



Energy Sustainability And Regulation Theory: A Theoretical Analysis Of Indicators

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ABSTRACT: The objective of this article is to analyze, in the theoretical field, the relations between energy sustainability and the Regulation Theory in order to contribute to the improvement of the decision-making process in the Brazilian electric sector. Institutions in the Brazilian electricity sector face major market challenges that put pressure on these organizations to be able to constantly plan integrated and sustainable actions. These challenges are linked to the pressing need for electricity and the need to operate efficient mechanisms to deal with environmental issues. The methodology, of a theoretical nature, was based on a bibliographic survey related to the themes: energy sustainability, Regulation theory and sustainability indicators. The study concluded that only through the construction of a model of sustainability indicators will there be strategic orientation to the decision-making process in electricity regulatory institutions.

KEYWORDS: Sustainability. Electricity. Regulation Theory. Indicators.

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I. INTRODUCTION

The promotion of sustainability through the institutional environment has been one of the main challenges in the Brazilian electric sector, especially since the privatization process of the electric sector in the country, where the National Electric Energy Agency - Aneel, as the sector's regulatory agency, has passed make efforts towards the search for economic efficiency and the protection of users of the energy input in the face of possible abuses of power in the monopoly. The search for economic efficiency would take place in order to guarantee the lowest cost service for the user and the search for protection for users of electricity, ensuring the smallest difference between the price and the cost of this input.

Electric energy is an elementary condition for the development process of any country in that it constitutes a strategic vector, alongside water and sanitation, telecommunications and transport. Electricity through its physical-chemical and electromagnetic peculiarities of matter makes it possible for machinery to operate by means of displacement currents of electrical charges within a conductor [3].

Concern about energy sustainability in the world is gradually growing, influenced by the need to ensure security of energy supply and supply as well as to decrease the increase in global temperatures associated with the use of fossil fuels [1], [17]. The conditions of availability of electricity in quantity, quality and competitive costs define the population's ability to guarantee a certain standard of quality of life. It is not surprising that this input has been approached as a strategic asset that involves economic, social, environmental, political, technological and demographic aspects [4].

The electrical energy supplied to homes in Brazil comprises an aspect that draws more and more attention when discussing the role of electrical energy in improving the quality of life of Brazilians. If, on the one hand, the country relies predominantly on a source of electricity generation with low relative costs, hydroelectric power plants, on the other, the costs of electricity in the country are quite high compared to other countries [3].

This investigation is limited to Aneel's institutional environment. The reality of facing market challenges in the Brazilian electric sector, based on the pressing need for electric input and on the mechanisms used to deal with socio-environmental issues, puts substantial pressure on not only Aneel, but the sector's institutions to be organized and able to plan integrated and sustainable actions in all regions of the country [4].

In this perspective, the problem of this article is based on the following question: how could institutions that regulate electricity distribution improve the decision-making process? The contribution of this questioning

aims to contribute to the promotion and development of research related to the theme, in order to strategically raise subsidies to the decision-making process in the Brazilian electricity sector. The research opportunity brings a perspective of evolution of sustainability indicators in the electricity sector in favor of improving the quality of life of the Brazilian population; guiding companies in the electricity sector that want to seek sustainable development in order to reduce social and environmental impacts, thus building a more sustainable energy matrix, guaranteeing sustainability for future generations.

The institutions' concern with measuring energy sustainability, especially regarding the risks involved in their operations (which can be direct risks, such as environmental liabilities and legal actions, or indirect risks, such as compromising the image and consequent decrease in sales and the value of actions), comprises a focus increasingly approached internationally [20]. There is growing interest in the construction of sustainability indicators in order to guide decision-making processes. Approaches to strategies, cleaner production, pollution control, eco-efficiency, environmental management, social responsibility, industrial ecology, ethical investments, green economy, eco design, reuse, sustainable consumption, zero waste, are increasingly frequent [10].

The Brazilian electricity sector, given the high consumption of electricity, needs to guarantee the country security in the production and distribution of electricity, as well as competitive standards for this input. This challenge needs to observe economic, social and environmental aspects that do not harm current and future generations; Aneel is responsible for providing favorable conditions for the electricity market to develop with balance between agents and for the benefit of Brazilian society.

