A new basis for the Brazilian electrical system: diversification of the renewable energy matrix

BY ALDREN VERNERSBACH

Introduction

The Electrical Industry of Brazil forms one of the largest electrical systems in the world[1], bringing together the segments of generation, transmission and distribution of energy in a wide unified and branched network. The institutional model designed in its conception originated an industrial organization based on the State's monopoly on generation and transmission activities, with permission for private companies to do the distribution.

The model of "dominant State" was justified by the need for national coordination to (i) manage energy flows in a regionally distinct territory; (ii) ensuring sufficient energy for an economy with strong growth and urbanization; (iii) and preserve the rational use of the country's energy sources. Subsequently, in the context of the State's fiscal crisis in the 1990s and with the intention of technologically updating the sector, an open market was established, implementing a new institutional model, with competition and concessions through auctions in each segment. To maintain control of the system, the National System Operator (ONS) and the National Electric Energy Agency (ANEEL), the sector's regulatory body, were created.

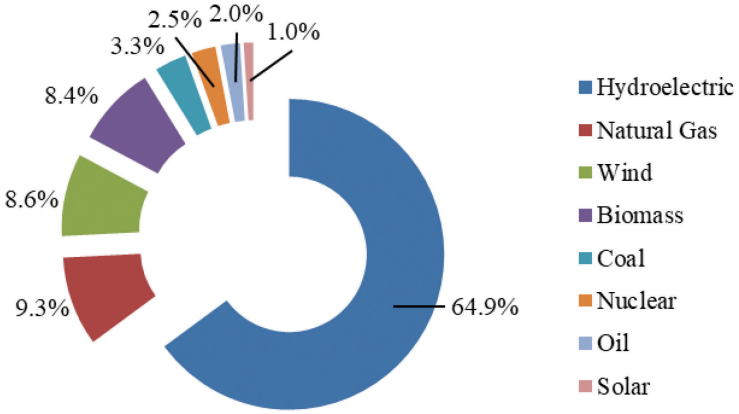
The shape of Brazil's electrical system is a globally successful case, as it supports immense demand and takes advantage of electricity generation across the country, ensuring unified supply. However, the concentration of generation in an intermittent source of energy – hydroelectric – has provided an oscillating supply, increasing the cost of electricity. The supply of energy is complemented by the thermoelectric park, whose infrastructure is costly, which contributes to the increase in electricity. Therefore, the Brazilian electrical system produces energy with a very variable cost, which is reflected in the costs of the entire economy. This is currently a problem to be addressed in the sector, which is a global example in the generation of renewable energy.

A very peculiar system

The Brazilian electrical system has very particular characteristics, which distinguish it from other global systems. Its uniqueness stems from the complete interconnection of the entire infrastructure, encompassing its segments throughout the extensive national territory, forming a large energy network called the National Interconnected System (SIN). Thus, both in terms of supply and demand, there is total network integration, capable of supplying the country, directing electricity according to the behavior of consumption and the capacity of energy generation assets.

The other peculiarity of the Brazilian electric sector is the conception of its matrix, based on the use of abundant natural resources.

The electrical matrix was consolidated based on renewable sources, notably the hydroelectric source, responsible for 64.9% of the energy produced in the country, followed by wind with 8.6%, biomass with 8.4% and solar with 1%. Therefore, about 83% of Brazil's electric matrix is sustainable, made up of renewable sources, a unique case for the world sector[2] (EPE, 2020b).



Graph 1 - Electric Matrix of Brazil – 2019
Source: Elaboration based on EPE data (2020).

The Brazilian matrix has an inverse composition to the global matrix, whose base is formed by non-renewable sources for electricity generation.

In the global electric matrix, renewable sources account for only 22% of generation, indicating the enormous process that the electric sector still needs to execute, aiming at the decarbonization of electricity generation. The demand for electricity grows 2.1% per year and considering the scenario of declared public policies, consumption will double by 2040. Considering a scenario of application of sustainability policies, the demand for electricity will be 31% of the primary energy to be consumed (IEA, 2020a, 2020b).

