



ENERGY TRANSITION AND THE MAIN CHALLENGES FACED BY THE BRAZILIAN INSTITUTIONS

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ABSTRACT

Energy transition represents a global movement aimed at addressing climate change and reducing greenhouse gas emissions (GHG). Brazilian institutions are currently facing numerous challenges in implementing the actions and plans outlined in the regulatory framework. Despite boasting one of the world's most sustainable energy matrices, Brazil is still in the process of deliberating decisions that would enhance the effectiveness of climate change mitigation, a matter currently under discussion in Congress. This paper aims to present the primary institutional challenges and the regulatory framework, shedding light on the delays in making decisions related to the energy transition. The methodology employed in this study draws from academic articles and studies conducted by experts in the field. The findings reveal that protracted discussions and conflicts of interest have hindered Brazil's active participation in the global discourse and delayed decisions in line with other countries, such as those in Europe and the United States. The difficulty in handling discussions in the Brazilian arena – including Congress, energy associations, and other institutions dealing with the theme – hampers national decisions, distancing them from reaching a conclusion.

Keywords: sustainability, energy transition, climate changes, regulatory framework,

Introduction

The energy transition refers to a fundamental change in the global energy system, seeking to replace non-renewable, highly polluting, and exhaustible energy sources, such as oil and coal, with renewable and cleaner sources, such as solar, wind, hydroelectric, and geothermal energy. This transition is driven by growing concern about climate change, energy security, and the need to reduce greenhouse gas emissions. In addition, the energy transition involves improving energy efficiency in all sectors, from industry to transport and infrastructure, to optimize the use of available resources and minimize the negative environmental impacts associated with energy consumption.

The energy transition is not just a technical change but also a socio-economic and political transformation. It requires the collaboration of governments, industries, research institutions, and society to establish appropriate policies, invest in innovative technologies, promote education and awareness of energy issues, and adapt consumption and production patterns. Although it is a complex challenge, the energy transition represents a crucial opportunity to build a sustainable future, with lower environmental impact, greater resilience, and greater diversification of energy sources. According to Global Greenhouse Gas Emissions 2019, China, the United States, and the European Union emit 42.6% of global emissions, while the last 100 countries on the list account for just 2.9%. Without significant action from the countries that emit the most CO₂, diversification of the world's energy matrix becomes unrealizable since it requires high investments, and most of the emissions are concentrated in just a few countries.

Theoretical reference

Brazil, as a geographically vast and ecologically diverse nation, possesses a multifaceted energy generation profile. The nation's energy generation derives from hydropower plants, manifesting as a prominent cornerstone of the country's energy matrix. Recent data from the Energy Research Company underscores this dominance, revealing that a substantial 75% of Brazil's electricity generation emanates from a combination of hydropower generation and thermal power plants [1].

Hydropower generation stands as the primary contributor to Brazil's electricity supply, emblematic of the nation's formidable hydroelectric infrastructure. However, it is noteworthy that Brazil's energy diversification efforts have been gaining momentum in recent years, reflecting global trends



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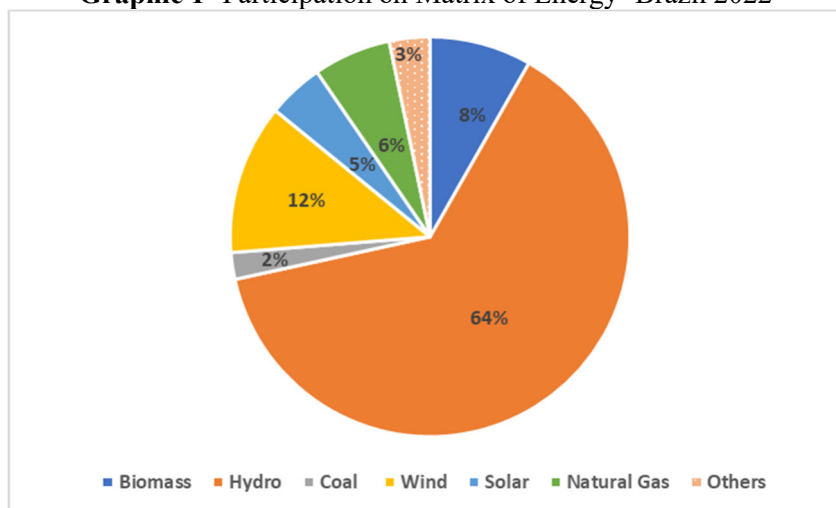
account for 2% of the nation's electricity generation, representing a growing segment in Brazil's energy portfolio. Similarly, solar power, though currently constituting a smaller fraction at 1%, demonstrates notable potential for expansion and integration within the national grid.[2]

This mosaic of energy sources within Brazil's energy matrix underscores the complexity and interplay of various technologies and resources in fulfilling the nation's energy needs. It also underscores the significance of ongoing efforts to further diversify and optimize the energy mix, with an overarching aim to enhance energy security, sustainability, and resilience in the face of evolving global energy dynamics.