In this sense, this research proposal is justified by the opportunity to raise subsidies to the decision-making process at Aneel. The attempt is to guide, through the elaboration of a model of energy sustainability indicators, an electric energy distribution management based on sustainable bases.

The analysis of the role of the electric sector in the Brazilian socioeconomic development also represents an opportunity for dialogue of the opposition of ideas based on the tension of opposites and by profound contradictions. This dialectical process attributes greater complexity to the energy debate and aims to reveal new possibilities for understanding the relationship between electricity and the development of society as a whole. In the course of this thesis, these economic, social and political contradictions are verified, which compose the same panorama.

In reality, the present analysis seeks to subsidize future actions for the use of Pará's electric potential towards the practice of socioeconomic development. Thus, all this effort is based on a conception whose experience acquired from the past, fed by present observations, creates conditions to better guide public planning. However, as noted [19], the collection of teachings and guidelines does not always comprise a task of simply consulting the past just to collect criticisms of the present, ignoring the uncertainties and pitfalls of time, without major commitments to the construction of the future. The universe of reflections must be based on the perception that the future is grounded by actions verified at every moment, but its realization will be subject to various forces that are beyond the reach of scholars and that even arise in a completely unforeseen way [19].

The methodology was based on a theoretical approach. The research is classified as bibliographic and where specialized literature materials such as journals, books and websites linked to the terms were verified: public management, electric power sector in Brazil, Theory of regulation and state of the art of sustainability indicators. In addition to this introduction, the text is didactically divided into five parts, namely: Institutional organization of the electric sector in Brazil, Sustainable development and sustainability, Energy sustainability indicators, Regulation Theory and final considerations.

II. INSTITUTIONAL ORGANIZATION OF THE ELECTRICAL SECTOR IN BRAZIL

The analysis of the institutional organization of the electricity sector will be based here from the mention of three definitions that are indispensable for understanding the intricacies that arise in the context of this theme: the electric energy, the energy sector and the electric sector. Electric energy comprises the product of an appropriate process of using the physical-chemical and electromagnetic properties of matter to provide the functioning of equipment that provides end-uses to society [19]. Thus, even as the authors point out, electrical energy is a secondary energy that can be acquired through primary energy sources transformed from converters. According to [7], the primary energy to electrical conversions most used today are: thermal energy, which is found in fossil fuels and biomass through thermoelectric plants; atomic energy of radioactive minerals from nuclear power plants; and water potential through hydroelectric plants.

The energy sector, in turn, comprises a set of bodies that seek to promote the strategic use of different sources of energy from available energy, economic and technological resources. In this sense, it consists of an open system that establishes relationships between its subsystems: electric, coal, oil, gas and others. Although this work does not widely discuss the systemic approach, it is necessary to highlight that the term "system" in the energy environment includes ecological, technological, social, economic and institutional characteristics, as well as the segments of the energy production chain.

The electricity sector is a social organization formed by systemic relationships that involve the process of transforming primary energy to end use by type of consumer. These relations are established between the components of the electric sector, such as: generation, transmission and distribution. According to [19], electricity generation comprises the entire process of transforming a primary source of energy into electricity and represents a very significant part of the environmental, socioeconomic and cultural impacts of electrical energy systems.

The electricity produced at the generation plants usually goes a long way to its place of use. This route involves the transmission systems, which connect the generation to the load centers (in cases where the distribution does not connect directly to the transmission, subtransmission systems are used). The distribution, finally, comprises the network that links the transmission (or subtransmission) to the points of final consumption. In Brazil, the institutional organization of the electricity sector stood out due to the electricity rationing imposed on Brazilian society by the sector between 2001 and 2002.

This panorama brought to the public debate the vulnerability of the then current model of the Brazilian electricity sector. It is unquestionable that the aforementioned model has not fulfilled its role in all aspects to the extent that it has caused the increase in tariffs, lack of energy, the non-attraction of investments and the indebtedness of companies in the sector. [7] points out that the guarantee of the functioning of the State and the realization of the rights established by the Federal Constitution to Brazilian society presuppose the supply of electric energy since these services are undoubtedly essential.