In Brazil, despite the use of renewable sources, generation concentrated on the use of the country's water potential has reduced the efficiency of the system, since the risks of the hydroelectric model have kept the energy tariff at very high levels. In view

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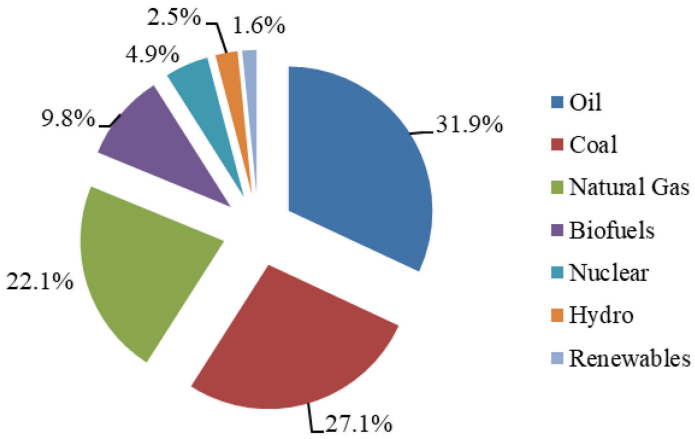
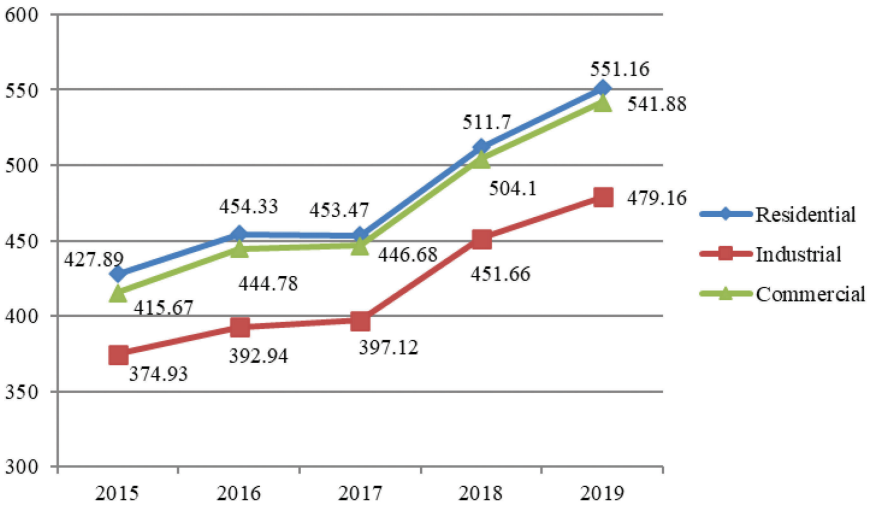


Graph 2 - Global Electrical Matrix – 2018
Source: Elaboration based on IEA data (2018).

of the increase in the use of energy in the economy, expansion of access to electricity and an increasingly deep and rapid process of electrification of economic activities, energy supply and tariffs have become an issue to be discussed urgently.



Graph 3 - Energy tariff in Brazil by segment (R$/MWh)
Source: Elaboration based on EPE data (2020).

In the last decade, the energy tariff has grown every year, indicating a gradual increase in electricity in Brazil. Analyzing the specific data, the residential tariff increased 65.3% between 2012-2019. For the industrial sector, the increase was 86.2% between 2012-2019. Water crises, with different levels of severity, have caused an increase in the electricity tariff (EPE, 2020b).

The participation of hydroelectricity in generation puts the system hostage to hydrological risk, natural to this type of model, with multi-annual regularization. The system is managed efficiently, seeking to optimize the water resources in the reservoirs, in order to minimize the cost of using thermoelectric plants. However, the alternative generation apparatus to complete the offer does not provide cheap energy. It is necessary to add a new efficient, diversified, sustainable and low-cost generator set to the system.

In this context, the energy policy for the country is faced with the need to define a new set of sources to be explored and to find ways to expand investment in the efficiency of energy use and in the digitization of microsystems. This change has become essential to maintain the energy transition and reduce the cost of electricity.

The use of the photovoltaic source is an alternative to the sector, by stimulating private investments in solar fields. However, there are regulatory hurdles and low financial incentives for large-scale expansion. The regulation applied to the generation of solar energy is still incipient and the incentives could be greater. Only the state of Minas Gerais has a policy of tax exemption and greater incentive for the creation of solar parks in its territory. The device allows the exemption from ICMS[3] to all models of shared generation, therefore, units of multiple consumers such as condominiums, consortia and cooperatives and remote self-consumption units. Exempt generating plants are those that produce up to 5 MW, which limits the benefit.

Thus, the photovoltaic sector does not achieve considerable growth compared to the others. The generation of electricity by the photovoltaic source increased 92.1% between 2018-2019 and the installed capacity was increased by 37.6%. However, investments are still small in order to create a complementary and cheap generation park.

