

INNOVATIONS IN THE BRAZILIAN ELECTRIC ENERGY SECTOR: ACTIONS OF NATIONAL ELECTRIC ENERGY AGENCY - ANEEL

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Overview

This study aims at analyzing the actions that ANEEL has currently developed in order to encourage innovation in the Brazilian energy sector and its impact on an energy generation company. As for the methodology used in relation to the goal, this is a descriptive and exploratory research. As for the procedures the research is documentary and based on case study. For the analysis of the documents, content analysis was used. The research has as study object the Brazilian electric energy sector. For the development of empirical research, regulatory events that encouraged innovation in the industry were identified. Primary data were used in this research, through interview with R & D program manager in a certain company, and secondary data obtained from the Regulatory Agency and the Brazilian Federal Government. Regarding the time of collection, this research is classified as a longitudinal study considering facts and data since the Constitution of 1988 promulgation until June 2016. For data analysis, content analysis based on Bardin was used. As results and conclusions of the research, it was observed that ANEEL seeks to promote and facilitate the full cycle of innovation chain, encouraging companies around initiatives that have appropriate scale to develop knowledge and transform ideas, successful laboratory experiments and quality of mathematical models into practical results that improve the performance of organizations and the society life (ANEEL, 2012). ANEEL purposes converge with Bessant and Tidd (2009) study and the generation of new ideas and their implementation, as well as the application of knowledge acquired by employees, as Trot (2012) reports. It was found that by ANEEL [from the Law 12.212 of January 20, 2010], electric utility companies are required to invest 1% of net operating revenues in R & D. R & D projects regulated by ANEEL are intended for training and technological development of electric utilities, in order to generate new processes or products, or the improvement of its characteristics (ANEEL, 2012), converging with Schumpeter (1989) study about innovation. Activities related to the implementation of R & D projects relate to creative or entrepreneurial nature with technical-scientific basis, and aimed at the generation of knowledge or to innovative application of existing knowledge. Thus, the transformation of the research result into technological innovation is the mainspring of the R & D Program regulated by ANEEL (ANEEL, 2012). As for the impact that ANEEL actions have on energy generating companies, it was noticed that the Agency impacts on program regulation and guidance of investments. With respect to regulatory frameworks, the company seeks to adapt quickly to changes and relies on institutions to conduct its R & D projects. ANEEL plays the role of facilitator both in proposing strategic themes as bringing different actors with common interests.

Keywords – Innovation; Energy Sector; ANEEL.

1 Introduction

Innovation is the act of making new combinations (SCHUMPETER, 1961). Under this assumption, Schumpeter argues that innovation is an evolutionary process and creative destruction in which the creation of new structures takes place in a system subject to ruptures. According to the National Electric Energy Agency (ANEEL) manual (2012), innovation is the introduction of products, processes, methods or systems not previously existing in the company or in the market, or with some new and different characteristic than hitherto in force, which can generate socioeconomic changes.

ANEEL, as an institution, has the objective of regulating the market, and it is constantly changing in order to adapt to the sector dynamics. In this way, the institutions are part of a dynamic process, continuous and relatively uncertain, inseparable from technological and social changes (CONCEIÇÃO, 2002).

According to Coimbra (2003), the institutions that regulate the electric sector were instituted with the purpose of regulating the sector, seeking a balance between the State, the users and concessionaires of electricity. In Brazil, the regulatory role arises from the 1990s, in which the neoliberal vision prevailed, which stipulated the institution of the minimum state, and whose function was to understand a new model of public management. Thus, in that view, it is no longer the State alone that is the only provider of public services, conferring this function to private initiative in several services, either through concession, permission or authorization, and the electricity supply service was one of them.

ANEEL has the objective of regulating and supervising the production, transmission and commercialization of electric energy, in accordance with the policies and guidelines of the federal government (PRADO, 2006). For both, in addition to its regulatory function, ANEEL offers programs that encourage electric energy companies to invest in R&D and energy efficiency.