As for the relations between the electricity sector and society, [7] even stresses the need to ensure the right to information and documents on the construction of dams since the preliminary surveys sent to Aneel. Electricity demand in Brazil tends to grow rapidly in the foreseeable future and the reform of the electricity sector should focus on investment. Furthermore, Brazil's large hydroelectric system needs special treatment to invest in hydraulic and thermal plants. If we recognize these facts, we must: declare a moratorium on the privatization of generators for the next six to seven years; work seriously during the period to define a set of transparent, comprehensive and politically viable rules for managing conflicts over the use of reservoirs; and to replace the current commercial arrangements, with a guaranteed case-by-case price, not regulated and disguised under competition rhetoric. In this context, the Federal Government needed to structure a model for the electricity sector that would guarantee an increase in supply in order to satisfy Brazilian economic growth.

The new model began to be designed in 2003 and had the year 2004 as its legal framework. Thus, according to Law 10.848 / 2004, the country had a new model for the energy sector that is gradually being implemented. The model seeks to develop public policies aimed at promoting the electric energy chain. The sector would now deal with the general criteria for guaranteeing the supply of electricity that ensure the appropriate balance between reliability of supply and reasonable tariffs and prices for the sale of electricity between: concessionaires, permit holders and authorized electric power services and installations, including their relations with their consumers in the National Interconnected System (SIN), as well as consumer protection mechanisms.

According to the new model, the Brazilian electric sector, for the realization of its purposes, starts to use strategic functions that seek to develop its actions, through an integrated institutional structure. These functions are: the formulation of policies and guidelines; planning and ensuring a balance between supply and demand; the regulation and delegation of the granting power; the supervision, control and operation of the systems; accounting and settlement; and the execution and provision of services. The formulation of policies and guidelines for the electric sector is developed based on: the National Congress, the Infrastructure Policy Chamber of the Government Council and the National Energy Policy Council (CNPE). The orientation of the policies and guidelines of the electric sector according to the interest of society represents a fundamental foundation for a sustained energy policy.

The CNPE, as a specific body in the Brazilian electricity sector and submitted for approval by the Presidency of the Republic, should be observed with greater attention. According to Decree no. 3,520, dated June 21, 2000, which deals with the structure and functioning of the body, it is observed that it develops policies aimed at: preserving the national interest, promoting sustainable development, protecting the environment and promoting energy conservation, attraction of investments in energy production, revision of energy matrices, among others. In order to implement these policies, the agency has the support of eight technical committees: Consumer and tariffs; Electricity supply planning; Energy matrix; Energy efficiency; Attraction of investments and legal frameworks; Complementary renewable sources; Import of energy and national fuel storage system; and Environment. The CNPE, according to Decree 3,520 / 2000, is formed by: Minister of State for Mines and Energy, who chairs the body, Minister of State for Science and Technology, Minister of State for Planning, Budget and Management; Minister of State for Finance; Minister of State for the Environment; Minister of State for Development, Industry and Foreign Trade; Minister of State of the Civil House of the Presidency of the Republic; a representative of the States and the Federal District; a Brazilian citizen specialized in energy matters; a representative of a Brazilian university specialized in energy matters (BRASIL, 2000). Planning and ensuring a balance between supply and demand, as a strategic function of the electricity sector, comprises the mission of the Ministry of Mines and Energy (MME).

The MME develops actions aimed at greater participation by the private sector with investments and responsibility for maintaining the country's energy reserves through a linear organization chart (Figure 6). Its structure has two companies linked as a mixed capital company: Eletrobrás and Petrobrás. Eletrobrás, which will be the object of attention for being focused on the electricity sector, runs the companies Furnas Centrais Elétricas SA, Companhia Hidroelétrica do São Francisco (Chesf), Companhia de Geração Térmica de Energia Elétrica (CGTEE), Eletrosul Centrais Elétricas SA (Eletrosul), Eletrobrás Termonuclear SA (Eletronuclear) and Centrais Elétricas do Norte do Brasil SA (Eletronorte).