In 2018, global production of electricity from renewable sources grew. In the case of the solar source, there was an increase of 24.3%. The energy produced from wind farms grew by 12.4%. These numbers indicate to the gradual expansion of the share of renewables in the global electrical matrix, in a diversified form (IEA, 2019).

Renewable energies are expected to account for 95% of the net increase in global energy capacity by 2025. The solar sector is expected to account for 60% of additional renewable generation capacity, and wind energy 30%. Regarding the wind sector, due to the drop in costs, generation on offshore bases is already growing, and should account for about 1/5 of the additional wind capacity (IEA, 2020c).

In the Brazilian case, the solar generation model has been developed by some companies in the country, but the high initial investment in photovoltaic technology and the tax structure discourage larger investments and long-term maturation. This set of factors hinders the expansion of the solar park in the country.

The diversification of the renewable matrix in Brazil is necessary in order to consolidate an alternative capable of counterbalancing the intermittency of the hydroelectric arrangement. In this way, it will be possible to reduce the energy tariff, which is essential,

since the cost of electricity generation corresponds to a considerable portion of the total costs of the production chains. It is worth mentioning that the hydrological risk still discourages the increase in the electrification of the economy when it becomes a cost for sustaining the sector. Therefore, diversifying the use of renewables sources to mitigate the fluctuation of the energy tariff, making electricity more accessible and cheap, is essential to economic growth.

An alternative system that ultimately guarantees the transition

Brazil's electricity system needs diversification of renewable sources to become more efficient and less costly. This diversification can also be added to a new subsystem that mitigates the general intermittency of renewable sources. In this sense, the expansion of the park of thermoelectric plants using natural gas is one of the most appropriate alternatives. Natural gas is a hydrocarbon with low emission of pollutants, reasonable energy efficiency and reduced cost.

Brazil has substantial gas reserves to make this alternative viable. The consolidation of a gas-fired thermal park can guarantee the energy security of the renewable system. Thermoelectric plants can be activated in circumstances of extreme fluctuation in generation from renewable sources already consolidated in Brazil.

In this way, a supply crisis such as the one in California is avoided, in which the cost of energy has increased, consumption has expanded and the system has not been able to support the demand for not having a sufficiently large electricity generation capacity, to supply the consumption shock. The California system did not expand its energy storage capacity and there was no planning that indicated the need for a complementary system to guarantee supply, considering the intermittency of renewable sources and the period of expansion of sustainable and low-risk electricity generation.

Conclusions

The diversification of energy generation requires a public policy that aligns economic interests with energy, environmental and social interests. To expand access to decentralized and cheaper energy, it is essential to make this objective transversal to public policies in Brazil.

The Brazilian energy policy needs to insert the new generation models in its consolidated framework of energy sources, in order to sustain the energy supply. The demand for electricity is constantly expanding, indicating that the Brazilian economic development, linked to the increase in the pattern of consumption and electrification of the economy, leads to a scenario of great demand, imposing an increase in power generation.

Making the Brazilian energy matrix more diversified is possible and necessary to reduce the electricity tariff, combined with the insertion of new renewable sources in the national electricity system. The incentive to wind and solar plants is essential to accelerate this process and allow the capacity of each source to be sufficient to meet the demand in a complementary way.

The conception of an economic regulation adequate to the new models of electric generation and the creation of incentives for the increase of renewable energy plants, are essential to form a base of devices that enable the expansion of other renewable sources of energy in the Brazilian electrical system.

References

Empresa de Pesquisa Energética (EPE). Anuário Estatístico de Energia Elétrica 2020 – Ano base 2019. Rio de Janeiro: EPE, 2020a.

Empresa de Pesquisa Energética (EPE). Balanço Energético Nacional 2020 – Relatório Final / Ano base 2019. Rio de Janeiro: EPE, 2020b.

International Energy Agency (IEA). Energy Outlook 2020. Paris: IEA, 2020a.

International Energy Agency (IEA). Electricity Information: Overview: Statistics report — July 2020b. Available from: https://www.iea.org/reports/electricity-information-overview.

International Energy Agency (IEA). Renewables 2020. Paris: IEA, 2020c. Available from: https://www.iea.org/reports/renewables-2020.

International Energy Agency (IEA). Energy Outlook 2019. Paris: IEA, 2019.

International Energy Agency (IEA). Energy Outlook 2018. Paris: IEA, 2018.

Footnotes

[1] Brazil is the seventh largest producer of electricity in the world.

[2] Data for the year 2019.

[3] ICMS is a Tax on Operations Relating to the Circulation of Goods and Provision of Interstate and Intermunicipal Transport Services and Communication.