In view of the above, research questions arise: "Has the National Electric Energy Agency, ANEEL, exercised its designated role in promoting technological development and innovation in the sector? What are the actions that ANEEL has developed in order to encourage innovation in electrical matrix? What is the impact of these actions in the generation of energy?" Thus, the **objective** of this study is to "Review the actions that ANEEL has developed with the aim of encouraging innovation in electrical energy sector of Brazil and its impact on a company for power generation".

This study is justified because the electric sector produces basic inputs that lead to economic growth and competitiveness of national companies, as well as being a strategic sector that stimulates economic growth comprehensively. In this sense, the industry requires that the investments made in it have a continuous flow. According to Aguiar (2009), ANEEL plays an important role in the infrastructure implementation in order to generate technological innovation in several segments, whether regulating investments in R&D programs or evaluating and approving the execution of research on the sector, as well as monitoring the results obtained.

Said that, the article is divided into six sections: this first section corresponds to the article introduction, being comprised by the presentation of the research theme and objective to be worked on. The second section deals with the theoretical basis. In the third section the research method is structured. Later, the fourth section presents the data analysis. The fifth section presents the final considerations from the results shown in the present study, and finally, the bibliographical references.

2 Theoretical basis

In order to analyze the data about impacts of ANEEL actions in relation to the innovation promotion in companies of the sector, first it is necessary to know the fundamental concepts around the innovation theme and later the principles of the institutional theory that will be used as basis for the proposed analysis having in view the institutional role played by ANEEL.

2.1 - Innovation

Rogers and Shoemaker (1971) argue that innovation may be beyond a new idea, a new practice, or material to be used in a particular project. According to Zaltan, Duncan and Holbeck (1973) it is perceived as an innovative idea, scheme or approach that, even already existing in other organizations, it is a novelty for the people involved.

Like Schumpeter (1961), Van de Ven (1986) points out that innovation is the development and implantation of new ideas by people who, over time, engage in transactions with others within the organization. Innovation is present in the combination of old ideas in a new formula, in a scheme that changes the current idea, as well as in a single approach perceived as new.

According to Dosi (1988), innovation is understood as the various ways of inserting or adopting new ways of performing tasks, whether by experimentation, imitation or adoption of new products. In this sense, Schumpeter (1989) argues that innovation can be: (a) introduction of a new non-familiar to consumer good or new quality of a certain good; (b) introduction of a new method of production - a not yet tried method within a certain productive branch; (c) opening up of a new market, i.e. a market in which the product of a given industry had never been accessed before, regardless of this market has or has not previously existed; (d) the discovery of a new source of raw material; and (e) reorganization of any industry, such as creating or disrupting a monopoly position. In this sense, it is observed that there is a consensus among the cited authors when defining innovation.

Innovation is a dynamic process which uses creativity in order to develop new ideas or transform an existing one, which may be a physical product, a service, a production or administrative process in organizations (ZHUANG, 1995). Lemos, Lastres and Albagli (1999) also consider as innovation the organizational changes used to the organization format and production management.

It is worth noting Crossan and Apaydin (2010) contribution who reported that innovation is the assimilation of a novelty that integrates value in economic and social aspects. Innovation is the application of acquired knowledge (TROT, 2012), as well as the renewal of products, services and markets, as well as the development of new production methods and the establishment of new management systems, being a complex process that involves risks and needs constant management (BESSANT; TIDD, 2009).

Innovation focuses on three factors, such as the generation of new ideas, selection of the best ones and their implementation. However, the innovation success depends on resources (people, equipment, money) and the company ability to manage them. To that end, the success of innovation management depends on the understanding of what to manage, on how to create the conditions to make things happen, on understanding what, why and when of the innovation activity and on understanding that the management of innovation involves dynamic capacity (BESSANT and TIDD, 2009).(BESSANT and TIDD, 2009).

2.1.1 - Innovation according to Neoschumpeterians

Schumpeter places innovation as the center of development, and the neoschumpeterian approach emphasizes the company as a central element in capitalist dynamics, since it is in companies that innovative processes occur. Neoschumpeterian school considers the technical change as the center of the explanatory process of company development and framework for analysis of economic performance, and consequently to the understanding of economic imbalances, using the institutions to define standards or trajectories of economic development (CONCEIÇÃO, 2002).