The regulation and delegation of the granting authority comprise another function of the institutional structure. Its mission is to guarantee the supply and quality of public energy services. The operationalization of this mission takes place through Aneel, which is an autarchy under a special regime linked to the Ministry of Mines and Energy and which was created by Law no. 9,427 of 1996. Aneel's purpose is to: regulate and inspect the generation, transmission, distribution and sale of electric energy; mediate conflicts of interest between agents in the electricity sector and between them and consumers; grant, permit and authorize energy installations and services; guarantee fair rates; ensure the quality of the service; require investments; stimulate competition between operators and ensure universal service. Aneel has the challenge of clearly defining the mechanisms that guarantee the satisfaction of the population's needs for electricity.

III. SUSTAINABLE DEVELOPMENT AND SUSTAINABILITY

The term development, in any conception, must result from economic growth accompanied by improvements in the standard of living of the populations, that is, it would be the result of changes in the structure of the product and the allocation of resources by different sectors of the economy, in order to improve indicators of economic and social well-being [9]. In this dynamic of understanding, [9] points to the existence of two currents of economic thought on the subject. The first current sees growth as a synonym for development, while in the second growth it is an indispensable condition for development, but it is not a sufficient condition [9]. In the first stream are the growth models of the classical and neoclassical tradition; while in the second stream, there are critically oriented economists, trained in the Marxist or Cephalian tradition, which conceptualizes growth as a simple quantitative variation of the product, while development is characterized by qualitative changes in the way of life of people, institutions and structures productive [8].

Sustainable development and sustainability are issues that permeate the world in governmental and organizational environments. In an international scenario constituted and concerned with climate issues, scarcity of natural resources and the water crisis, the theme arouses reflection for working together to build a more sustainable society. The relevance and scope of this reflection environment is given by the dimensions and connections that are inserted in a development process and the economic, social and environmental bases for this development.

The definition of the normative framework for sustainable development lies steeped in contradictions, insofar as the difficulty lies in the fact that economic interests are not subject to social and environmental interests. The discussions about the development of countries and the globalization process, for the most part, have changed the meaning of the term sustainable development at the time when it questions whether such terminology is used merely in favor of deepening capital relations of capital neoliberal. The definition of this term supposes a new world order, which results in a redistribution of powers that ignores the correlations of forces that are active in the world market, and the interests of industrialized nations in maintaining the position of advantage in the international panorama [3], [10].

In this perspective, it appears that the most acceptable idea for the construction of the understanding of sustainable development, in order to initiate a contribution to the term from a more categorical dimension, is based on the idea that sustainable development comprises a condition of continuous growth of an economy, in order to allow a reasonable concrete distribution of social wealth by expanding the population's access to the satisfaction of basic needs such as health, education, energy, water and sanitation [5].

Sustainable development has the objective of promoting sustainability. The definition and transmission mishaps of the sustainability category indicates the difficulty in translating the concepts into common and permanent actions [5]. The term sustainability is used, but little explained. It is conceptual in nature, poorly understood [16]. It is a fad or common sense [16]. Sustainability is linked to an activity that can be maintained for an indefinite period of time, so as not to reach its exhaustion, despite the unforeseen events that may occur during this period, based on relatively consistent economic, social and environmental bases [2]. Sustainability would then be defined as the ability to sustain economic, social and environmental conditions that promote meeting human needs in a balanced way; in this perspective, the possibility of assessing sustainability with institutions is conditioned to the development of measuring instruments, that is, to the construction of sustainability indicators aimed at the institutional dimension [5].

IV. ENERGY SUSTAINABILITY INDICATORS

Indicators, a term originating from Latin indicating that it means discovering, pointing and estimating, can communicate or inform about progress towards a certain goal, such as sustainable development, but they can also be understood as a resource that makes a trend or phenomenon that is not immediately detectable [11]. Thus, an indicator comprises a parameter, or value derived from parameters, that points and provides information about the state of a phenomenon to a significant extent.

With the intention of ascertaining the state of the art of the indicators, the World Resources Institute (WRI) carried out a study in the early 1990s to identify the stage of understanding of this term and its levels of application from the researches that were or were being carried out until then [11]. These investigations examined programs developed by numerous national and international organizations, where it was found that the benchmark for sustainability indicators was the World Conference on Environment and Development, Rio-92, with the construction of its final document, Agenda 21 [16]. The Conference is known for what was called the Global Biodiversity Strategy, presented by WRI, from the United States of America, and by the World Union for Nature, in Switzerland. The Report was made up of suggestions with the purpose of conserving the planet's biological diversity and presented a plan for the sustainable use of biological resources [11], [16].

