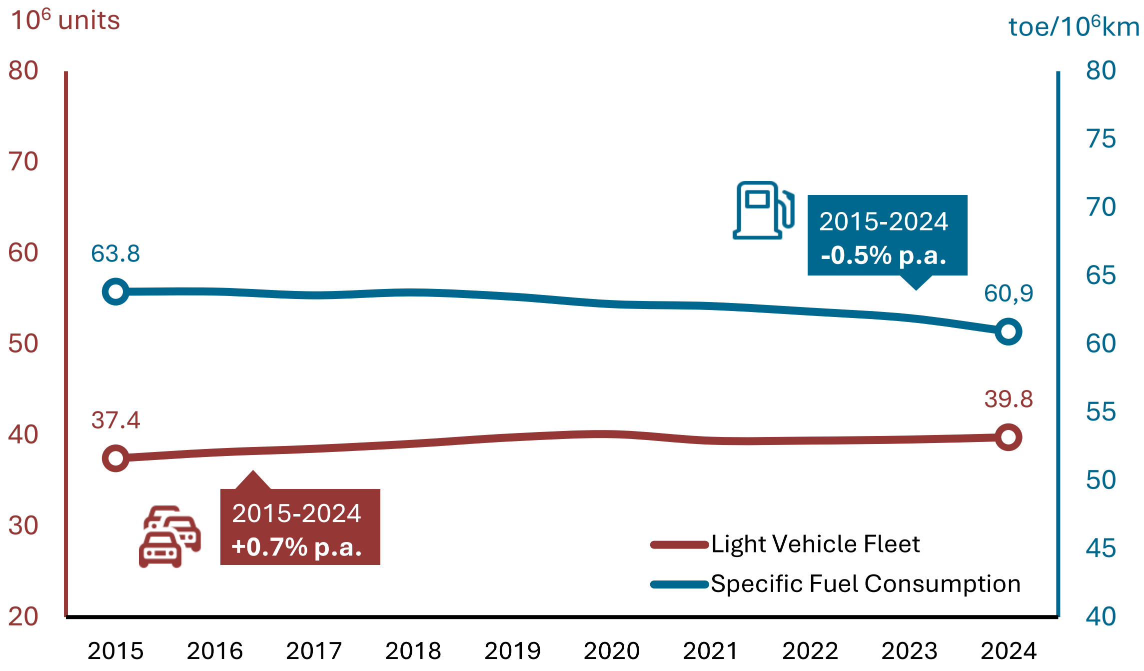
Source: Compiled by EPE



Individual passenger transport

Figure 51: Light vehicle fleet and specific fuel consumption

Source: Compiled by EPE



In 2024, sales of new light vehicles increased by 14.1% compared to 2023, with emphasis on the growth in sales of light diesel vehicles (up 17.8%) and electrified vehicles (up 88.8%), reaching 2.5 million units sold that year. In all, electrified light vehicles accounted for 7.1% of total sales in 2024, a significant increase compared to the 4.3% observed in 2023 (ANFAVEA, 2025).

However, for that same year, the estimated circulating fleet of light vehicles grew only 0.6% compared to 2023, indicating a slowdown in its growth in recent years and a consequent average aging of these vehicles in circulation.

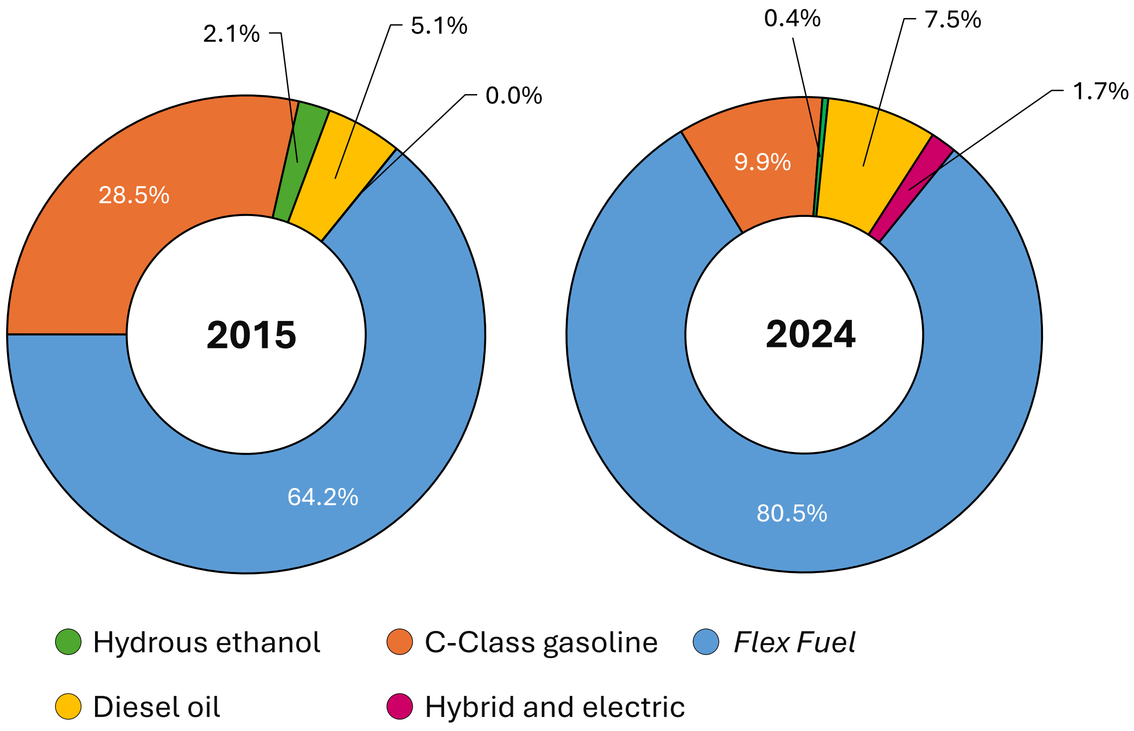
This trend of relative stabilization can be explained, mainly, by the significant increase in the price of automobiles observed from 2019 onwards, as well as by the high interest rate and the gain in penetration of transportation applications, making the acquisition and maintenance of automobiles excessively expensive compared to more affordable alternatives that have become popular in Brazil over the last decade.

In 2024, there was a reduction of 1.6% in specific energy consumption compared to the previous year, mainly reflecting the increase in the share of electrified vehicles in the fleet, which increased from 1.4% to 1.7% of the total number of light vehicles in circulation – representing a growth of 26.3% in the total fleet of hybrid and electric vehicles. In addition, part of the gains related to energy efficiency can be associated with the adoption of technological innovations and incentive policies, such as turbochargers, direct injection and automatic transmission, in addition to the stimulus promoted by programs such as Proconve, PBEV and Rota 2030.

Individual passenger transport

Figure 52: Light vehicle fleet by type of motorization in selected years

Source: Compiled by EPE



Regarding motorization and energy sources, the majority presence of flex fuel cars is maintained, as well as the trend of gradual replacement of the fleet of vehicles exclusively running on ethanol or gasoline by flex vehicles. At the same time, there is a growth in the number of electric, hybrid and diesel vehicles.

Between 2023 and 2024, despite the increase in the popularity of light diesel vehicles, the electrified fleet showed similar growth in order of magnitude, reaching 145 thousand additional units in circulation in the period and offsetting efficiency reductions related to the increase in the number of SUVs in circulation.

Of the total electrified vehicles in circulation, 54% correspond to hybrid-electric vehicles (HEV), although battery electric vehicles (BEV) showed more significant growth compared to HEVs in 2024: their estimated fleet grew by 32% compared to 2023, while the estimated fleet of hybrid light vehicles grew by 22% compared to that year.

In recent years, electrified vehicles have shown strong growth due to the entry into the Brazilian market of electric vehicles with lower acquisition cost, added to factors such as the expansion of charging infrastructure, state tax exemptions, environmental appeal, in addition to perspectives of low energy cost and low maintenance demand.

The increase in the share of electrified vehicles in the fleet represented a contribution of 1.9% to the reduction of energy intensity from 2023 to 2024, considering the energy gains of BEVs and HEVs in relation to the total fleet.

Individual passenger transport and energy consumption by source

Figure 53a: Energy consumption by source

Source: Compiled by EPE

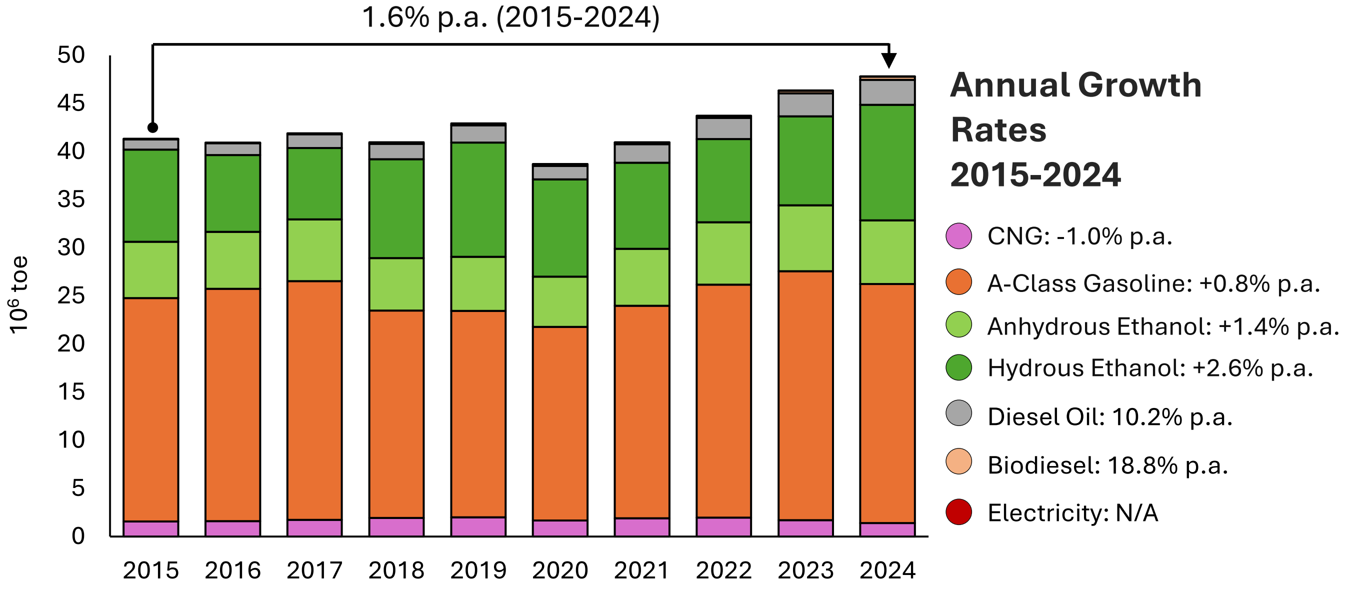
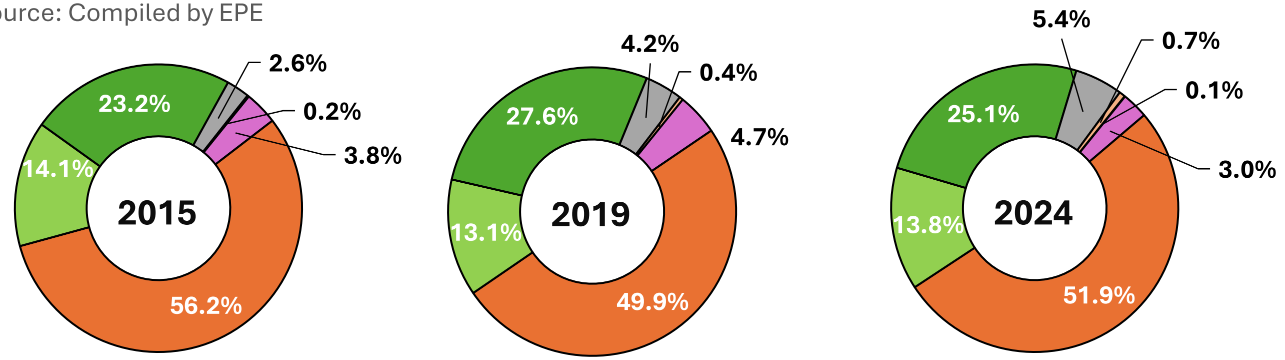


Figure 53b: Share of energy consumption in the selected years

Source: Compiled by EPE



Between 2015 and 2024, energy consumption in individual road transport grew at a rate of 1.6% p.a., in step with the slowdown in the growth of the light vehicle fleet since 2015. In this period, gasoline A (automotive) and CNG showed a reduction in their participation, with gains for hydrous ethanol and diesel oil.