In this sense, Nelson and Winter (1982) argue that companies' efforts to innovate take place through the search for new opportunities, centered on what the present or future technological context offers, in order to reach advantageous positions in the market. Therefore, competition is what sustains innovative behavior, which according to evolutionary thinking, is fundamental to the realization of the selection stage (AREND; CARIO; ENDERLE, 2012).

According to Nelson and Winter (1977, 1982), in the evolutionist approach, technical progress becomes endogenous and has as its guiding principle the technological paradigm, defining in advance the opportunities to be pursued and those to be abandoned. Thus, it can be seen that the technological paradigm has the exclusion power (DOSI, 1984). Technological paradigms are specific to each technology, each sector being a technology of technical change, based on scientific or tacit knowledge, and the accumulation of innovators' skills, through previous experiences (DOSI, 1984). In technological paradigm, there is a pattern of problem solving, whose results of progress within that make up a certain technological trajectory, improving the technology, through the perception of opportunities perceived by the agents (DOSI, 1982).

Each technological paradigm incorporates a specific combination of exogenous determinants of innovation and determinants that are endogenous to the competition and technological accumulation process of particular firms. Thus, each paradigm comprises modes of search, knowledge bases and combinations between the forms of technological knowledge, whether public or private. Each organizational arrangement incorporates procedures to allocate resources in particular activities and for the efficient use of these resources in the search for new products, processes and procedures to improve existing routines (DOSI, 1988).

In this sense, according to Nelson and Winter (1982), routines can be considered the technique, that is, the way of work of the firm, being able to adapt it according to its needs, when a technical change is necessary to remedy some setback or problem. The firm will be able to perform it, because it has power over its routines, and can change them. This process of altering routines is considered as a learning process, which seeks new solutions to the routine of the agents, and to the techniques used by them (ZAWISLAK, 1996).

Thus, innovation is performed when the firm seeks to solve problems and improve its processes by changing the routines, and the learning that occurs at that moment, through the repetition of tasks, which makes learning faster, because it allows the accumulation of knowledge and enables the acquisition of skills that will be useful in solving problems and in the perception of opportunities, which will result in the evolution of the company. In this sense, it is perceived that the capacity of the company is developed through path dependencies, that is, habits, traditions are part of the firm history, and its trajectory, not only matters, but can influence decision processes (ZAWISLAK, 1996).

According to Neoschumpeterians, technological regimes are diverse and depend on the combination of properties such as: (a) conditions of opportunity (potential of innovation to be pursued); (b) conditions of

appropriability (how to protect the gains of innovation); (c) cumulateness level of knowledge (innovation advances over pre-existent one); And (d) the nature of knowledge base (public, private, tacit, codified, simple, complex, formal and informal one) (MERERBA, ORSENIGO, 1996).

Thus, the evolutionary approach has as its proposal the construction of models that simulate the change of the industrial structure in view of the innovation process, considering that the generation of innovations is the probabilistic result of R & D strategies, as expressed in the level of the company expenses for this, and that its success depends on the competitive conditions (POSSAS, 1989).

Neoschumpeterian school links, more precisely, technology with institutions, advocating the supremacy of the innovation process and technological change on the directions of economic growth. The institutionalist approach, in turn, contemplates the inclusion of individuals, their habits and idiosyncrasies in the definition of institutionalized strategies, which will originate the said process (CONCEIÇÃO, 2012).

Following section will present the Institutional Theory, its characteristics and evolution.

2.2 - Institutional theory

Institutional theory considers that the institutions and actions of individuals are inseparable and that institutionalization is a continuous and dynamic process that highlights cultural influences on decision making and formal structures. It argues that organizations and individuals are suspended in a network of values, norms, rules, beliefs and taken as certain premises, which are partly of their own creation (TOLBERT; ZUCKER, 2007).

These cultural elements define how the world is seen. They offer plans to organize, specifying the forms and procedures which the organization should adopt (MEYER and ROWAN, 1977). Institutions, therefore, represent restrictions on the choices that individuals and communities can exercise, even if the restrictions are open to changes over time.