The discussion on energy sustainability indicators is directly linked to the debate on methodologies for measuring the level of development of societies and the sustainability of their production systems, which can provide information about a particular phenomenon that is important for development and would be demonstrated through these indicators [19]. The use of indicators is extremely important in the process of improving society and the economy as a whole, however, the number of sustainable development indicators available in the literature is excessive and often demonstrates the absence of a methodology that integrates the economic, social and economic dimensions. environmental; studies on more specific indicators have relatively more limited advances [19].

In this context, any variable, and consequently any indicator, be it descriptive or normative, has a particular significance. The most important characteristic of the indicator, when compared to other types or forms of information, is its relevance to policy and decision-making. In this sense, to be representative, the indicator has to be considered important by both decision makers and the public. The most desired indicators are those that summarize or simplify the relevant information, make certain phenomena that occur in reality become more apparent; this aspect is particularly important in environmental management; in this area, specifically, it is necessary to quantify, measure and communicate the relevant actions.

In the environment of organizations, sustainability has challenging paths. Sustainability is the balance between the three pillars: environmental, economic and social. The expectation that companies should contribute progressively to sustainability arises from the recognition that businesses need stable markets, and that they must have the technological, financial and management skills necessary to enable the transition towards sustainable development [21].

Some authors highlight the definition of the Triple Bottom Line (TBL) concept by Elkington in 1987 and officially published in 2000 and 2002, relating three pillars to analyze the sustainability phenomenon: economic, social and environmental perspective [21]. The formation of a triple bottom line can be reflected in terms of an increase in the value of the company, which can be obtained through gains around its social, human and environmental capital, which can be measured through different elements. The following are some models of energy sustainability indicators available in the literature.

IBGE's indicators [12] are formed by economic, social, environmental and institutional aspects. The elaboration of these indicators is part of the set of international efforts to implement the ideas and principles established in Agenda 21, of the United Nations Conference on Environment and Development, in which it addresses the connection between environment, development and information for decision making. decisions [12]. Aneel's indicators, in turn, are composed of dimensions: economic; social; ecological; technological; and politicians. The political aspects are those that come closest to the institutional environment. The indicators used are only: security of supply and deconcentration of public authorities, thus not attributing representativeness and precision in the evaluation of institutions in the electricity sector [5].

[7] 's proposal also appears in the literature as an important indication. These indicators can be: social, economic and environmental. The economic indicators are: expenses with salaries and benefits; taxes and fees in general; investment in safety, environment and health; investment in research and development; investment in community development; investment in national technology; and sponsorship of environmental projects [7]. The social indicators are: food; social charges; amount paid to private pension; medical and social assistance to employees; number of occupational accidents; investment in employee education; number of occupational diseases; investments in cultural projects for employees; professional development capacity; number of women working in the company; childcare assistance; participation in the company's results; transparency and communication of information; number of employees with disabilities; percentage of leadership positions held by women; effectiveness of contributions to society; lawsuits related to environmental problems; ISO 14,004 trained

employees; investments in education for the community; investments in social projects; investments in university research [7]. Environmental indicators are: air quality; energy efficiency; use of natural resources; environmental Quality; water quality; and environmental responsibility [7].

The indicators can assign orders of magnitude to the state of sustainability of the electricity sector from each sector of the economy, in order to guide the decision-making process. The sectors of the economy present different demands for electricity, potential for job creation, added values, investment needs, levels of efficiency, among other elements that act in the face of specific characteristics. In this sense, it is possible to understand, through indicators, how the scenario of growth in investments in the electric energy sector could be considered a determining factor for the socioeconomic development of Pará. The Brazilian electricity sector will be reviewed based on an approach that involves economic, social, environmental and political dimensions across the country's economic sectors and that has the ability to measure sustainability relationships, in order to provide references to the decision-making process.

V. THEORY OF REGULATION

The infrastructure sectors in Brazil underwent a restructuring due to the replacement of the State by the private sector in its operation, which resulted in the need to develop new regulatory frameworks [18]. The Brazilian public administration has walked in recent decades focused on a debate about the ideal size of the State, when in reality, what was pressing was to think of this State from effectively sustainable bases.

