Residential Electricity Consumption by Income Classes

This study highlights the existence and increase of inequality in access to electricity by households from different income classes in Brazil in recent years.

Produced by: epe

Planning the expansion of a country's energy supply requires identifying and understanding the energy consumption patterns of the different producing segments and families. Therefore, understanding the residential sector's energy demand disaggregated by income classes can contribute significantly to improving energy planning and forecasting models, and designing better-targeted public policies.

Electricity consumption in the Brazilian residential sector reflects the great socioeconomic inequality that has historically marked the country in regional terms and by income class. Annual per capita consumption ranges from 371 kWh (equivalent to residential consumption per capita in Morocco) for the lowest income class to 2,221 kWh (equivalent to residential consumption per capita in Japan) for the highest income class in 2019 (Figure 1). Concerning the concentration of electricity consumption by income classes in 2019, the four lowest income classes (up to 5 minimum wages), which together represented around 78% of national households, were responsible for 58% of residential electricity demand; while the three highest income classes (more than 5 minimum wages), which together represented around 22% of national households, were responsible for 42% of residential electricity demand (Figure 3).

Figure 1. Annual Per capita Electricity Consumption (in kWh) of the Brazilian Residential Sector by Income Classes and Home Appliances in 2019.

Figure 2: Distribution of Households by Income Classes in Brazil from 2005 to 2019.

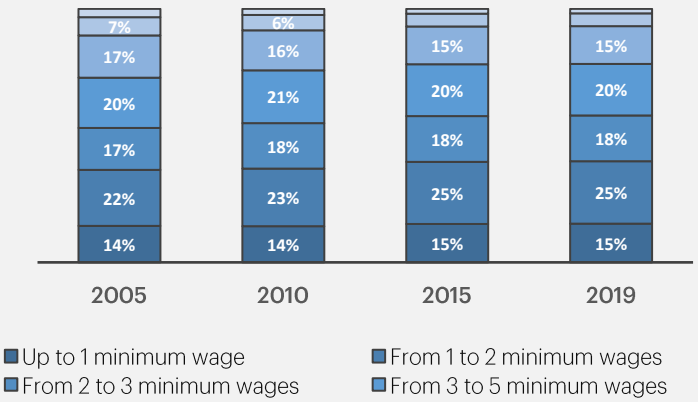
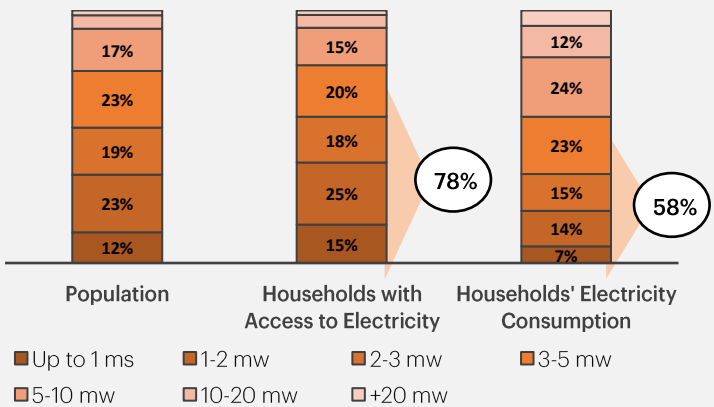


Figure 3: Distribution of Population, Households and Electricity Consumption by Income Classes in Brazil in 2019.



Note: By mw, please interpret it as "minimum wage(s)". In January 2019, the Brazilian minimum wage was BR$ 998, equivalent to US$ 273.

Figure 4: Electricity Consumption (TWh)* of Home Appliances by Income Classes in Brazil in 2019

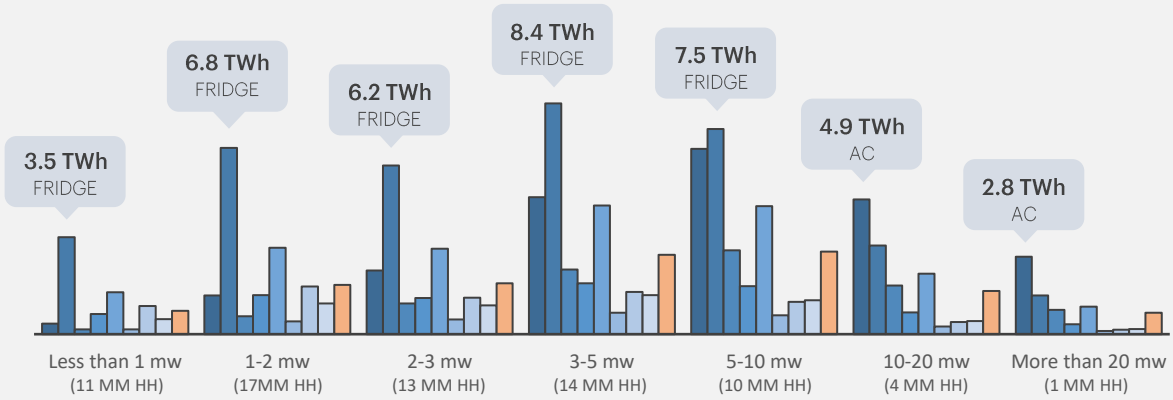


Figure 5: Electricity Consumption (TWh)* of Home Appliances by Income Deciles in Brazil in 2019