According to DiMaggio and Powell (2005), organizations are more homogeneous and less directed towards competition and the need for efficiency, which is due to the uncertainty generated by new actions and procedures. For Selznick (1996), institutional theory analyzes the need for forms, processes, strategies, distinct perspectives and competencies as they emerge from interaction and adaptation patterns of the organization.

According to Selznick (1996), the repetition of actions and transfer of knowledge about the achievement of certain actions to other people or organizations, makes these actions become habits. The habit also implies that the action in question can be performed in the future in the same manner and with the same effort (BERGER and LUCKMANN, 1996).

Berger and Luckmann (1996) argue that the greater the sharing of social structures, the wider will be the institutionalization sphere. For Scott (2001), institutionalization in organizations varies according to their size, because there may be something or someone that will lead to institutionalization of certain practices.

According to Arend, Cario and Enderle (2012), the Institutional and Neoschumpeterian approaches consider historical aspects, the institutions and the technical change of an economic process. In linking institutions to innovation processes, the functions of institutions and their attribution in relation to innovations should be analyzed. Therefore, it is opportune to consider the functions of institutions, such as: reducing uncertainty by providing information, managing conflicts and cooperation, and providing incentives (LEMONS, 2013).

According to Lundvall and Borrás (2007), there are policies to promote innovation in the institutional context, using instruments in science and technology policy, as well as policies aimed at changing the institutional context in order to promote innovation, including changes in universities, education, labor market, capital market, business regulation and competition.

In this sense, it is understood that institutions are sets of habits, norms, routines, established practices, rules and laws that guide the relations between individuals, groups and organizations (EDQUIST, 2005), that is, they are the rules of the game (FIANI, 2011). Fiani (2011) argues further that having the institutions as rules, these can be restrictive, since they structure the relations between individuals in society.

According to Conceição (2002), Veblen, the main exponent of Old Institutionalism, conceptualizes the institution as the result of a present situation, which shapes the future through a selective and coercive process, guided by the human point of view. This concept is established under three questions: (a) inadequacy of neoclassical theory in treating innovations, considering them as given, and thus ignoring the conditions of their realization; (b) concern about how change occurs and the consequent growth; and (c) emphasis given to the process of economic evolution and technological transformation.

Hodgson (2002) emphasizes that habits originate the institutions, granting them power and normative authority with a greater durability; in reproducing habits of thought institutions create mechanisms of normative acceptance. In this sense, according to Conceição (2002), institutions are stipulated habits that pass from the

common thought to the generality, that is, they are routines that have been strengthened and are followed by a group in a certain society.

According to North (1993), institutions define the incentives of individuals who interact in society, they are the rules of the game, and organizations and their entrepreneurs are the players. Thus, it is the organizational agents that make the institutional changes and that make the decisions in the companies. These endogenous changes are resulting from learning, which together with factors external to the firm, are determinants of institutional change.

According to Zysman (1994), institutions, through their specific policies, shape development, and their structures are the result of the historical process of industrial development and political modernization, considering factors such as the dissemination of information and generation of new ideas. For the author, rather than investment, it is necessary to construct an adequate institutional environment to generate growth, and to recognize that it involves conflicts and uncertainties. Thus, the adaptation and selection are essential for defining strategies and trajectories of business growth.

The next section is intended to present the methodology used in this research.

3 Research procedures

With regard to the problem approach, this research is qualitative. According to Creswell (2010), qualitative research is used in order to explore and understand the meaning that a group of individuals gives to a particular subject or problem. The objective of a qualitative research is to understand the context in which a certain phenomenon is inserted from the relation that such phenomenon establishes with the subject and by him is interpreted in the light of the theory.

In relation to the objective, it is a descriptive research, because it seeks to accurately describe the facts and phenomena of a given reality (TRIVINOS, 1992).

As for the strategy, this is a case study. According to Stake (2000), the case study is not a methodological choice, but the choice of what will be studied. As a form of research, the case study is defined by the interest in individual cases, not by the research method used. It is an investigation process about the case and the product of that investigation, it is specific, unique, it must have limits and present patterns of behavior. The case study is usually organized around a few research questions, not just informative questions, but questions of thematic lines on how and why (Stake, 2000).