In 2024, the energy consumption of individual road transport grew by 3.2% compared to the previous year, with an increase in demand for hydrous ethanol (30.1%) concomitant with a reduction of 3.9% in demand for gasoline C. This movement was leveraged by the reduction in the price ratio of ethanol in relation to gasoline due, among other reasons, tax advantages for ethanol, such as the reintroduction of PIS and Cofins (federal tax rates) for gasoline in 2023 and the adoption of a single-phase taxation regime for fuels in the same year.

Also in the period from 2023 to 2024, CNG suffered a 16.6% reduction in consumption, representing its lowest share since 2015. This movement can be attributed to the increase in its price compared to gasoline, although the fast adoption of electrified vehicles by taxi drivers and apps, a traditional CNG niche, may have contributed to this trend. Regarding the electromobility of light vehicles, electricity consumption reached 26.6 thousand toe or 309.5 GWh in 2024.

Freight transport

Between 2015 and 2024, the energy intensity of cargo transport decreased at a rate of 1.7% per year, with negative variations occurring for all modes of transport. In 2024, freight transport maintained the trend of reducing energy intensity, with a drop of 1.1% compared to 2023. This behavior was, in large part, a reflection of the trends in the road mode, whose energy consumption per ton transported fell 4.1% compared to the previous year.

In 2024, the activity of road freight transport grew more than other modes, even despite its already significant participation in the national cargo transport matrix, maintaining the trend of expansion of its participation in the sector in the face of less energy-intensive modes.

In addition, in 2024, domestic truck licensing grew by 15.7% compared to 2023, totaling 125 thousand vehicles, following the demand for the flow of agricultural goods for export and products for distribution in urban areas.

Apesar do aumento em sua participação no transporte de cargas, o modo aéreo não atinge 0,1% da atividade cargueira, de forma que, mesmo com sua elevada intensidade energética frente aos demais modos, ainda não representa um consumo energético expressivo.

Figure 54: Energy intensity by mode [toe/(10^6 t.km)]

Source: Compiled by EPE

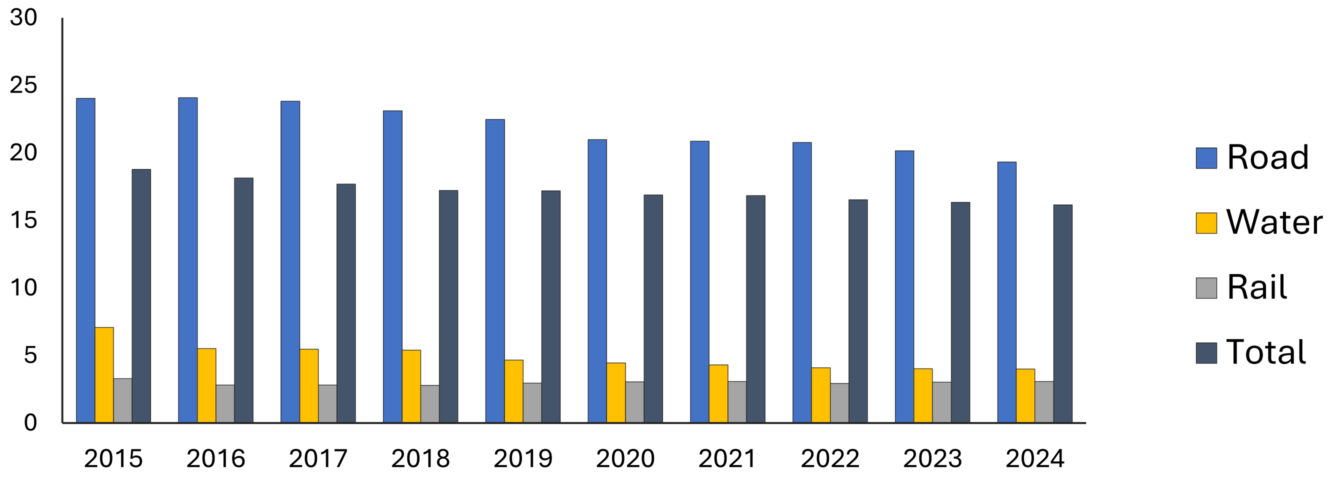
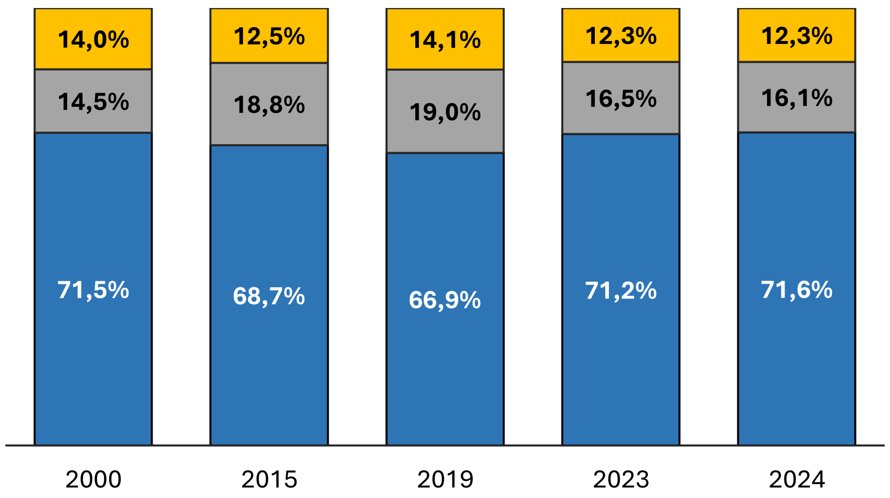


Figure 55: Activity by mode [t.km]

Source: Compiled by EPE



Road freight transport

Figure 56: Truck fleet by category (million units)

Source: Compiled by EPE

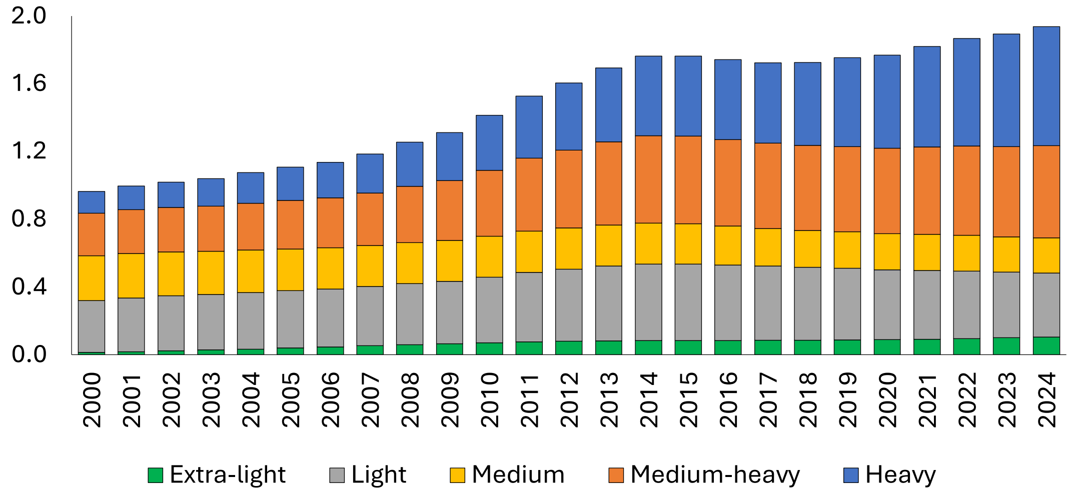
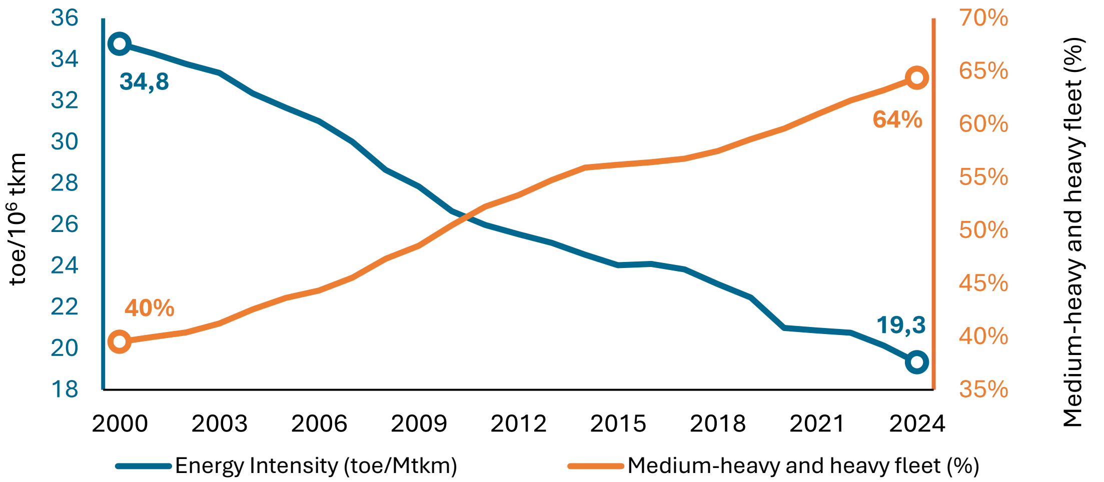


Figure 57: Relationship between energy intensity and fleet composition

Source: Compiled by EPE



In the period from 2015 to 2024, the truck fleet grew 1.0% p.a., with a highlight to the growth in the number of semi-light, heavy and semi-heavy trucks, which, together, represent a total of 1.9 million units. Compared to 2015, the fleets showed increases of 23.5%, 5.0% and 48.5%, respectively. Light and medium trucks showed reductions of 16.3% and 12.3% in their number of vehicles in circulation.

Due mainly to the need for the flow of agricultural production and long-distance transport, there was a replacement of light and medium trucks by heavier models, alongside with the use of a growing number of semi-light and light commercial vehicles for urban last-mile transport (mainly for the delivery of products from e-commerce).

Between 2005 and 2024, much of the improvement in energy efficiency can be associated with the increase in the estimated proportion of semi-heavy and heavy-duty vehicles in the truck fleet, relating a greater share of higher-capacity vehicles to a lower energy intensity for cargo transport. This behavior is particularly pronounced considering Euro 5 and Euro 6 trucks, which present incremental efficiency gains as an auxiliary tool in reducing emissions.

Also from 2005 to 2024, the percentage of heavy and semi-heavy vehicles in the fleet grew from 44% to 64% of the total trucks, while energy efficiency in this way improved by 39% over the same period.

