PLANNING AND ENERGY INSECURITY IN THE BRAZILIAN ELECTRICAL MATRIX

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Abstract: Brazil is going through a moment of energy insecurity similar to what happened in the early 2000s and again the decrease in rainfall is pointed out as the main cause for the possible “blackout”, but is a “blackout” likely in the current economic context of the country? Were the decisions taken the most appropriate, considering the technical and economic aspects? This work wants to bring elements to the debate on energy planning, analyzing technical, economic and managerial aspects and their relationship with the composition and use of the Brazilian electric energy matrix. The methodology is composed of data collection and processing, with the collection carried out through bibliographic review and in statistical databases on the subject in question. Data processing showed that the increase in installed energy capacity and the internal supply of electricity were greater than the growth of population and GDP in Brazil since 1980, leaving management to answer the question of supply/demand of energy for meet the Brazilian and if the decisions taken by the managers were the most appropriate.

Keywords: Energetic Plan, Energetic Matrix, Electrical Matrix.

PLANEJAMENTO E INSEGURANÇA ENERGÉTICA NA MATRIZ ELÉTRICA BRASILEIRA

Resumo: O Brasil atravessa momento de insegurança energética semelhante ao ocorrido no início dos anos 2000 e novamente a diminuição das chuvas é apontada como principal causa para o possível “apagão”, mas é provável um “apagão” no atual contexto econômico do país? As decisões tomadas foram as mais adequadas, se considerarmos os aspectos técnicos e econômicos? Este trabalho quer trazer elementos para o debate sobre planejamento energético, analisando aspectos técnicos, econômicos e gerenciais e sua relação com a composição e uso da matriz de energia elétrica brasileira. A metodologia é composta por coleta e processamento de dados, com a coleta realizada por meio de revisão bibliográfica e em bancos de dados estatísticos sobre o tema em questão. O processamento dos dados mostrou que o aumento da capacidade instalada de energia e da oferta interna de energia elétrica foram maiores que o crescimento da população e do PIB no Brasil desde 1980, restando para a gestão a responder à questão da oferta/demanda de energia para atender a brasileira e se as decisões tomadas pelos gestores foram as mais adequadas.

Palavras-chave: Planejamento Energético, Matriz Energética, Matriz Elétrica.

1. INTRODUCTION

Brazil is going through a moment of energy insecurity similar to what happened in the early 2000s and, again, the decrease in rainfall is pointed out as the main cause for the possible blackout, without considering the consequences of the planning and decisions that were taken.

As a starting point to analyze this possibility, we have an electricity matrix composed mostly of renewable sources (78%), according to the National Energy Balance 2022 [1], but very dependent on hydropower. This protagonism of hydroelectricity, which currently generates 50% of the country's electric energy, makes the Internal Electric Energy Supply - IEES, particularly vulnerable to periods of low rainfall, when the volume of reservoirs decreases. But it is during prolonged periods of scarcity of rain that energy insecurity presents itself in the form of a possible blackout, as it was in 2001 and can also be now, in this critical period that spans from the end of 2021.

The main objective of the present work is to contribute to the debate on energy planning by analyzing the causes of a possible “blackout” in 2022 through technical, economic and energy planning aspects.

2. WORK METHODOLOGY

The methodology of this work is composed of data collection, treatment and analysis. Data collection was carried out through bibliographic review in books, periodicals and statistical databases that address the subject in question, such as National Electric System Operator (ONS), National Integrated System (SIN), National Water Agency (ANA) and the National Institute for Space Research (INPE). Data processing considered economic, social, environmental and technological aspects based on a reflection on the Brazilian energy scenario and aimed to examine particular issues of the electricity crisis in the face of electricity generation conditions and the possibility of reflecting its consequences.

3. DATA ANALYSIS

4.1 - Analysis of deforestation data in the Legal Amazon

Historical data from 1981 to 2020 show that, annually, between April and October, rainfall is low, indicating that the level of reservoirs may decrease and recommending the use of thermoelectric plants preventively, before the situation reaches a critical level.