A. Brazilian scenario on renewable sources on energy

Brazil is a large country with a vast diversity in energy generation. Most of the generation originates from hydropower plants. According to the Energy Enterprise on Research (EPE), 64% of the electricity generation comes from hydropower generation, 2% from thermal power plants, 2% from wind power sources, and 1% from solar. [3].

Graphic 1- Participation on Matrix of Energy- Brazil 2022



Source: Balanço Energético Nacional 2023

Despite Brazil having one of the cleanest energy matrices in the world due to its strong dependence on hydroelectric power, which has historically been the country's main source of electricity, the search for greater diversification of energy sources and concern about climate change have driven the development of other renewable technologies. Solar and wind energy have gained prominence in Brazil, driven by government incentives, technological advances, and falling production costs. Large wind farms and solar power plants have been established in various regions of the country, contributing significantly to the total energy generation capacity.

Additionally, bioenergy from agricultural and forestry waste also plays a key role in the Brazilian energy matrix, being used to produce biofuels and generate electricity. Despite the progress, Brazil's energy transition faces challenges such as the need for continued investment in infrastructure and technology, adapting the electricity grid to the intermittency of renewable sources, and ensuring energy security during the transition. Public policy plays a crucial role, with the definition of renewable energy targets, tax incentives, and regulations that encourage the adoption of clean technologies.[4]

These challenges will be discussed in the next topic.



B. Main challenges and the energy transition

Brazil has one of the most sustainable energy matrices in the world. Although the challenges faced in the regulatory framework are significant, it is important to discuss the consequences for the energy transition agenda.

The effectiveness of economic growth and the energy transition is directly established by the institutions that each country has. These institutions are related to laws, decrees, decisions of the Supreme Court, and the Parliament. When a country has institutions that guarantee property rights, economic growth will occur.

When the discussion is related to climate change and the energy transition, which deals with economic and political actions that will result in a decrease in greenhouse gas emissions, the role of institutions is crucial [5].

Brazil has a robust regulatory framework that addresses climate change and energy transition; the crucial point is the effectiveness of those actions in the short and long term.

We know that to encourage investment and promote energy efficiency, a robust regulatory framework is necessary. On the other hand, it is imperative that the transition is inclusive, considering the social and economic impacts on the communities affected by the change. Training skilled labor and promoting environmental education are pillars for a successful transformation. [6], [7].

According to the IRENA outlook, to reach the 1.5°C Scenario, it will require an investment of USD 5.7 trillion per year until 2030, including a redirection of investments of USD 0.7 trillion per year from fossil fuels to energy transition technologies. Most of these funds will come from the private sector and the public sector. These investments are important to achieve the goals of the energy transition. The IRENA outlook lists the main paths and actions to decrease greenhouse gas emissions with the support of social and economic policies [8]

I. Decarbonization uses advanced technology and many solutions that provide electrification, green hydrogen, and other renewable sources.

Despite the increasing use of other energy solutions and renewable technology, the regulatory framework must incentivize, in both the long and short term, the use and development of these sources. Any effort toward decarbonization will result in the reduction of greenhouse gas emissions in the future.

To reach the climate targets, it is important to consider actions that will reduce energy dependence on fossil resources and replace carbon-based infrastructure and industries. This requires substantial investments and overcoming economic interests between countries.

The attractiveness of investments is crucial to achieving the purposes previously established in the regulatory framework.[8]

II. Economic growth target and decarbonization decisions must be aligned toward the national goals.

Energy stability can conflict with emission reduction goals due to internal pressures to maintain economic growth. At the same time, external pressure from climate agreements, such as the Paris Agreement, encourages the adoption of more ambitious mitigation targets and the acceleration of the energy transition.[8].

It should also be noted that international cooperation plays a key role in this process, seeking partnerships between the largest emitting countries and nations with expertise in clean energy and green technologies. The development of clean energy technologies, such as energy storage, carbon capture and storage, and green hydrogen, offers countries the opportunity to diversify their energy sources while reducing their carbon emissions.



III. The attractiveness of investments for the energy transition agenda is necessary, and the economic sectors must be included in the strategic plans.