Road freight transport

The transport of greater volumes of cargo per vehicle and the progressive renewal of the fleet have allowed the maintenance of gains in energy efficiency of road transport, both in the structural and technological spheres. The structural gains refer to the growth in the share of heavy and semi-heavy trucks, which, although they consume more fuel per distance traveled, allow significant gains in the activity for the same fuel consumption.

Thus, between 2015 and 2024, the activity of road freight transport grew 48.6%, much higher than the increase in fuel consumption recorded in the sector, of 19.4%. Despite this, the year 2024 presented a record in the demand for diesel oil B for transportation, of which 41 billion liters were consumed by trucks, which corresponds to 78% of the total demand for this fuel in the transportation sector.

The increase in biodiesel in fossil diesel (B14) as of March 2024, allowed most of the additional diesel demand to be met by biodiesel, limiting the increase in fossil diesel demand to only 1.5% in 2024 (Figure 58). The energy efficiency of trucks has increased (Figure 59) due to technological improvements, despite the potential negative effects of biodiesel.

Figure 58: Road transport diesel consumption and average biodiesel levels
Source: Compiled by EPE

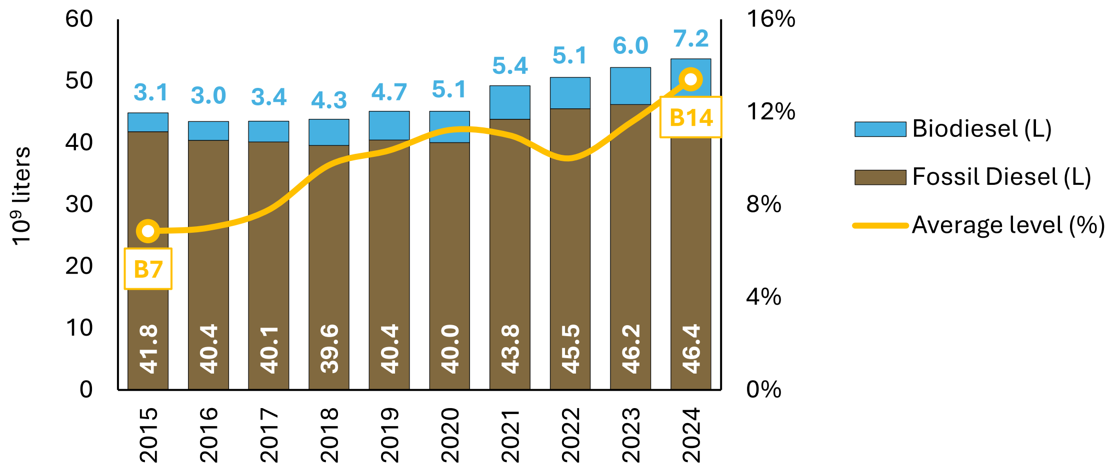
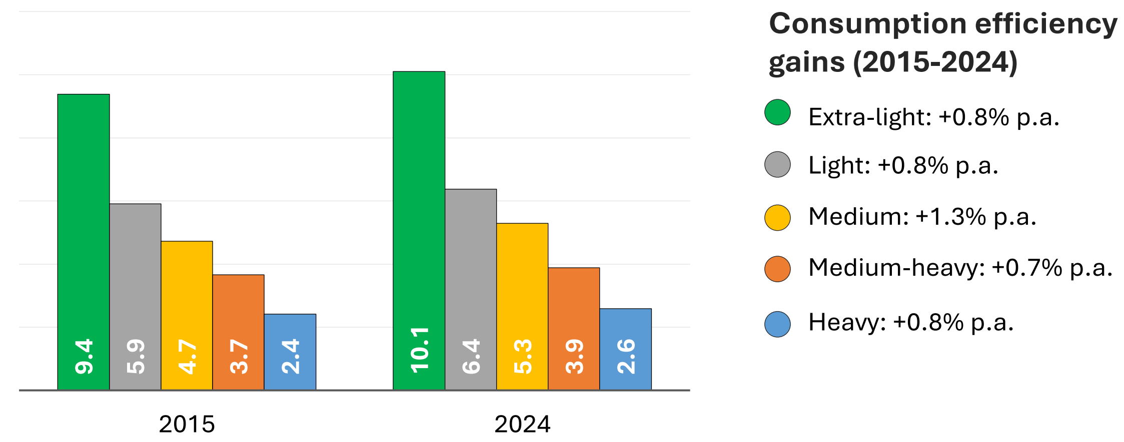


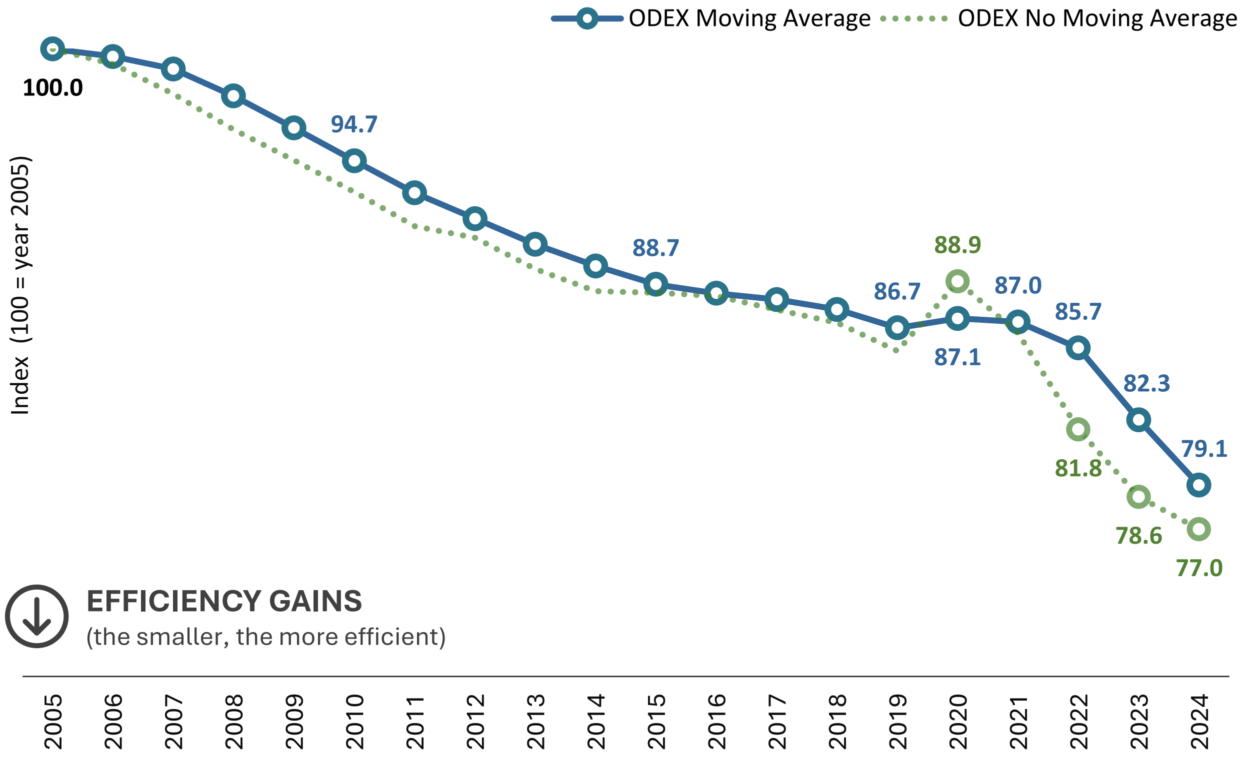
Figure 59: Average fuel consumption of new vehicles sold (with freight) [km/L]
Source: Compiled by EPE



Evolution of the transport sector's ODEX

Figure 60: ODEX Evolution

Source: Compiled by EPE



The adoption of new technologies and the development of projects focused on energy efficiency, often encouraged by programs such as Proconve, PBEV and, more recently, MOVER, have contributed to the gains observed in road freight and passenger transport.

The transport sector's ODEX has shown successive improvements driven by energy efficiency gains. In particular, road freight transport was able to obtain good results through the expansion of the fleet of heavy and semi-heavy trucks, allowing the transport of significantly higher volumes of cargo per trip, in addition to efficiency gains with the adoption of vehicles of Proconve P7 and P8 standards. From 2005 to 2024, the percentage of heavy and semi-heavy vehicles in the fleet grew from 44% to 64% of the total trucks, while the energy intensity of this mode improved by 39%.

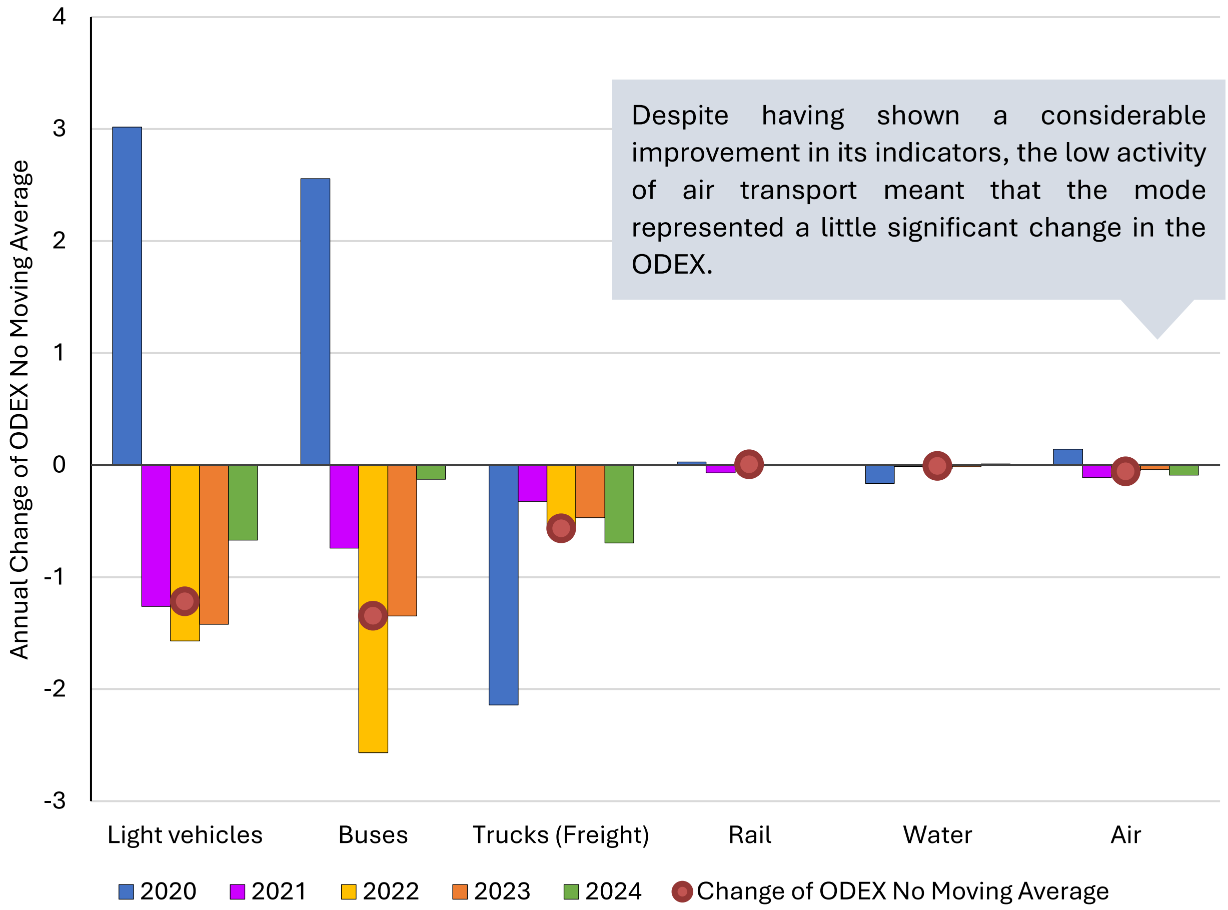
In relation to light vehicles, the estimated energy intensity has fallen by 0.4% p.a. since 2005, despite the increase in the share of SUVs (usually less efficient), which is equivalent to an improvement of 7.2% in energy intensity.

