BRAZIL IN THE ENERGY TRANSITION: OPPORTUNITIES AND CHALLENGES FOR ELECTRIFICATION OF ENERGY DEMAND

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# Overview

The energy transition, as a global process of change in the energy system towards decarbonization, seeks solutions to reduce the intensive use of fossil fuels, in favor of renewable energy sources, and to boost the efficient use of energy, including forms of storage. Among the various strategies to face the energy transition, the electrification of energy demand stands out. When associated with the supply of renewable electricity, it can promote the effective replacement of fossil fuels. According to IRENA (2023), this strategy alone could contribute for 19% of the decarbonization to achieve of the net zero in 2050.

This study aim is to analyze the Brazilian indicative 10-year energy plan, in order to identify opportunities and challenges for the electrification of energy demand. This work will specifically analyze actions related to the strategy of energy demand electrification. The choice of the approach is justified not only by the need to address a highly complex issue, but also by the relevance of the electricity sector in the context of the energy transition and by the urgency of the analysis approach from the perspective of demand. After all, the energy transition requires changes on the supply side as well as on the demand side (IRENA, 2023).

Therefore, this work intends to contribute to monitoring the progress of actions in the Brazilian electricity sector in the context of the energy transition, based on the identification of relevant themes for the alignment of national energy planning with the global goal of decarbonization.

**Methods**

The analysis of the alignment of Brazilian energy planning with the global goals for energy transition was carried out by comparing official national data with performance indicators planned for the G20 countries and for the world average by the International Renewable Energy Agency (IRENA), published in the World *Energy Transitions Outlook* 2023 report (IRENA, 2023). This document monitors the key performance indicators (KPI) of the energy transition in relation to the global goals for 2030 and 2050, based on the 1.5ºC scenario recommended by the UN International Panel on Climate Change. In the case of Brazil, the Ten-Year Energy Expansion Plan for 2031, published by the Energy Research Company (EPE, MME, 2022), was used as a reference.

The comparison was made, first, based on the analysis of the KPIs evaluated by IRENA. Among six monitored KPIs, five are related to the strategy of electrifying energy demand, directly or indirectly. For these, the data of the world average, of the G20 countries and of Brazil were compared. Subsequently, the KPIs were broken down into other performance indicators, organized into 8 groups of indicators.

Then, the indicative planning scenarios of the three countries/regions (Brazil, world average and G20 countries) were compared, by the analysis of 16 progress indicators related to the electrification of energy demand.

To assess whether the planning of each country/regions is on track or not to achieve the goals of the 1.5ºC scenario, a scale of performance ranges was applied, in which superior performance is equal to or greater than the achievement of 90% of the goal, average performance means being between 50% and 90% of the goal achievement and inferior means performance less than 50% of the goal. For the Brazilian case, the G20 targets were considered, except for the indicators that do not present specific targets for the G20 countries in the reference document. In these cases, the goals of the world average were used.

Finally, the findings identified in the analysis of indicators were summarized using the 5W2H methodology and SWOT matrix, in order to systematize the opportunities for Brazil in the implementation of the strategy for electrification of energy demand.

# Results

The analysis has shown that the renewable sources in the energy matrix exceed the target of the 1.5ºC scenario in Brazilian energy plan. However, the penetration of electricity in total energy consumption is low, with insufficient increase expected. Although Brazil has a renewable electricity matrix, there are challenges in installed capacity and in the expansion of intermittent sources. The electricity sector's dependence on hydroelectricity may represent vulnerabilities in the face of climate change. In addition, the country's indicative planning points to a reduction in the share of renewable energy in the installed capacity for electricity, which contradicts the global trend.

The analysis also considered indicators related to demand, including the industrial, buildings, transportation and H2V production sectors. In the industrial sector, Brazil has a high share of renewable energy and planned energy performance compatible with the target for 2030. In the area of buildings, the share of renewable energy exceeds the targets of the 1.5°C scenario, with plans to increase electrification aligned with the energy transition. In transport, the share of biofuels is remarkable, but electrification falls short of global targets. Regarding H2V production, despite the recognized potential, there is no comparative data available for Brazil. H2V production costs in Brazil are lower than the international market average, which can influence the demand for electricity and offer alternatives for renewable energy generation in the country.

The strategy of electrification of energy demand in Brazil is timely due to the predominance of renewables in electricity matrix, which can contribute to the decarbonization of various sectors of the economy. However, it is crucial to increase the share of electricity in energy end-use to meet the 1.5°C scenario targets. While Brazil already uses electricity in most buildings, in the transport sector, electrification will focus only on light vehicles and public transport, while biofuels and H2V are alternatives for heavy loads. The industry sector and the H2V production present significant opportunities for electrification, with the potential to boost national competitiveness and lead the global renewable energy market.

**Conclusions**

The electrification of energy demand is a crucial strategy in the energy transition and can contribute significantly to the decarbonization of the energy sector by 2050. In the Brazilian context, this transition offers vast business opportunities, expanding the electricity market and promoting the development of a new production chain for green hydrogen and its derivatives.

The analysis revealed that the greatest opportunity for electrification of energy demand in Brazil is in the industrial sector. This can be achieved both through direct electrification in industrial production processes that operate at low temperatures, and through indirect electrification, through the introduction of H2V and its derivatives in production processes that operate at high temperatures. There is also a huge opportunity to amplify the use of electricity applied to H2V production, which can be used not only in the industrial sector, but also in the heavy transport sector and for energy storage and export.

It was observed that the current context positions Brazil in an advantageous way in the global market. However, several challenges need to be overcome, such as directing investments in R&D+I and electrical infrastructure. Additionally, it is essential to promote integrated and secure regulatory policies to attract significant investment.

As an active stakeholder in the global energy transition, Brazil needs to act efficiently and assertively and reassess its energy strategy to position itself as a protagonist, to join to the energy transition more effectively.

Finally, it should be noted that the indicative planning of the Brazilian energy sector through the Ten-Year Energy Plan does not adequately reflect the challenges to achieve the goals of net zero emissions in 2050. The country's energy planning needs to work on a national energy transition plan, which aligns the country's energy trajectories with the targets of the national Nationally Determined Contributions (NDCs).

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