But since the blackout of 2001, some decisions can be questioned, such as allowing an increase in the deforested and burned area or the advancement of irrigation projects. These are decisions that affect the sources of rivers and the rainfall regime. The National Institute for Space Research - INPE, through the PRODES project, monitors deforestation in the Legal Amazon by satellite and has produced annual deforestation rates in the region since 1988. According to INPE, the Legal Amazon has already lost 17% of the entire biome through deforestation. Of this total, 300 thousand km^2 have been deforested since 2001, that is, in this twenty-year period [2].

As a result, some of the major rivers are dying, jeopardizing the water supply for the population and negatively affecting electricity generation based on hydroelectric plants.

4.2 - Analysis of data from the Drought Monitor 2021

ANA – National Water Agency publishes a regular and periodic monitoring of the drought situation, whose consolidated results are published through the Drought Monitor Map. Monthly information on the situation of droughts is made available up to the previous month, with indicators that reflect the short term (last 3, 4 and 6 months) and long term (last 12, 18 and 24 months), indicating the evolution of the drought in the region [3].

The Drought Monitor consolidates the technical and scientific knowledge already existing in different state and federal institutions in a common document containing information on drought conditions (severity, temporal and spatial evolution) and impacts on the different sectors involved. The Monitor facilitates the translation of information into tools and products that can be used by decision-making institutions and individuals, in order to strengthen Monitoring, Forecasting and Early Warning mechanisms, being a valuable tool to aid the management of water resources and energy planning.

For the year 2021, rainfall was below average, with a worsening in the drought condition in the Northeast Region in January, February and March, with intensification, worsening of the drought and expansion of the area with severe drought in May, June, July, August, September, October and November. For the Southeast Region, the scenario was of worsening drought in January, February, March, April, May, June, July, August and September. with an increase in areas with severe drought and from severe to extreme in the months of April, May, July, August, November and December. Finally, the Central-West Region experienced an advance of severe drought and weak drought in the months of January, March, April, May,

June, July, August, September and October, in addition to the persistence of the intense drought scenario, due to the long-term accumulated rainfall deficits – greater than 12 months. As can be seen, the scenario shown by the Drought Monitor in 2021 already foreshadowed difficulties for the energy supply from hydroelectric plants. It was not an unexpected occurrence.

4.3 - OIEE Growth Data, Population and GDP

The installed power generation capacity, which was 33 GW in 1980, rose to 74 GW in 2000 and 175 GW in 2020, according to BEN - Historical Series (EPE, 2020). Meanwhile, the resident population, which was 122 million in 1980, rose to 175 million in 2000 and reached 213 million in 2020, according to the Instituto Brasileiro de Geografia e Estatística - IBGE [4].

Analyzing the data on the Internal Electricity Supply – IES in Brazil, population growth and GDP, it is possible to establish an IES / GDP / inhabitant ratio and compare it with the evolution of the installed capacity for energy generation. From 1980 to 2020, the Domestic Electricity Supply - DES grew almost five times, while the Gross Domestic Product - GDP and the Resident Population grew twice. The IES/Pop ratio grew almost three times over the same period and the DES/GDP approximately twice. In other words, the IES always grew more than the indicators related to Demand, such as Population and GDP.