Although the proportion of activity in the railway and waterway systems did not expand in relation to the road mode, the reduction of their energy intensities contributed to avoid an increase in fuel consumption in the period, which would have been observed if there were no efficiency gains in these modes of low energy intensity.

It is important to mention that, throughout the period, the evolution of the ODEX presented a setback during the COVID-19 pandemic, mainly attributed to the reduction in the activity of public transport modes, which started to circulate with reduced capacity. Regarding buses, although energy intensity worsened by a total of 5.4% between 2005 and 2024, the intense worsening observed during the pandemic period caused a marked increase in ODEX in 2020, followed by a rapid recovery, especially between 2022 and 2023, which produced an abrupt drop in the indicator, marking the rapid recovery in public transport activity.

Evolution of the transport sector's ODEX

Figure 61: Annual Change of ODEX Without Moving Average by mode
Source: Compiled by EPE



Taking into account the interval from 2020 to 2024, it can be concluded that road transport was the main responsible for the improvement of ODEX in the period. This fact was caused, above all, by its predominance in the transportation sector, which gives it greater weight compared to the others.

The road freight mode, which had shown a marked improvement during the pandemic, continues to represent a relevant share in the improvement of the transport ODEX, although its weight in the improvement of the indicator has been reduced in relation to passenger transport between 2021 and 2023.

Despite having suffered a significant worsening in 2020 due to the COVID-19 pandemic, road passenger transport showed an accelerated recovery between 2021 and 2023, which cooled in 2024. In general, this behavior can be associated with the recovery of a large portion of the activity after the pandemic.

Representing a significantly smaller fraction of transport energy consumption compared to light vehicles, buses showed very significant variations in ODEX in 2020 and, in the opposite direction, in 2022, indicating trends of worsening and sudden recovery, coinciding directly with the beginning and end periods of the global health emergency. Together with the increase in efficiency obtained by cargo transportation in the period, this movement resulted in a drastic variation in the indicator between 2022 and 2023. Thus, the rapid advance in the improvement of the ODEX can be understood as a combination of the improvement in the efficiency of road freight transport with the sudden recovery of activity in passenger transport observed between 2021 and 2023.

Energy Efficiency Policies and Programs in the Transportation Sector

Several government programs are associated with the increase of energy efficiency in the Brazilian transport sector

Infrastructure and transport logistics

- *Canal Verde*
- *Programa de Parcerias de Investimentos (PPI)*
- *Pro Trilhos*
- *PAC – Efficient and Sustainable Transport Axis*
- *Programa de Sustentabilidade para Infraestrutura de Rodovias e Ferrovias Federais*

Fuels

- *Programa Nacional de Produção e Uso de Biodiesel (PNPB)*
- *National biofuel policy (RenovaBio)*
- *Programa Nacional do Hidrogênio (PNH$_2$)*
- *Gás para Empregar Program*
- *Combustível do Futuro Program*
  - *Programa Nacional de Combustível Sustentável de Aviação (ProBioQAV)*
  - *Programa Nacional de Diesel Verde (PNDV)*
  - *Programa Nacional de Descarbonização do Produtor e Importador de Gás Natural e de Incentivo ao Biometano*

Emissions, efficiency and industrial policy

- *Programa Brasileiro de Etiquetagem Veicular (PBEV)*
- *Programa de controle de emissões veiculares (Proconve)*
- *Programa Mobilidade Verde e Inovação (MOVER)*
- *Sistema Brasileiro de Comércio de Emissões (SBCE)*
- *Programa MelhorAr*
- *Plano Setorial de Transporte e Mobilidade Urbana (PSTM)*
- Emission limits for new motorcycles (CONAMA 18/1986 e 297/2002)
- *Nova Indústria Brasil (NIB)*

Urban mobility

- *Política Nacional de Mobilidade Urbana (PNMU)*
- *PAC – Large and Medium Cities Mobility*

Integrated Transport Plan

- *Plano Nacional de Logística (PNL)*
- Sectoral Plans (Road, Rail, Port, Air, and Waterway)
- General Plans

Naval industry

- *BR do Mar*
- *Agenda 2030 Portuária*
- *Porto Sem Papel*

Fleet renewal

- *PAC – Fleet Renovation*

Systemic Efficiency

Transport System Management

Vehicular Efficiency

Fuel quality and development

epe 20+

Final Thoughts of the Transportation Sector

The transport sector is the largest consumer of energy in the country, closely followed by industry. Among the reasons for the high energy intensity of the segment, its great dependence on road mode stands out. In 2024, the increase in fuel consumption was lower than the growth in transport activity, reflecting the positive results of the energy efficiency gain. This phenomenon was particularly accentuated by the increase in the proportion of more modern trucks with higher load capacity, added to advances in automotive engineering and the incipient electrification of the fleet.

In 2024, individual transport activity grew by 4.7% compared to the previous year, although the estimated fleet increased by only 0.9%. This phenomenon can be explained by economic and behavioral reasons, such as the increase in the price of vehicles, the high level of interest rates, and the popularization of transportation apps. At the same time, there is a rapid expansion of the fleet of electrified vehicles, which grew 26.3% in 2024, representing 1.7% of the total estimated fleet of light vehicles and showing the potential to further accentuate the sector's efficiency gains.

The demand for Otto cycle fuels in automobiles grew 2.8% in 2024, representing a slowdown compared to the previous year. The growth of 30.1% in the consumption of hydrous ethanol stands out, which absorbed part of the demand for gasoline C and CNG, which in turn fell compared to 2023. As a result, ethanol now represents 48.6% of the demand for Otto cycle fuels in automobiles, of which 31.4% corresponds to hydrous ethanol.

Final Thoughts of the Transportation Sector

The activity of public road transport grew 5.4% in 2024, but still without returning to the level of 2019, which had already been falling since it reached its all-time high in 2013. Although the recovery observed from 2021 to 2023 has catalyzed a significant relative improvement in ODEX, public transport has still presented difficulties in replacing individual transport, reinforcing the importance of investments and subsidies in the sector to obtain greater structural efficiency gains.

Cargo transportation by trucks grew 4.8% in 2024, representing 71.6% of the national activity of freight transportation. For the rail mode, the activity grew 1.9% and for the waterway, 4.2%. In all, cargo transportation consolidated an increase in total activity of 4.2% in 2024, surpassing the 3.5% of the previous year. With the adoption of a fleet of more efficient trucks with greater load capacity, there was a reduction of 4.1% in the energy intensity of road cargo transport, which maintains its consolidated position as the foundation of Brazilian logistics.

Regarding passenger air transport, in 2024, there was a growth of 5.0% in 2024, surpassing the activity of 2019 and reflecting a growth perspective for the sector. At the same time, metro-rail transport showed an estimated growth in activity of 2.0%, but the sector is still struggling to reach the pre-pandemic passenger occupancy.

Driven by programs such as Proconve, significant gains in energy efficiency in road transport have been observed through advances in vehicle engineering. However, the recovery of the share of waterway and rail modes to pre-COVID-19 pandemic levels remains a key way to increase energy efficiency through intermodality. Investments in the consolidation of infrastructure for these modes are of great importance to stimulate a fair and sustainable energy transition in the transport sector.

Special chapter:

Energy Efficiency Program (PEE) regulated by ANEEL and International Overview of Energy Efficiency Policies - IEA

Source: Hospital Bethesda, em Joinville/SC, após eficientização energética conduzida pela Celesc com recursos do PEE.

1. HISTORICAL CONTEXT

The **National Electric Energy Agency (ANEEL)** coordinates and regulates the **Energy Efficiency Program (PEE)**, which since its creation has mobilized substantial investments from electricity distributors and legal obligations.

The PEE was instituted by Law No. 9,991, of July 24, 2000, establishing the obligation for electricity distributors to make annual investments in actions aimed at improving efficiency in the final use of energy. This measure represented a milestone in the Brazilian electricity sector, by consolidating the allocation of specific resources for energy efficiency projects, creating a regulatory environment that stimulated the expansion of the chain of products and services focused on the theme in the country.

More than a regulatory instrument, the PEE has become a strategic public policy, with positive impacts on the dissemination of efficient equipment and appliances, the reduction of consumption waste, the reduction of the need for new investments in the electricity system and the promotion of social and environmental benefits associated with actions to reduce consumption and demand for electricity.

The program has also contributed, during its **25 years of existence**, to the strengthening of national technical skills and to the creation of an energy efficiency market, involving service providers, manufacturers of efficient equipment, research institutions, universities and organizations from the public and private sectors.

Throughout its history, the PEE has gone through different phases, adapting to legal and regulatory changes and the demands of society and the electricity sector. As a result, **it has consolidated itself as one of the main instruments for promoting energy efficiency in Brazil**, aligned with national energy efficiency guidelines with relevant energy, social and environmental results and impacts.

This history will be detailed below, through a chronology that highlights the main legal and regulatory milestones that have shaped the evolution of the program from its creation to the present day, with the process of improving the rules and guidelines of the PEE, included in ANEEL's Regulatory Agenda for the 2025-2026 biennium, with the forecast of publication of the new regulation by the end of 2026.

Figure 1: Timeline:

The trajectory of the Energy Efficiency Program (PEE) managed by ANEEL

Source: ANEEL (2025)

1998
REN ANEEL 242/1998
1% da ROL*.

1999
REN ANEEL 261/1999
0,9% da ROL em EE + 0,1% em P&D*.

2000
LEI Nº 9.991/2000
0,5% da ROL; vigência até 31/12/2005.

2001
REN ANEEL 394/2001
Mantém 0,5% da ROL (até 31/12/2005).

2002
REN ANEEL 492/2002
Mantém 0,5% da ROL (até 31/12/2005).

2005
REN ANEEL 176/2005
0,5% da ROL até 31/12/2005; 0,25% a partir de 01/01/2006. 50% dos recursos destinados à Baixa Renda.

2007
LEI Nº 11.465/2007
0,5% da ROL até 31/12/2010; 0,25% a partir de 01/01/2011. Mercados < 1.000 GWh/ano: 0,25%–0,5%.

2008
REN ANEEL 300/2008
0,5% da ROL até 31/12/2010. Gestão via SGPEE (sistema de gestão do programa).

2010
LEI Nº 12.212/2010
0,5% da ROL até 31/12/2010; 0,25% a partir de 2011. Mercados < 1.000 GWh/ano: 0,25%–0,5%. 60% dos recursos para Baixa Renda (TSEE).

2013
REN ANEEL 556/2013
Aprova o PROPEE. 50% dos recursos nas duas maiores classes de consumo (mercados < 1.000 GWh/ano isentos). CPP obrigatória ao menos 1x/ano.

2015
LEI Nº 13.203/2015
0,5% da ROL até 31/12/2022; 0,25% da ROL a partir de 01/01/2023.

2016
LEI Nº 13.280/2016
80% dos recursos aplicados pelas distribuidoras (0,4% da ROL); 20% ao PROCEL (0,1% da ROL). Até 80% às unidades rurais, Baixa Renda ou TSEE. Cooperativas < 500 GWh/ano isentas.

2018
REN ANEEL 830/2018
Revisa o PROPEE. Mantém 50% nas duas maiores classes de consumo. Cooperativas < 500 GWh/ano isentas.