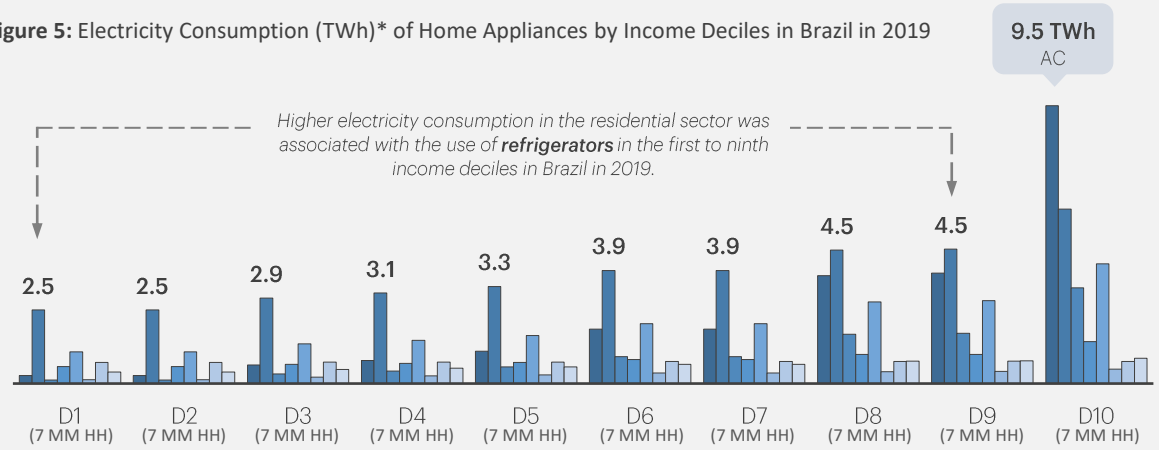


Figure 4 shows that residential electricity demand is concentrated in the middle-income classes (between 3 and 10 minimum wages) due to the joint effect of specific consumption per appliance and the number of equipment concentrated in each income class, influenced by the number of households. Removing the "income class size" effect due to the application of the desegregation technique by deciles, Figure 5 shows a significatively higher electricity demand in the highest income decile. As an illustration, air conditioners in households belonging to the highest income decile (D10) were responsible for a greater demand than the sum of the electricity consumption of all air conditioners in the first seven income deciles (D1 to D7) in 2019.

*Absolute value influenced by per capita consumption and the number of people in each income decile. **MM HH = million(s) household(s)

HOW TO MEASURE THE INEQUALITY IN THE DISTRIBUTION OF RESIDENTIAL ELECTRICITY CONSUMPTION BY INCOME CLASSES?

In order to have an additional indicator to measure the annual evolution of inequality in electricity consumption by income classes in the period from 2005 to 2019, the Residential Electricity Consumption Gini Index (REC Gini) was calculated from the curves of Lorentz for each year, obtained by ranking the residents of households of each income decile by their corresponding annual per capita consumption. The REC Gini can vary from 0 to 1, with 0 equaling the absence of inequality and 1 equaling the maximum concentration in the distribution of electricity consumption among households. The REC Gini, which had decreased from 2005 to 2014, reversed its trajectory and increased from 2015 to 2019. This change in the trajectory of the REC Gini can be explained by the national economic situation, as well as by the increase in the price of electricity due to water scarcity in 2014 and the introduction of the electricity tariff flag system.

Figure 6: Brazilian Residential Electricity Consumption Lorenz Curve in 2019.

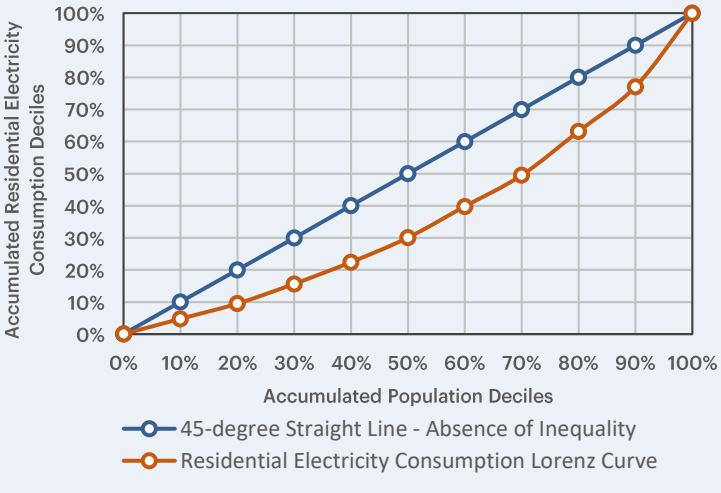
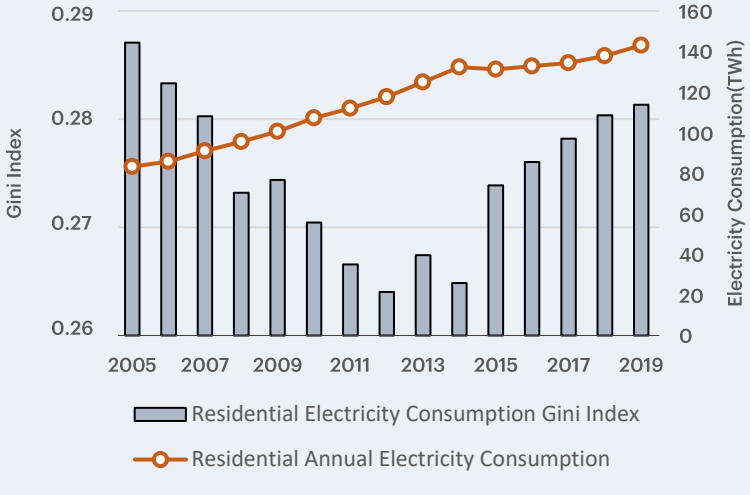


