

Evolution of the Brazilian residential carbon footprint based on direct energy consumption



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ABSTRACT

As one of the leading nations on climate negotiations, Brazil has to go beyond its voluntary commitment to reduce its carbon footprint and become a more constructive and less low-key player in the UNFCCC negotiations. In this context, the study's main objective was to evaluate the Brazilian residential energy consumption, its regional specificity, and the related carbon emissions. The results show that the poor coming out of poverty affects the size of the increase in energy demand. Especially in the case of carbon emission from direct energy consumption for cooking, in which as the poor come out of poverty their demand for high efficiency energy carriers increases leading to lower emissions or *vice versa*. Also, the results show that the country must ratifies its commitments to the global efforts to combat climate change not only by elaborating but also by conducting more ambitious initiatives to reduce carbon emissions from its own territory.

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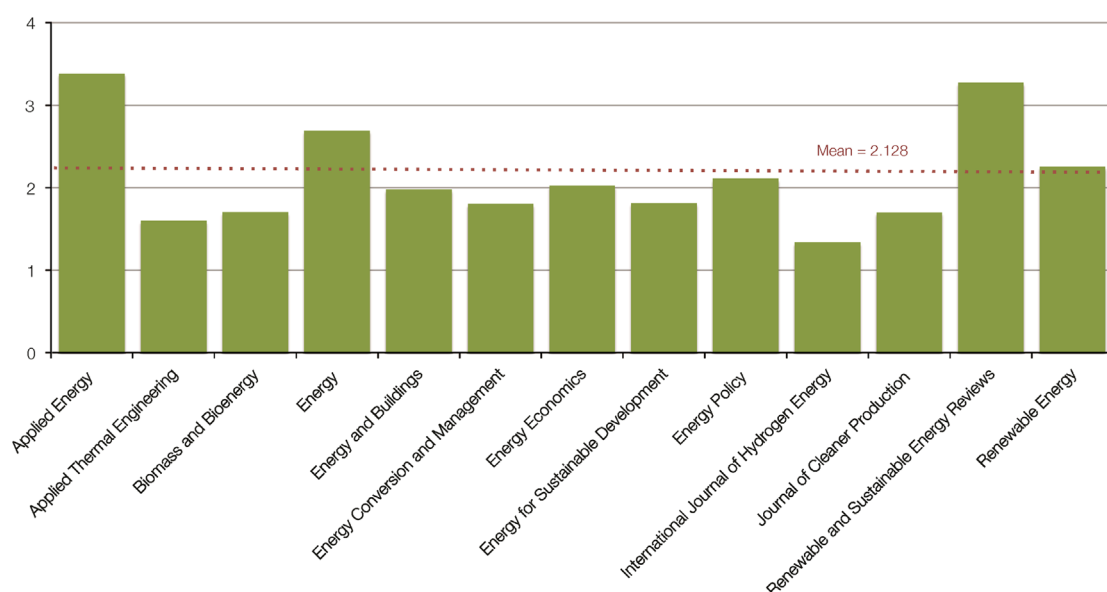
1. Introduction

As one of the leading nations on climate negotiations, Brazil has committed voluntarily to reduce its carbon footprint by a value between 36 and 39 percent until 2020 [1,2]. In 2013, the overall

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Brazilian carbon footprint has, on the one hand, already decreased by 41 percent since 2005 due to strong political will on reducing deforestation and, consequently, carbon emissions from land use change. On the other hand, recent figures show an increase in carbon emissions of the energy sector despite its large share of hydroelectricity in the Brazilian energy matrix and the large use of ethanol as fuel in transportation. The sector's carbon footprint increased about 36 percent in the same period [3]. Direct causes of this increment are the use of fossil fuel-based thermoelectric



Source: Prepared by the authors based on data from ScienceDirect (2015) and SJR (2015)

Fig. 1. The SJR impact factor of selected publication titles.

power plants to guarantee the rising electricity demand and the growth in gasoline consumption due to governmental indirect control on ethanol prices¹ during the last years [4,5].

Looking exclusively at the residential sector from 2000 to 2013, it represents a small share of the overall carbon footprint. Yet, its energy requirements are steadfast increasing due to the recent socioeconomic development in the country. In fact, electricity consumption has double since 2005 [6–10]. Therefore, reliable information about consumption patterns of households and the underlying driving forces behind these very patterns are a helpful evidence for policymakers to grasp the effectiveness of strategies planning the energy sector development, specifically in a vast country such as Brazil in which socioeconomic differences among geographic regions are still present despite recent improvements. For example, the Southeast region – which is the most developed and populated region of the country – consumed about 44 percent of the total energy supplied to the residential sector in 2013, while the North region – in which the Amazon forest is located – consumed only seven percent [6–10]. Therefore, the main objective is to evaluate the Brazilian residential energy consumption, its regional specificity, and the related carbon emissions so as to understand the evolution of consumption patterns and its potential future impacts in the country.

In order to deal with regional complexity, this study includes all energy directly used by homes and related carbon emissions at local level for each one of the five geographic regions in the country. It is important to mention that the direct energy consumption approach does not consider energy used for transportation by people living in these homes and the embodied energy in all non-energy goods and services consumed by them.

1.1. Literature review and analytical approach

The literature review was driven by archival research method, in which the process of analysis comprises the following steps [11]:

- *Defining the database source:* for this analysis the chosen database was the *ScienceDirect*, which is the world's leading platform for high quality peer-reviewed journals and full-text books. The Anglo-Dutch publisher Elsevier operates the database and it is a platform for access to nearly 2500 academic journals and over 26,000 books.
- *Delimitation of scope:* the range of 14 years delimits our research. The material collection was conducted between the years 2000 and 2014.
- *Defining unit of analysis:* the analytical unit chosen was a single research paper in English language published in top international journals with energy as the subject area.
- *Classification context:* during the classification steps, we defined three analytical samples. For example, the first sample was defined by selecting the following terms and Boolean connectors, “residential” OR “household” AND “energy” AND “emission”. The second sample contained the highest ranked publications in a given subject area. Finally, the third sample used search filters focused on two topics: “energy consumption” and “CO₂ emissions”.

The first sample contained 21,576 published papers in high quality peer-reviewed journals between 2000 and 2014, from which, the analytical process selected 9500 research papers based on the *SCImago Journal Rank* (SJR indicator). SJR indicator is a measure of scientific influence of academic journals that accounts for both the number of citations received by a journal and the importance or prestige of the journals where such citations come from. Hence, the second sample contained research papers from publication titles with high SJR indicator in energy as the subject area. The requirement was that all selected publication titles must be classified as Q1, which means the highest values or the top 25 percent journals in a given subject area. Fig. 1 shows the selected publication titles and their SJR impact factors.

¹ In 2011, that became a competitive issue for ethanol producers when the Brazilian government set price caps for gasoline sold by Petrobras in an effort to control inflation. Since then, 47 ethanol mills were forced to close and 70 others are under bankruptcy protection, according to a 2014 December report from Brazil's sugarcane trade group Unica.

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