2020
REN ANEEL 892/2020
Veda uso dos recursos do PEE em unidades consumidoras livres conectadas diretamente à Rede Básica.

2020
MP Nº 998/2020
Prioriza iniciativas e produtos da indústria nacional. Direciona à CDE recursos não comprometidos com projetos contratados/iniciados (01/09/2020 a 31/12/2025).

2021
REN ANEEL 920/2021
Revisa o PROPEE. Gestão do programa via OPEE (Observatório do PEE). Mantém 50% nas duas maiores classes de consumo.

2021
LEI Nº 14.120/2021
Até 31/12/2025: mínimo de 70% do total disponível do PEE para projetos de EE.

2021
REN ANEEL 929/2021
Define operacionalização do recolhimento à CDE. Percentuais de EE (% da ROL), CDE e PROCEL: até 31/12/2022: 0,28–0,4 (EE), CDE até 0,12, PROCEL 0,1; 2023–2025: EE 0,14–0,2, CDE até 0,06, PROCEL 0,05; a partir de 01/01/2026: EE 0,2 e PROCEL 0,05.

2024
REN ANEEL 1086/2024
Regulamenta a Olimpíada Nacional de Eficiência Energética - ONEE

2. OPERATIONAL ARRANGEMENT

The Energy Efficiency Program (PEE) has its governance structured in a decentralized way, but with strong regulation through the **Procedures of the Energy Efficiency Program**, consisting of 10 modules approved by ANEEL Normative Resolution No. 920/2021.

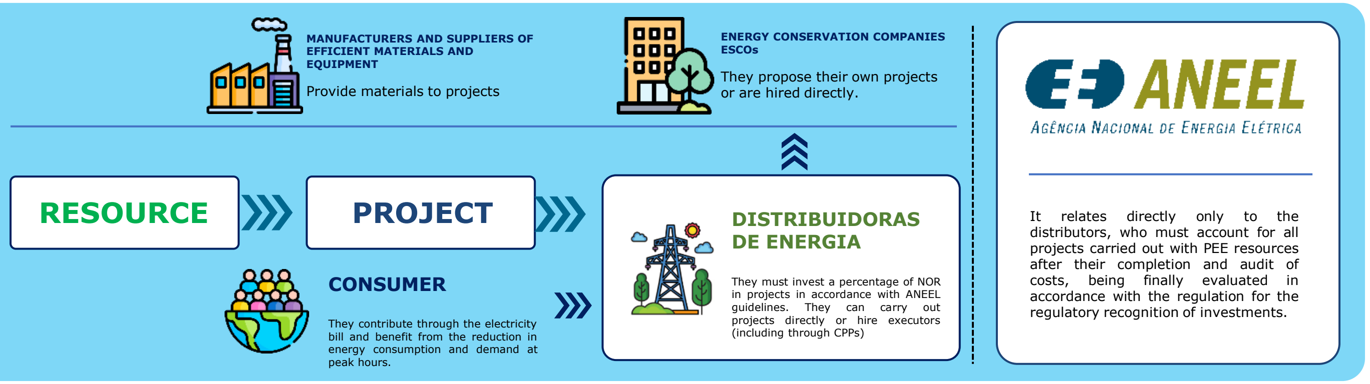
The resources come from the electricity tariffs paid by electricity consumers and are mandatorily allocated by the distributors, which must invest a percentage of their Net Operating Revenue (NOR) in efficiency projects in accordance with the guidelines defined by the regulator.

Distributors are the central link in operationalization: they can carry out their own projects, directly hire executors or select proposals through Public Calls for Projects (CPPs), held annually by each company in its concession area. Executors can be third parties, such as Energy Conservation Companies (ESCOs) or public and private institutions that are proponents and beneficiaries of projects. Manufacturers and suppliers of materials and equipment are also part of the chain as responsible for providing efficient services and technologies.

A Financial execution is monitored at the end of the projects by independent audits hired by the distributors, which ensure the veracity and compliance of the expenses according to previously defined procedures. After completion and audit, the projects are submitted to ANEEL, which carries out the final evaluation and verifies that the investments and results obtained through Measurement and Verification are in accordance with the applicable methodologies.

With the improvement of the PEE rules underway, the Subsidy Taking process having already been completed and the Regulatory Impact Analysis having begun, the PEE is moving towards seeking more alignment with national energy efficiency and transition policies, expanding the aspects of transparency in the management of resources and improving the regulatory model, with the objective of increasing the effectiveness and integration of the Program.

Figure 2: Operational Arrangement of the PEE and main stakeholders involved



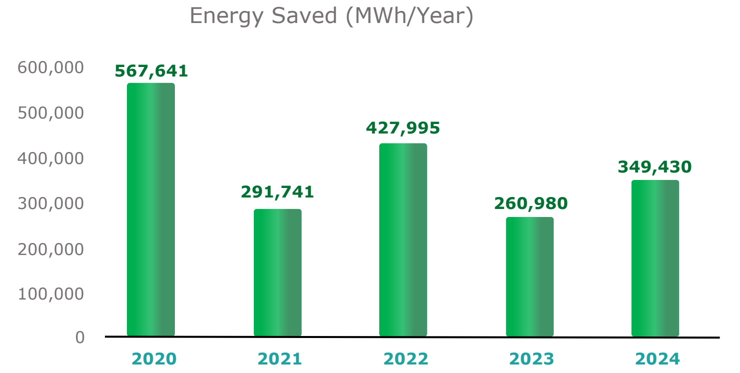
3. MAIN AGGREGATE RESULTS

In the five-year period 2020–2024, the projects completed under the Energy Efficiency Program (PEE) generated, on average, **379,557 MWh/year** of energy savings, a result obtained from the annual savings measured in each year (567,641 MWh/year in 2020; 291,741 in 2021; 427,995 in 2022; 260,980 in 2023; and 349,430 in 2024), which add up to **1,897,787 MWh** in the period.

In the same period, **1,851 projects** were completed, which allows us to estimate an **average annual savings of approximately 1,025 MWh per project**. The following projects were completed: 449 projects in 2020; 321 in 2021; 354 in 2022; 349 in 2023; and 378 in 2024.

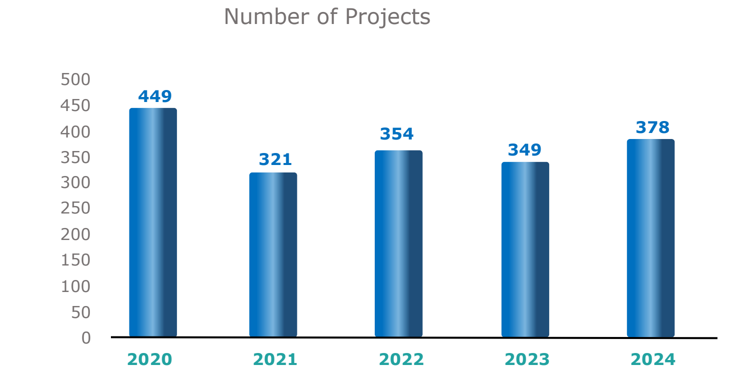
These results confirm the PEE's continuous commitment to energy sustainability, ensuring permanent reductions in consumption and reinforcing the security of the electrical system.

Chart 1: Overall Energy Saved in the PEE (2020-2024)



Source: Observatório do Programa de Eficiência Energética – OPEE

Chart 2: Number of projects in PEE (2020-2024)



Source: Observatório do Programa de Eficiência Energética – OPEE

2020: Full-scale launch and focus on urban LED

The year 2020, with **567.6 thousand MWh/year saved**, marks the peak of productivity in the five-year period and the consolidation of standardized solutions.

Dominant theme: Public Lighting (LED) – strong mobilization of projects to replace conventional luminaires with LED in roads, parks and squares, favored by rapid efficiency gains and short execution times.

Important add-ons:

- Switch to LED indoors (administrative buildings, schools, hospitals), reinforcing the impact on public power and commerce/services.
- Sanitation/water and wastewater: modernization of pumps and pumping systems, with good cost/benefit ratio.

2021: Consolidation in LED and expansion of public fronts

Even under the effect of the pandemic, the PEE maintained operational robustness, with **291.7 thousand MWh/year saved**.

Central theme: Public Lighting (LED), confirming itself as an anchor technology.

Thematic expansion:

- Public Power: buildings and education, with projects in schools, universities and health units, expanding the presence of the program in public buildings.
- Sanitation and water pumping in municipalities and water/sewage companies, with direct gains in consumption and quality of service.
- Low Income, with the exchange of inefficient equipment and regularization of connections, ensuring the social character of the PEE.

2022: Diversification and entry of Solar Generation

With 427.9 thousand MWh/year of savings, 2022 marks a partial return to the level of 2020 and introduces new technological solutions.

Continuous predominance: Street Lighting (LED) and LED indoors.

Relevant news:

- Photovoltaic solar generation projects, especially in public buildings and schools, anticipating trends in distributed generation and self-consumption.
- Industrial (motors, drives and automation), signaling progress in production processes and greater diversity of sectors served.

Integration with climate policies: initiation of actions associated with renewable sources, reinforcing the energy transition character of the PEE.

2023: LED still hegemonic and focus on commercial environments

With **260.9 thousand MWh/year of savings**, the PEE maintained capillarity and thematic scope.

Structuring axis: Public Lighting (LED).

Additional Highlights:

- Switch to LED in commercial environments and service chains (supermarkets, shopping malls, retail).
- Public Power: buildings and education, reinforcing integration with efficiency programs in public management.
- Residential projects aimed at changing equipment and efficiency kits.

2024: Institutional expansion and social reinforcement

With **349.4 thousand MWh/year saved**, 2024 reaffirmed the PEE as an instrument of national public policy.

Dominant typology: Public Power, with a strong presence of schools, universities, hospitals and direct administration bodies, consolidating budgetary gains and example.

Frequently Asked Topics:

- Public Lighting (LED), maintaining a strategic position.
- LED indoors, including in public equipment and commerce/services.
- Sanitation (water/sewage) with pump modernization and system automation.
- Solar photovoltaic in niches, reinforcing the convergence between efficiency and renewable generation.

4. INVESTMENTS: SCALE AND CONTINUITY

The Investment Chart summarizes the relationship between Amount Due (compulsory legal obligation as provided for in Law No. 9,991/2000) and Amount Invested in the PEE (according to the annual statement of investments made) per year. In the period 2020–2024, the total accumulated value of the obligations totaled R$4,311.3 million, while the Amount Invested totaled R$3,849.7 million, or 89.3% of the legal obligation during the period.

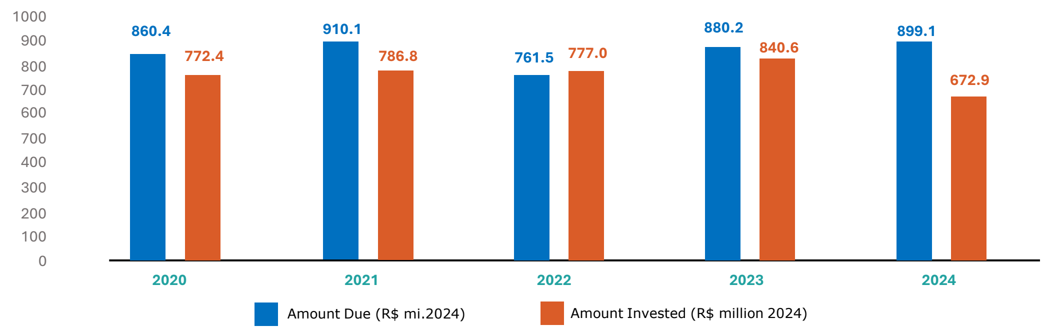
Annually, the results were: 2020 (Due R$ 860.4 million; Invested R$ 772.4 million; rate 89.8%), 2021 (R$ 910.1 million; R$ 786.8 million; 86.5%), 2022 (R$ 761.5 million; R$ 777.0 million; 102.0%), 2023 (R$ 880.2 million; R$ 840.6 million; 95.5%) and 2024 (R$ 899.1 million; R$ 672.9 million; 74,8%).