In this new perspective, regulation started to assume a mission of encouraging and guaranteeing the necessary investments, promoting the well-being of users and increasing economic efficiency; understanding the environment that involves the process of producing rules and guiding the conduct of actors in a given social space [18]. Among the great challenges of regulatory activity, is the search for balance in the environment of relations between consumers, the State and economic agents [9]. However, political democratization, relatively recent privatizations, the functioning of regulatory structures and the level of organization of public institutions in Brazil have not yet been able to allow the consolidation of an efficient governance network committed to sustainable development [4].

In the debate about State reform, a common obstacle is the interpretive confusion between regulation and regulation, as such expressions differ, since regulation refers to the act of regulating, and regulation refers to a set of executive determinations that it complements with minutiae a law, to enforce it [6]. The State, as an economic operator, has the function of regulating relations between the various agents of the socioeconomic system, being able to use different devices, such as regulation or direct action, since one device does not exclude the other, although the use of both have simultaneously aggravated state power, creating weaknesses in public institutions [6].

Regulation comprises the environment that involves the process of producing rules and guiding the conduct of actors in a given social space; the main objectives of regulation are basically: to encourage investments and support efficiency in production and use [14], [13]. Through [18], these objectives gain more specific intricacies, where for these authors the objectives of regulation are: To seek economic efficiency in order to guarantee the lowest cost service for the user; avoid abuses of power in the monopoly, guaranteeing the smallest difference between price and cost, in a way equivalent to the desired levels of service quality; ensure universal service; ensure the quality of the service offered; establish channels to respond to users' complaints regarding the provision of services; promote innovation; ensure technological standardization and compatibility between equipment; and protect the environment.

In this perspective, the economics of regulation supports the operation of government restrictions on decisions in some infrastructure sectors in the country regarding price and quantity [4]. The justification for government intervention is that under certain conditions, competition does not work very well, either because of the existence of a natural monopoly or because of the existence of externalities [15], [4].

Regulatory Agencies and regulatory standards emerged from the imperative to regulate activities that were previously in the public sector and became the responsibility of the private sector. The National Electric Energy Agency - Aneel, through its regulation, has been looking for results and improving its institutional performance from the perspective of sustainability verified from the normative reference of sustainable development [4].

In these perspectives, the regulator of the electricity sector, Aneel, has been encouraging concessionaires to have a more sustainable energy matrix, supporting research projects for energy development and efficiency, enabling innovations promoting significant growth in the improvement of their processes and services, facing the challenges of the electric power sector, whether promoting the efficient and rational use of electric power or associated with actions to combat waste. Aneel seeks to encourage and promote innovation, fostering culture, stimulating various researches to foster the development of the electricity sector, improving the provision of services and providing security of electricity supply in the country.

VI. CONCLUSION

Faced with the challenge of this article, which is to analyze, in the theoretical field, the relations between energy sustainability and the Theory of regulation in order to contribute to the improvement of the decision-making process in the Brazilian electric sector, the investigation inferred that only through the construction of a model of sustainability indicators, there will be strategic orientation to the decision-making process in electricity regulatory institutions.

It is important to highlight that the challenges of the Brazilian electricity sector lie in the pressing need for electricity and the need to operate efficient mechanisms to deal with environmental issues. However, management plans, audit initiatives or internal control mechanisms that seek to address the mentioned challenges cannot be developed if there are no sustainability indicators determined with each institution that is part of the electricity sector. The application and analysis of sustainability indicators in institutions in the electricity sector may also serve as a guide in the search for strategic paths, including those that lead to a sustainable electrical matrix.

The study is also aware of the impossibility of promoting a concrete improvement in the standard of living of the population of Pará exclusively from electricity. And in this perspective, it also highlights the need to pursue investigations from other strategic sectors to the socioeconomic development process, such as the transport and telecommunications sectors.

Finally, this investigation awakens the relevance of developing new studies aimed at the other component bodies of the Brazilian electricity sector that were not addressed at this time, as well as the creation of periodicity conditions in the calculation of indicators. The intention is to expand the capacity for assessing sustainability in the institutional dimension of the Brazilian electricity sector and guide the decision-making process based on the result of the calculated indicators.

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