Table 1. Internal Electricity Supply/GDP/Population

	Installed Generation Capacity (GW)	Internal ElectricitySuply - IES (GWh)	Gross Domestic Product – GDP (10^9 US$ppc (2010))	Resident Population (10^6 hab)	IES/POP	IES/GDP
1980	33.472	139.170	1.298	122	1.142	107
1990	53.050	249.358	1.517	150	1.665	164
2000	73.671	393.259	1.953	175	2.251	201
2010	113.327	550.447	2.804	196	2.812	196
2020	174.737	645.915	2.858	213	3.039	226

SOURCE: Prepared by the authors from EPE data (BEN - Historical Series) [5]

4.4 - Data analysis and planning

According to the CMSE - Electricity Sector Monitoring Committee registered in the meeting official notes of the 242nd Meeting held on 12/07/2020, in which the

conditions of electro-energy service of the National Interconnected System - SIN, the National Electric System Operator - ONS were evaluated , in November 2020 *“there were no significant volumes of rainfall in the main basins of interest to the SIN, from the perspective of electricity generation, resulting in the observation of critical inflows in the basins that are part of the Southeast/Midwest and South subsystems, as well as as in the SIN as a whole. Thus, in terms of Affluent Natural Energy - ENA, November 2020 was the 2nd worst in the Southeast/Midwest, in the 90-year history, having already been verified in the previous month the worst inflow in the history for the month of October"*. And it goes on to report that in terms of Stored Energy - EAR in November *2020 "storages of 17.7%, 18.3%, 52.2% and 28.9% were verified in the Southeast/Midwest, South, Northeast subsystems and North, respectively, evidencing the impossibility of starting the recovery of the storage of the main reservoirs of the SE/CW and South, contrary to the behavior expected for the beginning of the typically wet period”.*

4. RESULTS AND DISCUSSIONS

The 2021 electricity crisis in Brazil is based on four aspects: registered rainfall; lack of strategic planning and management for the Brazilian electricity sector; diversity of the energy matrix with growth in non-renewable sources and excessive dependence on water sources for electricity generation in the country.

The low average rainfall in Brazil recorded in the database of the National Institute for Space Research - INPE [2] indicates that the rainfall regime is not sufficient for the reservoirs to operate safely, with annual averages for 2019, 2020 and 2021 lower than the averages observed between 1981 and 2010, indicating a more serious water crisis in 91 years, according to the Ministry of Mines and Energy.

The great Brazilian rivers, supplied exclusively by rainwater or springs, are responsible for the essential water indices to guarantee 65% of electricity generation [1]. In addition to the scarcity of rainfall in recent years, other factors may also have impacted the decrease in the level of the reservoirs shown in Figure 1 [6], such as the increased use of water from these rivers for irrigation and the deforestation of riparian forests for expansion of extensive livestock.

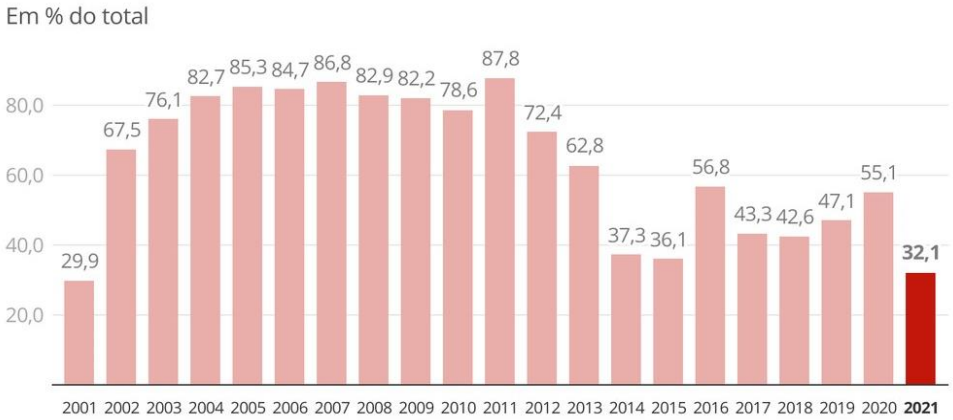

Figure 1: Reservoir levels in the South and Southeast of Brazil (2001-2021)

The Figure 1 shows the levels of the country's main reservoirs for electricity production, according to the National Electric System Operator (ONS) [7]. Note that the level of reservoirs in 2021 (32%) is the closest to the lowest level observed in 2001 (30%). It is also noticed that the low rates of the reservoirs since 2014 already serve as a warning for the supply of the hydroelectric system.