The average cost of projects remained in the range of R$1.7–2.4 million/project over the period: R$1.70 million (2020), R$2.41 million (2021), R$2.21 million (2022), R$2.39 million (2023) and R$1.78 million (2024).

The PEE's resource allocation profile in the 2020–2024 five-year period shows a concentration on four fronts that, together, account for 86.1% of the budget: Low-income (29.1%), Public Lighting (23.4%), Public Authority (19.9%) and Trade and Services (13.7%). The other typologies registered: Educational (5.0%), Residential (3.1%), Industrial (2.4%), Public Services (2.3%), Rural (0.8%) and Others (0.4%).

Between 2020 and 2024, the percentage distribution of the number of projects carried out under the Energy Efficiency Program (PEE) by typology was as follows: Public Lighting, 34.0%; Public Power, 26.3%; Trade and Services, 19.0%; low income, 6.7%; Public Services, 4.4%; residential, 3.4%; Industrial, 3.1%; Educational, 1.9%; Rural, 0.5%; and Others, 0.8%.

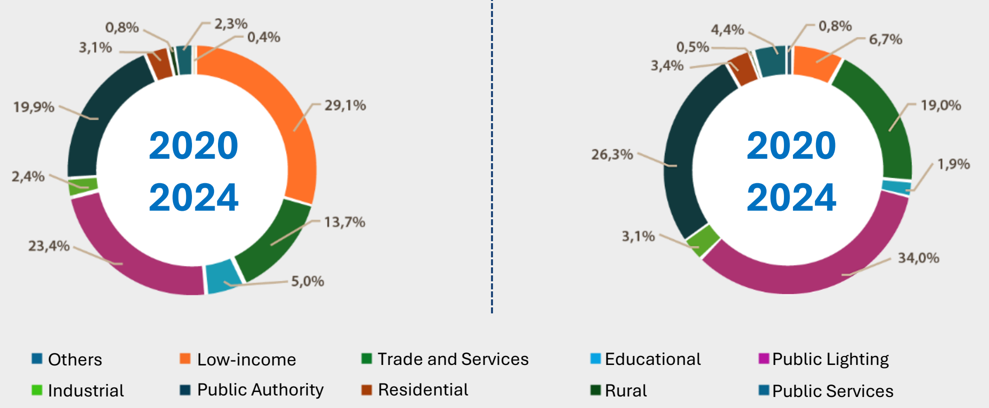
Chart 3: Financial transactions per year (2020 a 2024) (* million R$)



Source: Painel de Monitoramento PEE – Movimentação Financeira (values adjusted for inflation, according to the Brazilian Consumer Price Index). Annual fees: 2020, 4.52%; 2021, 10.06%; 2022, 5.79%; 2023, 4.62%; 2024 4.83%.

Chart 4: Investment in PEE Projects – percentage by category (2020-2024)

Chart 5: Number of projects carried out by typology in the PEE (2020-2024)



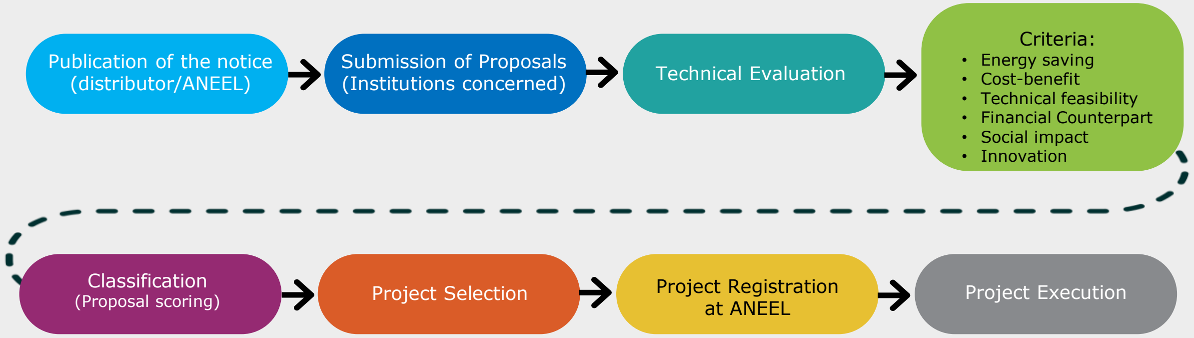
Source: Observatório do Programa de Eficiência Energética – OPEE

5. PUBLIC CALLS FOR PROJECTS

The **Public Calls for Projects (CPPs)** were instituted by ANEEL in 2013 as a **participatory instrument within the scope of the Program**, with the objective of increasing transparency, expanding the scope of projects in line with the needs to improve the country's energy efficiency, democratizing access to the Program's resources, allowing interested institutions – such as public agencies, universities, companies and private entities – could directly propose energy efficiency projects, prioritizing the implementation of the projects that present the best score among the selection criteria, resulting in the optimization of the resource. The process is no longer restricted to the exclusive performance of distributors, creating an institutional opening for different actors in the sector to engage in proposing solutions aimed at reducing energy consumption and promoting the rational use of energy resources.

The format of the CPPs is based on a **competitive selection process**. Distributors, in compliance with ANEEL guidelines, publish call notices, detailing the requirements, selection criteria and resources available by type of project. Interested institutions present their proposals under the pre-established formats and standards and according to the guidelines of the PEE, which undergo a technical and classification evaluation. The analysis considers criteria such as potential energy savings, cost-benefit, technical feasibility, financial counterpart, social impact and innovation. Based on this evaluation, only the projects that achieve the best scores are contemplated for execution, ensuring that resources are allocated to the most effective and relevant initiatives. This model strengthened the governance of the PEE by expanding the interaction between distributors, civil society and specialized companies, in addition to stimulating the professionalization of the energy efficiency market. The CPPs also contributed to diversifying the portfolio of projects and increasing the capillarity of the Program, allowing innovative solutions of different sizes to be evaluated in a fair and transparent manner. In the current context of the reformulation of the PEE, the improvement of the Public Calls remains one of the central points to reinforce the social participation, transparency and effectiveness of the Program in the energy transition and decarbonization agenda.

Figure 3: Rite of realization of CPPs:



Source: STE/ANEEL

6. OUTSTANDING PROJECTS

6.1. Actions with Low-Income Consumers

One of the pillars of energy efficiency programs is the work with the **population located in areas of social vulnerability**. The actions carried out in this context aim to promote access to more efficient equipment, adequacy of electrical installations and educational actions on conscious consumption, which helps consumers to have a more adequate understanding of issues related to their consumption and energy bill, enabling better bill management.

Initiatives such as:

- Replacement of incandescent and fluorescent lamps with LEDs in vulnerable areas;
- Replacement of old refrigerators with more efficient models;
- Educational campaigns on the rational use of energy;
- Adequacy of electrical installations to reduce losses and increase safety;
- Exchange of urban solid waste for bonuses on the energy bill as a source of income from recycling;
- Involvement of the local community in lectures and workshops for income generation with a direct impact on reducing electricity bills, improving quality of life and contributing to social inclusion.

Projects aimed at this audience represent a significant portion of the PEE's investments, **reflecting the commitment to energy justice**.

6.2. National Energy Efficiency Olympics (ONEE)

The National Energy Efficiency Olympiad (ONEE) is an ANEEL initiative, designed to promote the culture of rational and safe use of electricity among students across the country. Until 2025, ONEE remained aimed at students in the 8th and 9th grades of Elementary School, with plans to expand to High School in the next editions. Inspired by the format of science olympiads, **ONEE incorporates gamification, digital resources, and participatory methodologies** to transform technical concepts of energy efficiency into dynamic, accessible, and comparable learning experiences across education systems.

The creation of ONEE, in 2018, responded to a gap in ANEEL's Energy Efficiency Program (PEE): the lack of a national, structured, and measurable instrument for energy efficiency education in everyday school life. This design was matured in pilot cycles and, with Normative Resolution No. 1,086/2024, the mandatory annual participation of energy distributors was consolidated, elevating the Olympics to the condition of a permanent educational public policy, aligned with the guidelines of the PEE and the goals of the National Energy Efficiency Plan.

Evolution and results. The 2021 and 2022 pilots were decisive in validating the methodology, improving the use of digital platforms, and adjusting execution to regional realities. In 2021 (Pilot 1), in a context still marked by pandemic restrictions, the cooperation between distributors (COELBA, ENEL, RGE and EDP) enabled the adoption of 100% digital solutions for registration, application and correction, reaching around 40 thousand students, 1,081 schools and 2.7 thousand teachers, with an investment of around R$ 1.76 million. In Pilot 2 (2022), participation expanded to 34 distributors in 25 states, consolidating the use of WebApp, mobile application and online environments, which allowed us to scale the reach to approximately 188 thousand students, 3,679 schools and 7.8 thousand teachers, with an investment of R$ 5.4 million. In 2024, the first year of compulsory participation by all distributors, ONEE reached 263 thousand students, 4,603 schools and 10.1 thousand teachers; there were 8,000 medalists and 27 winners in a national ceremony in Brasilia, with an investment of R$ 4.8 million. **For 2025, 345 thousand students, about 8,000 schools and approximately 25 thousand teachers were enrolled, with investments estimated at R$ 6 million, including sponsorships and additional counterparts**.

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National Coverage

With emphasis from the State, Copel delivers the Energy Efficiency Olympics award

Students from 19 schools in Acre are awarded in the National Energy Efficiency Olympics

Triplets win gold at the National Energy Efficiency Olympics

Students from Minas Gerais stand out in the results of the 2024 National Energy Efficiency Olympics

Registration for the 2024 National Energy Efficiency Olympics is open; 5.8 thousand students from SC should participate

Structure and methodology. ONEE combines pedagogical strategies based on gamified learning paths and interactive assessments, with the use of digital platforms to engage students and support teachers. The application of the Item Response Theory (IRT) allows for more accurate measurement of levels of proficiency and comparability between editions, classes and networks. In each edition, a distributor acts as a proponent-coordinator, with the support of the others, under the supervision of ANEEL. Financing is carried out with resources from the PEE (Law No. 9,991/2000) and can be complemented by sponsorships and counterparts. In 2025, for example, around R$ 800 thousand were raised through these channels, signaling the ability to mobilize partners and additional financial sustainability. This operational architecture ensures standardization of content, wide accessibility, and continuous monitoring of results, while preserving flexibility for regional adjustments and pedagogical innovation.

Connection with public policies and impacts. ONEE operates as an educational tool that complements regulatory programs, equipment labeling, and energy intensity targets. The initiative acts on the 'activity effect' of final consumption, reducing waste and expanding social adherence to efficient practices. The effects include teacher training and appreciation, greater energy understanding among students and families, and strengthening of collaboration networks between schools, distributors, and institutional partners. In 2024, the symbolic results (medals and awards) were added to quantitative evidence of reach and engagement, reinforcing public legitimacy and the attractiveness of sponsorships.

Perspectives. The priorities for the next editions are the gradual inclusion of High School, the improvement of impact metrics (quantitative and qualitative), the national standardization of the methodology and the expansion of partnerships. There is also potential for internationalization of good practices, positioning Brazil as a reference in energy efficiency education. By articulating innovation, inclusion and sustainability, **ONEE contributes to the energy transition with a focus on human capital, a culture of efficiency and citizenship**.