In the context of energy planning, strategies are gaining increasing relevance as governments formulate policies, programs and financing modalities to support equitable, sustainable and just energy transitions on a global scale.[8]

In all perspectives of community energy transition scenarios, ensuring adequate physical, human and financial resources remains an essential element for enabling local economic growth. For example, communities that have abundant and high-quality access to housing, as well as high-speed internet connectivity, will be in a better position to cope with energy-related economic changes, especially in rural regions. Access to capital and financial services emerges as an additional component for sustaining and diversifying economies, especially those in the midst of transition.

C. The Brazilian framework and its influence on energy transition

To fulfill the 1.5°C Scenario, it is expected that the electricity sector will be decarbonized by mid-century. To accelerate the use of these sources, it will be necessary to deploy all forms of renewable energy technologies for generating purposes, including wind (onshore and offshore), solar photovoltaic (PV), concentrated solar power (CSP), hydropower, biomass, geothermal energy, and ocean-based (tidal) energy. According to the IRENA outlook report, it is expected that wind and solar PV will lead the transformation, supplying 42% of total electricity generation by 2030 (up from just over 10% today).[8]

Whether or not the goals will be reached, the regulatory framework plays a significant role in the energy transition plan.

Brazil has extensive regulations that have ensured the increasing use of renewable sources since the 2000s. Table 1 shows each regulation and the main points considered to accelerate the path toward the energy transition.

Table 1 – Brazilian Regulation on energy Transition

Law no 9.478/1997	Deals with a National Energetic Policy and creates the National energy policy and National Agency of Fuel Fossils (ANP)
Decree no 5025/2004 – PROINFA Program to Incentive Renewable sources	Incentives the use and generation of energy by using renewables energy resources- biomass, solar, wind power, small hydropower plants (PCHs)
Law no 12.187/2009	Creates the National Policy of Climate change (PNMC). The purpose of this regulatory framework is to rule the actions that will impact the climate change and the economic development and social system
Law 12.490/2011	Deals with the rules of inspection of the activities related to national supply of fossil fuels. and the emissions of GEE

Source: Elaborated by authors (2023)

In Brazil, the regulatory framework is consistent and encompasses a considerable focus on energy. Despite recent high growth rates, even faster deployment of renewable capacity will be needed.

Brazil has a dense and robust regulatory framework. Although internal actions toward the energy transition have been proceeding at a slow pace, the discussions and conflicts of interests have compromised the effectiveness of the results. The role of the institutions is crucial to speed up those actions toward the energy transition. The decisions took in the past are being effective nowadays but the geopolitical scenery requests actions that result in the decreasing of the GEE emissions urgently.



The conflict of interests and the complexity of the actions in a continental country like ours the role of the institutions will play a significant role in a chaotic and devastated environment scenery.

In other words, the decarbonization program is a complex agenda that requires investments and the construction of specific infrastructure in some sectors to advance the energy transition agenda. A 1.5°C Scenario-compatible climate pathway calls for a scaling up of investment from USD 35 trillion under the PES to USD 5.7 trillion under the 1.5°C Scenario between 2021 and 2030.[8]

Conclusions and results

In order to achieve the objectives of energy transition, it is imperative that investments are not only substantial but also effectively utilized. According to the IRENA (International Renewable Energy Agency) outlook, the 1.5°C Scenario necessitates an annual investment of USD 5.7 trillion until 2030, which includes a redirection of funds from fossil fuel industries to energy transition technologies, amounting to USD 0.7 trillion per year. Both short-term and long-term investments have been made by Europe and other nations, with projected expenditures of USD 1 trillion to embrace this agenda by 2050. In addition to curbing greenhouse gas emissions, this transformation entails a comprehensive infrastructure overhaul, encompassing urban transport electrification, the substitution of fossil fuels with renewable sources, and an expanded deployment of energy-efficient technologies. [8].

Conversely, initiatives aimed at addressing the following key pillars include:

- Augmenting electricity generation from renewable sources.
- Increasing the proportion of renewable energy in the overall final energy consumption.
- Accelerating improvements in energy conservation and efficiency.
- Expanding the role of direct electricity in the total final energy consumption.
- Elevating the production of clean hydrogen and its derivative fuels.
- Enhancing the capture of CO₂ through carbon capture and storage (CCS), bioenergy with CCS, and other carbon removal and storage measures.

While Brazil must tailor its approach to the unique nuances of its reality, achieving alignment and coordination across all levels of governance (federal, state, and local) is imperative. As emphasized by Nobel Prize laureate, institutions play a pivotal role in advancing economic development. In today's context, the environmental agenda holds significant importance, and the impact of the aforementioned actions outlined in this agenda will reverberate within the ambit of energy transition. These challenges must be duly acknowledged and addressed to attain higher levels of development.

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