Figure 7: Evolution of the Residential Electricity Consumption, and the Residential Electricity Consumption Gini Index in Brazil



TAKEAWAYS AND POLICY RECOMMENDATIONS

Inequality in income distribution is reflected in the households' electricity consumption patterns from different income classes. Economic and social restrictions explain the heterogeneity of electricity consumption patterns between income groups. The reality of a family that survives on up to a monthly minimum wage is very different from one whose income is greater than twenty minimum wages, as illustrated in Figures 4 and 5 and Table 1.

The heterogeneity of per capita electricity consumption can be explained by the contrasts in ownership of electrical and electronic appliances and in the usage habit and power of these devices. Regarding the appliances' ownership, refrigerators – considered the main appliance for food conservation in households – had an average ownership of about 1.02 equipment/household in the country in 2019, with values ranging from 0.96 for the lower income class (households earning up to 1 minimum wage per month) to 1.25 for the higher income class (households earning more than 20 minimum wages per month). In contrast, for air conditioners, whose ownership was only 0.18 equipment per household in Brazil in 2019, the discrepancy in ownership was even greater among the income classes - it ranged from 0.04 to 0.83.

The heterogeneity of electricity consumption patterns presented in the residential sector leads to the conclusion that there is a potential demand for energy services, that can be adequately met in the coming years with the improvement of Brazilian households' socioeconomic conditions and with the implementation of targeted subsidy programs for low-income households and energy efficiency programs that encourage the conscious and rational consumption of electricity.

For energy efficiency policies to be more effective, they must focus on appliances with price levels compatible with the income classes that concentrate most of Brazilian residential electricity consumption (Figures 4 and 5). In a scenario in which an evolution of income with better distribution is expected in the coming years, energy efficiency actions become particularly relevant for energy planning once purchasing power gains for lower-income households tend to lead to an increase in energy demand (due to the purchase of new and more powerful appliances, and more intense usage habits). In addition, monitoring the Residential Electricity Consumption Gini Index (REC Gini) is an interesting mechanism to be introduced in energy planning in developing countries to assess the results of energy policies focused on social inclusion and sustainable development.

Table 1: Participation of Final Uses in Residential Electricity Consumption by Income Classes in Brazil in 2019.

Final Uses	Income Classes						
	Up to 1 mw	1-2 mw	2-3 mw	3-5 mw	5-10 mw	10-20 mw	+20 mw
Cooling	10.4%	13.4%	17.2%	20.7%	24.6%	31.3%	35.4%
Lighting	7.8%	7.1%	6.3%	5.7%	5.2%	4.5%	4.1%
Laundry	2.4%	2.9%	3.3%	3.2%	2.9%	2.5%	2.4%
Food Conservation	39.0%	37.0%	35.0%	33.3%	31.3%	28.3%	26.5%
Entertainment and Communications	13.2%	11.5%	9.7%	8.2%	6.9%	5.6%	4.7%
Other Uses	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%
Water Heating	16.1%	15.6%	15.0%	14.5%	13.9%	12.5%	11.5%
Cooking	1.3%	2.3%	3.1%	3.9%	4.8%	4.7%	4.7%
Beauty and Personal Hygiene	0.4%	0.5%	0.7%	0.8%	0.9%	0.8%	0.9%
Residential Cleaning	0.0%	0.1%	0.1%	0.2%	0.3%	0.3%	0.3%
Food Preparation	0.4%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

This document is the result of the joint evaluation of the Survey of Possession and Habits of Use of Electrical Appliances in the Residential Sector (PPH), released by the Brazilian National Electric Energy Conservation Program – (PROCEL/Eletrobras) in 2019, the Household Budget Surveys (POF), released by the Brazilian Institute of Geography and Statistics (IBGE) in 2019, and the annual Household Sample Surveys (PNAD/IBGE). Those surveys are essential to enable a better calibration of the EPE's Residential Sector Energy Demand Projection Model (MSR), providing increasingly consistent results for future projections. For more information on the methodology used, access the Technical Note published by EPE on its website in 2021 (only in Portuguese).

Residential Sector Energy Demand Projection Model

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Note: The icons used in this edition were obtained from the platform www.flaticon.com .

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