Chart 5: ONEE: Evolution of student participation (2021-2025)

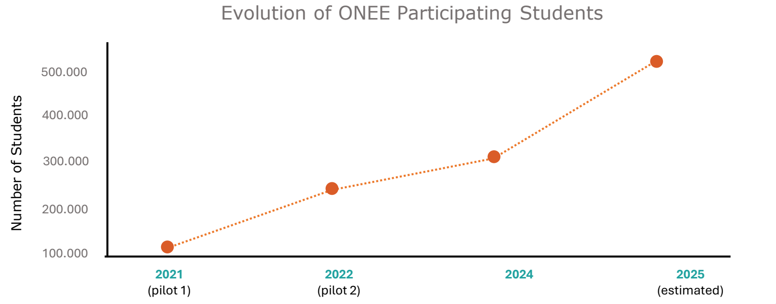


Chart 6: ONEE: Evolution of student participation (2021-2025)

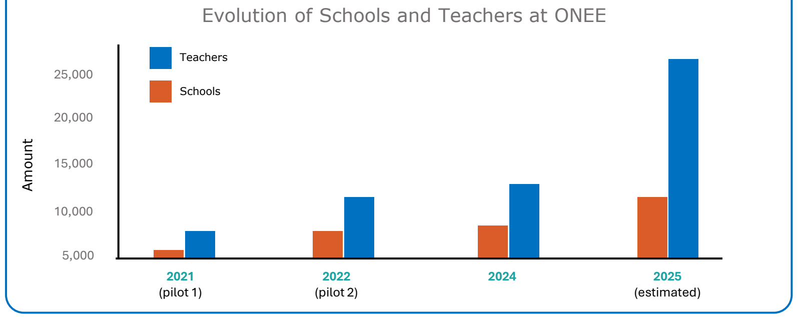
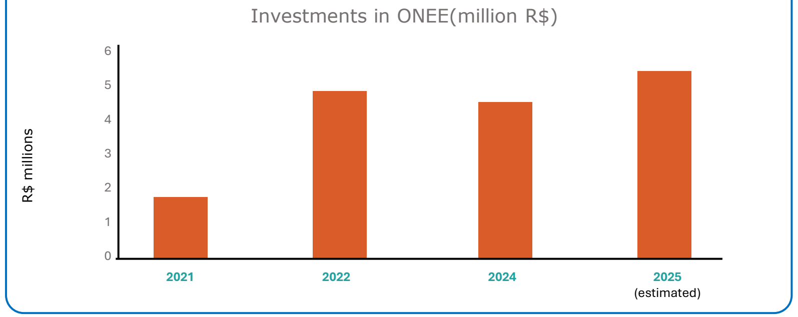


Chart 7: ONEE: Investment per edition (2021-2025)



6.3. Energy efficiency in hospitals

The **Priority Project for Energy Efficiency in Public Hospitals or with a Certificate of Charitable Entity for Social Assistance – CEBAS** was structured within the scope of the Energy Efficiency Program (PEE) regulated by ANEEL, with the objective of increasing the effectiveness of energy efficiency actions in a sector of great social relevance. Public hospitals and those certified by CEBAS have significant consumption of electricity, whose expenses are borne by public resources, and, for this reason, are strategic targets for the rationalization of energy use, with positive repercussions for both budget management and environmental sustainability.

The project was based on Procel estimates, according to which each public building in the three spheres of power has the **potential to reduce electricity consumption by around 20%.** This diagnosis was the basis for the initiative, structured in stages that included carrying out energy diagnostics, modernizing facilities, replacing inefficient equipment and training technical teams responsible for managing and maintaining hospitals.

The central motivation was associated with the essentiality of hospital services, the representativeness of their consumption in the public sector and the visibility that these institutions exert in society. The actions sought not only to reduce costs and increase the reliability of supply, but also to generate a demonstrative effect, encouraging the dissemination of sustainable practices in other segments.

The project had specific guidelines: application of non-repayable resources; coverage restricted to public hospitals or certified by CEBAS; requirement of a cost-benefit ratio equal to or less than 0.8 (or up to 1.0 in cases with distributed generation); proof of environmentally appropriate disposal of replaced equipment; and systematic measurement and verification (M&V) of the results, according to the rules of PROPEE.

The implementation took place in two phases. In the first, energy diagnoses were carried out to identify the potential for savings and select viable actions. In the second, the proposed measures were executed, such as the modernization of lighting systems, air conditioning, oxygen plants, autoclaves, in addition to the implementation of distributed generation. Training was also promoted to train the teams in the operation and maintenance of the new equipment.

The results were expressive: **the annual savings reached about 37.8 thousand MWh**, equivalent to the consumption of a medium-sized city in the Southeast, and the **reduction in demand at the peak reached 2.2 MW**. The overall cost-benefit ratio was 0.79, showing a significant return for society. Also noteworthy is the improvement of hospital services, the reduction of public spending, the training of technical teams and the contribution to environmental preservation.

In all, 117 hospitals in different regions of the country were benefited, from the participation of 14 electricity distributors. The total investment exceeded R$ 127 million, of which more than R$ 122 million was contributed by the PEE and approximately R$ 5 million came from counterparts from health institutions. Copel led in the number of hospitals served, followed by CPFL Paulista, CPFL Piratininga, RGE Sul and Celesc. The implementation had institutional support from the Ministry of Health and the Ministry of Regional Development, which acted as intervening entities, ensuring integration between energy efficiency policies, public health and regional development. This articulation ensured greater effectiveness of the actions and strengthened the legitimacy of the project in the eyes of society.

In addition to the quantitative indicators, the qualitative impacts were equally relevant: modernization of hospital facilities, greater comfort and safety in health environments, release of public resources for other priorities and professional appreciation through training and qualification, ensuring the sustainability of the results in the long term. Another prominent effect was the stimulus to the market for energy efficiency equipment and services, promoting economic development and job creation. The demonstrative nature of the project, implemented in high-visibility institutions, served as an incentive for other sectors, expanding the positive effects of the public policy on energy efficiency.

The Priority Hospital Project has become a milestone in the trajectory of the PEE, highlighting energy efficiency as a strategic ally of public health policy, contributing to the moderation of energy demand, the reduction of greenhouse gas emissions and the advancement of a sustainable and inclusive development model.

Chart 8: Investments by distributor (R$ millions)

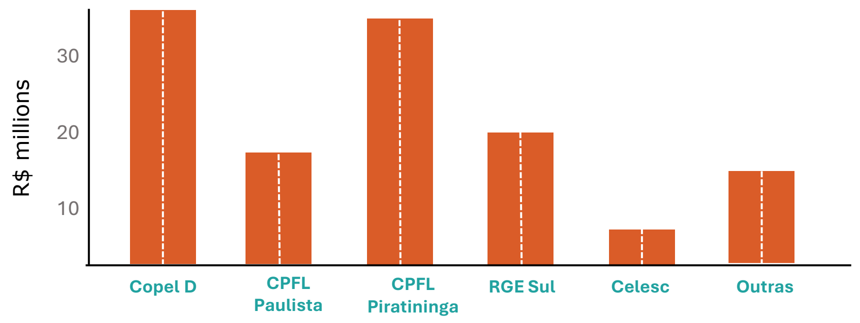
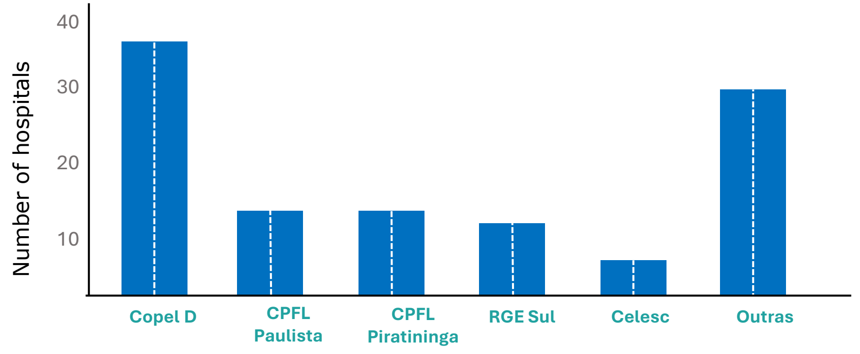


Chart 9: Hospitals participation, by distributor



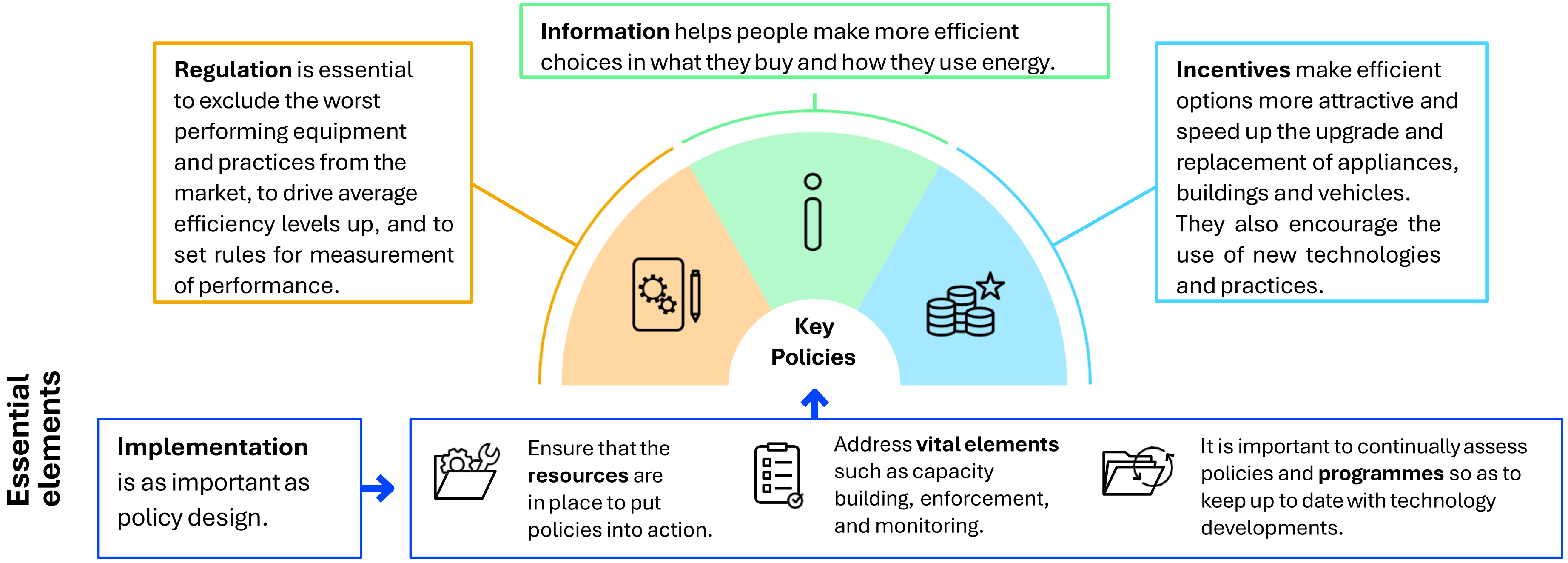
International overview of energy efficiency policies-IEA

Energy Efficiency Policies

Policy Package for Energy Efficiency

Energy efficiency is central to improving the lives of all people. It provides affordable and reliable energy access, bolsters the security of energy supply, accelerates clean energy transitions and supports economic growth and resilience. For these reasons, energy efficiency policies can deliver many benefits to people – lowering energy bills, improving health outcomes, and creating new jobs, while ensuring these benefits are shared by all. A strong, early focus on energy efficiency is essential to achieve net zero emissions by 2050.