The Figure 2 compares the electrical matrix of the year 2000 with the matrix of 2020, where dependence on the water source was 89% in that year, rising to 65% today. In addition, the diversification of the matrix can also be noticed, mainly with the contribution of wind energy and biomass and the emergence of solar energy. However, a worrying factor is the increase in energy generation from non-renewable sources. This increase has caused a significant increase in the value of the energy tariff, which accentuates the country's economic crisis.

Figure 2: comparison of the Brazilian Electricity Matrix in 2000 and 2020

In 2020, Brazil registered the lowest level of implementation of new hydroelectric plants in the two recent decades, while capacity in thermoelectric plants went in the opposite direction and showed the strongest growth in seven years.

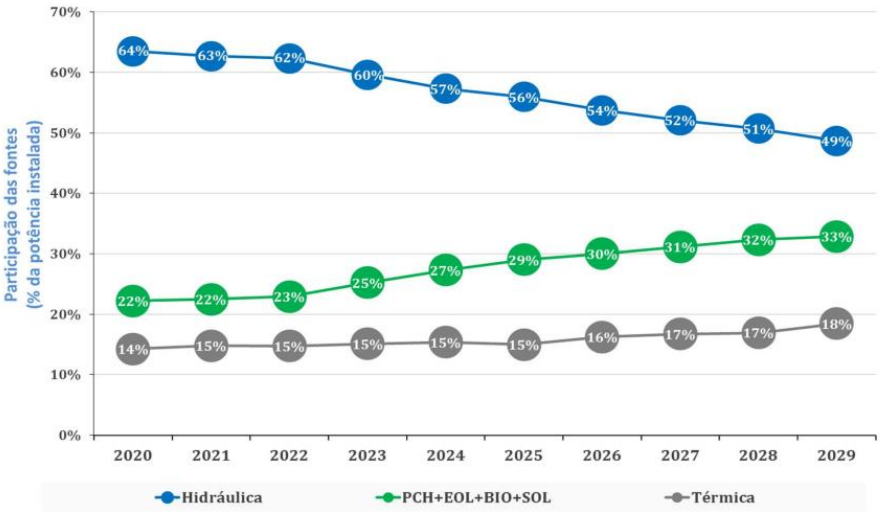

Figure 3: Participation in the Installed Capacity of Electric Generation [1]

The Figure 3 shows the projection of electricity generation for the next decade, with a decrease in hydroelectric generation and an increase in thermoelectric generation.

5. FINAL CONSIDERATIONS

The Brazilian electricity matrix is very dependent on hydroelectric generation and, consequently, on the rainfall regime, and it is necessary to reduce this dependence to ensure the country's energy security and one of the possibilities is to increase the share of renewable energies in our matrix.

In order to analyze the causes and consequences of the current electricity crisis in Brazil, this study considers as causes of the possible energy crisis in 2021/2022, low rainfall, failure in planning and management and excessive dependence on the source water for electricity generation.

This study considers that there is no possibility of blackouts, since the increase in the Internal Electricity Supply - IES has always been greater than the increase in the Resident Population and the Gross Domestic Product - GDP. The IES / Resident Population and IES / GDP ratios show favorable indexes for the growth of the IES, so there is no demand for electricity that exceeds the supply. However, the IES needs to be managed, as it is composed of several sources, with a predominance of hydropower.

On the other hand, it is possible that the growth of renewable energies can solve only a small part of the electricity generation problem in Brazil, as it is a complex operation to supply electricity to an extensive, populous country with unequal distribution of consumption, several sources generation, different characteristics of consumption, dispatch, storage, intermittency and seasonality.

Energy Planning will continue to be important and the decisions made based on it are fundamental for the country's energy supply, which leads us to consider that technical, economic and managerial aspects should always be analyzed together, never in isolation.

6. REFERENCES

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