Implementing energy efficiency measures requires a well-designed and integrated policy framework. International experience shows that an effective policy package combines regulatory instruments, financial incentives, and information-based tools to drive improvements across sectors. Such a framework is most effective when grounded in clear, ambitious, yet achievable targets that are effectively communicated to all relevant stakeholders. Careful design and implementation will deliver efficiency's full potential to enhance energy security, create jobs, increase living standards, cut energy bills and reduce emissions.



Achieving more ambitious action on energy efficiency

Based on the IEA's analysis of best practices and the work of the Global Commission for Urgent Action on Energy Efficiency, the following ten strategic principles can help guide policymakers to enhance and expand their energy efficiency policies and programmes, and to accelerate energy efficiency gains through new and stronger policy.

1. Prioritise cross-cutting energy efficiency action for its economic, social and environmental benefits: A stronger, all-of-government policy focus will enhance social and economic development, energy security and resilience, decarbonisation, and rapid job creation and economic stimulus.

2. Act to unlock efficiency's job creation potential: Energy efficiency can quickly deliver job growth and can become a long-term, sustainable employment sector.

3. Create greater demand for energy efficiency solutions: Efficiency action will be most rapidly scaled up through a focus on increasing demand for efficient products and services and enabling greater levels of market activity.

4. Focus on finance in the wider context of scaling up action: Mobilising finance is an essential element of efficiency action, and policies to do so will be most effective if they are part of a wide, coherent approach to driving market scale.

5. Leverage digital innovation to enhance system-wide efficiency: Policymakers can take advantage of digital innovation's potential to enable smart control, better energy management, and wider energy system optimisation.

6. The public sector should lead by example: Governments should lead through investment in public sector efficiency and driving innovation and higher standards throughout its reach.

7. Engage all parts of society: Implementation of efficiency action can happen at all levels of society, with cities, businesses, and local communities all playing a particularly important role in its success.

8. Leverage behavioural insights for more effective policy: People are at the centre of energy efficiency action, and insights from behavioural science can help design smarter policies.

9. Strengthen international collaboration: International collaboration and exchange of best practice allow countries to learn from each other and to harmonise approaches and standards where appropriate.

10. Raise global energy efficiency ambition: Governments should be significantly more ambitious in both the short- and long-term when setting their efficiency targets, policies and actions.

Energy Efficiency Obligation Schemes

An Energy Efficiency Obligation (EEO) scheme is a regulatory requirement for energy utilities or suppliers to achieve energy savings by improving efficiency, such as funding efficient heating and insulation for consumers. EEOs can also support objectives like demand flexibility and aid vulnerable consumers. While energy efficiency grants are a direct government cost, EEOs shift these costs to obligated companies, distributing them across household energy bills, making them beneficial for countries with limited fiscal capacity for direct grants.

- These EEO schemes share three key features: a quantitative target for energy efficiency improvement; obligated parties that must meet the target; and a system that defines the energy-saving activities that can be implemented to meet the target.

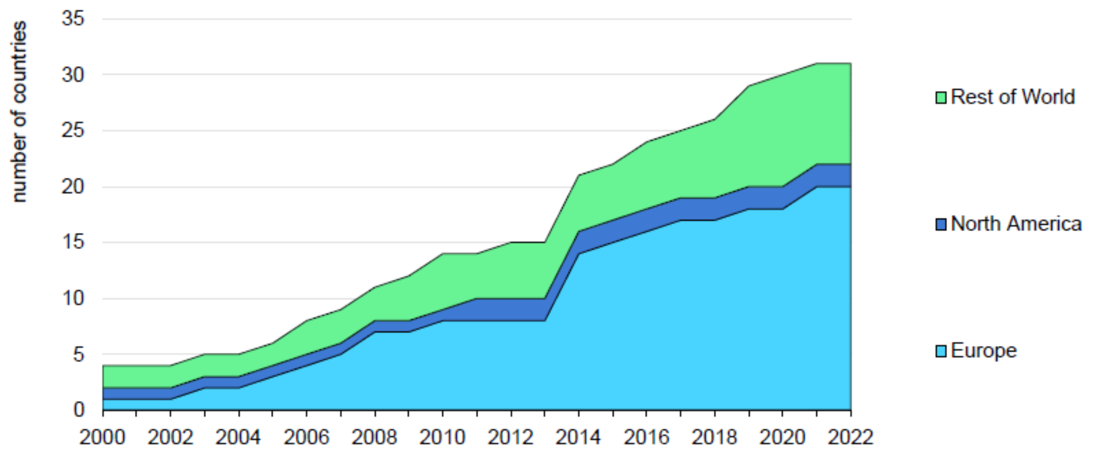
The success of an EEO scheme is based on the Obligated Party achieving or exceeding its energy saving targets. This is a cyclical process with target and reporting phases, generally running for 3 to 4 years.

This approach enables policymakers to periodically assess and adjust targets to align with high-level objectives and respond to unanticipated events.

Globally, over 31 countries have some form of EEO in place; they vary in scope, focus, and design, and the number of schemes has grown steadily over the last 20 years.

Figura S3: Number of countries with active Energy Efficiency Obligation schemes, 2000-2022

Fonte: IEA (2023)



EEOs are market-based instruments allowing Obligated Parties to determine how to achieve set energy or emissions targets. Some EEO schemes use "white certificates," which certify specific energy or emissions reductions and are tradable between over- and under-performers, tied to an obligation for achieving savings targets.

How to implement EEO schemmes and policy examples

The main components of an EEO scheme include an adequate legal framework, scheme administration (institutional structures and capacity, operational methodologies) and obligated party delivery models (delivery mechanisms, funding/financing products, methodologies, organisational strategies). EEO structures vary widely from one jurisdiction to another and can be adapted to local circumstances.

- EEOs are adaptable tools in terms of scope, fuel, and target setting – however, it is important to know what the objective is (e.g. reducing emissions, lowering energy consumption, minimising peak demand, etc.) to target the scheme appropriately.
- The costs are borne by the utility, which also bears the risk from operations and potentially missed targets. This can make EEOs a low-risk and low-cost tool for governments.

Energy Efficiency Obligation Schemes can incorporate requirements to support specific target groups (e.g. vulnerable households). **France's White Certificate Scheme and Obligation** has been running since 2006 and has been updated several times since then to include more sectors and revise targets. Since 2016, a new obligation has been introduced to ensure a minimum number of white certificates is achieved from actions implemented among low-income households. During 2022-2025, more than 3,000 certificates were issued, accounting for more than one-third of the white certificates targeting low-income households. A significant change of the definition has been in force since 2022, to better focus the 'energy poverty' white certificates on the very-low-income households.

EEO can also incorporate peak-load reduction targets, thereby improving energy security and lowering energy prices. **In the Australian province of New South Wales, an Energy Savings Scheme** has been in place since 2009, seeking to deliver the lowest-cost primary energy savings. This scheme has been regularly reviewed and updated to set more ambitious targets. As of 2025, there is also an **EEO Peak Demand Reduction Scheme**, which is more targeted and aims to deliver the lowest-cost electricity savings during a specified summer peak demand period (between 2:30 p.m. and 8:30 p.m.).

Various EEOs have also been used to enhance energy efficiency in large, energy-intensive industries. **In India, the Perform, Achieve and Trade scheme (PAT)**, has successfully delivered cumulative energy savings of about 25.77 MTOE (surpassing the target of 22.63 MTOE) in the large-scale energy intensive industries from 2012-2023.

One of the most essential elements of a successful EEO is a robust monitoring and verification framework. Policymakers will need to be able to evaluate whether the energy-saving measures were actually undertaken as reported. Calculations of energy savings are often done through estimations based on a pre-agreed formula rather than measured data, as this is simpler and cheaper to administer.

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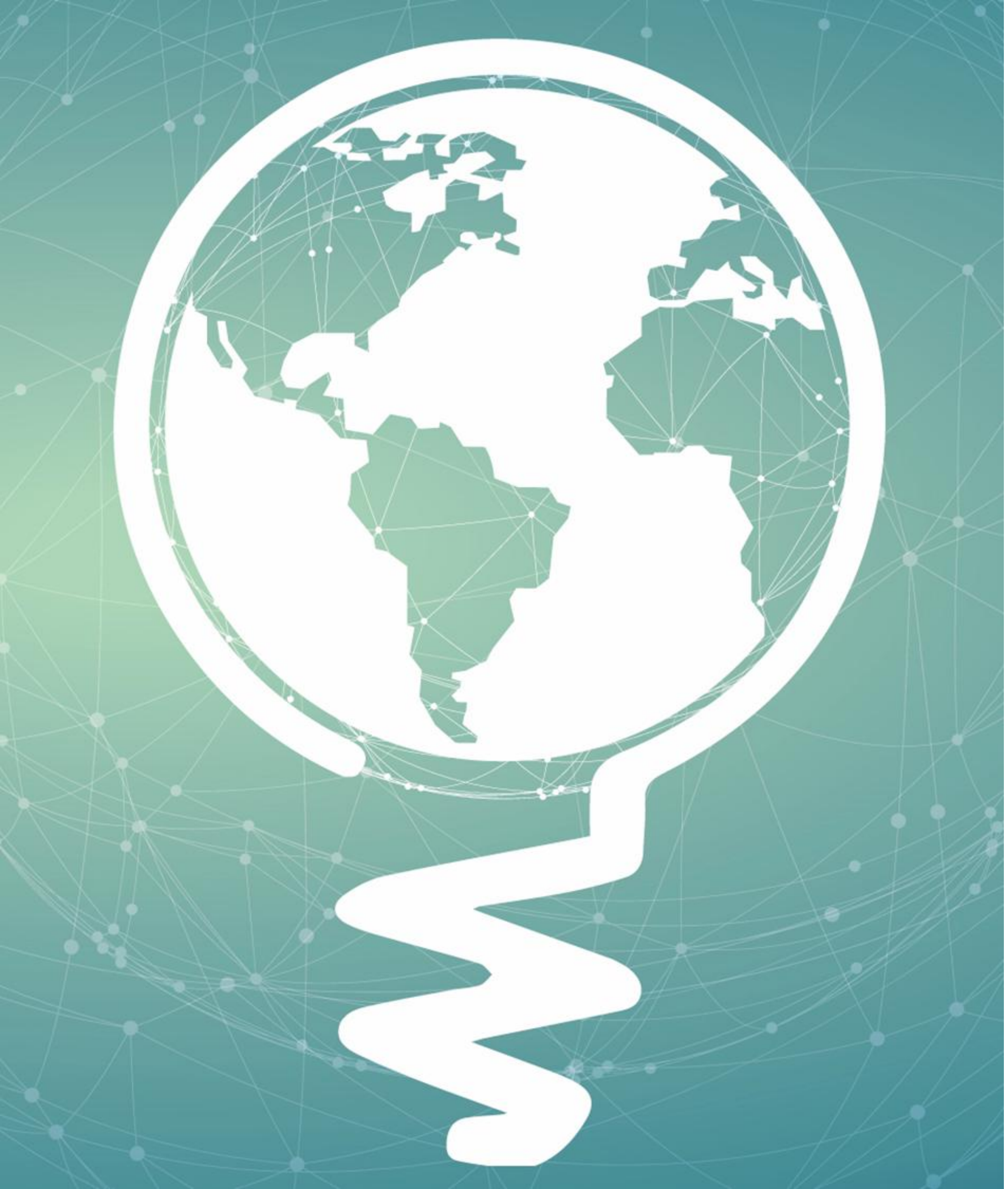

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