The research is carried out in the Brazilian Electricity Sector. For the development of the empirical investigation, regulatory events will be identified, which stimulated innovation in the sector and occurred during the period under study.

Regarding collection time, this research is classified as a longitudinal study, considering facts and data from the Promulgation of the Federal Constitution of 1988 until June 2016. The data necessary for the analysis were obtained from the Regulatory Agency and Brazilian Federal Government.

This survey relied on primary and secondary data. The primary data are those that arise from the direct interaction of the researcher with the research participants (sample) through questionnaires, interviews, observations, among other methods. The secondary data are those that have no direct relation with the recorded event. The tool chosen to collect the primary data was the interview by email, which does not allow the researcher's influence (CRESWELL, 2010).

In the first contact with the interviewee, by telephone, on June 30, 2016, the participant was welcomed with a brief explanation about the research, and he/she asked that the questions about categorized subjects were answered by email. The interview was answered on September 5, 2016, by email. The survey respondent is responsible for a hydroelectric plant, built in RS, which came into operation in 2005. Its installed capacity is 690 megawatts, enough to meet the equivalent of 30% of the demand in Santa Catarina or 20% of the total energy consumed in Rio Grande do Sul.

The secondary data were obtained from ANEEL website. Thus, issues were elaborated, Table 1, which guide the data collection and positions the study based on the impact that ANEEL's actions exert on an energy generating company.

From this, four questions were compiled to delimit the scope of the work and still contribute to the grouping of the information.

Frame 1: Interview script

Interview Script	
1	What is ANEEL impact on the company?
2	Regarding regulatory frameworks important to innovation, what did the company do (expected or was it launched abruptly)? What were the resulting projects and innovations?
3	How does the company see ANEEL role in fostering or at least guiding innovation in the electricity sector?
4	Does the interviewee perceive the same movement that the company had in other companies in the sector? Was there one that was most benefited, and some (or some kind) that was most affected?

Source: Own elaboration.

The proposed questions have a direct relation with the general objective of the present work, since they address institutions and innovations.

To analyze the data, content analysis was used (BARDIN, 2009; TRIVINOS, 1992), which seeks to uncover the non-evident meaning, the latent content of the documents. Content analysis takes place in three phases: pre-analysis, material exploration and treatment of results.

Initially it was used content analysis in order to establish the categories for analysis. In accordance with Apolinário (2012), the content analysis aims at searching the meaning of texts, whether they are articles or transcription of interviews conducted with subjects, either individually or collectively. The product of the analysis consists of theoretical interpretation of the categories that arise from the researched material, and may also have been defined previously. This procedure is used in empirical social sciences (BAUER; GASKEL, 2003).

Using content analysis, the responses were obtained through interviews by email, with support from secondary data and theoretical framework.

4 Research results

This chapter describes the empirical results obtained through the documentary research regarding the electric power sector, the regulatory frameworks signed by ANEEL, and then the information reported through interview with the manager of the electric power generating company.

4.1 - The electricity sector and the national electric energy agency - ANEEL

The electricity sector was chosen for this study due to its expressiveness in the Brazilian economy, being considered an area of strategic importance. According to Losekann (2003), the electric sector has singularities, such as the impossibility of stocking its main product, being regulated and dependent on public policies regarding price, investments, margins and returns (BERNINI, 2010).

The Brazilian electrical sector is regulated by the National Electric Energy Agency (ANEEL), created in 1995. The sector went through structural and institutional changes in the 1990s, changing from a state monopolistic configuration, in which it was the service provider and sole investor, to a market model, with the participation of several agents and investments divided with private capital. This restructuring was carried out in the same period of the State role reform, through the Constitution of 1988 (PINTO; MAISONNAVE, 2012).

According to Salgado and Motta (2005), the reforms in the sector included the privatization of the same, introduction of a model of regulation based on the premise that, with the current stage of technological development, the activities of generation and commercialization of energy are competitive, while those of transmission and distribution are natural monopolies, but passed on to the private sector.

The structural adjustments made relate to the operation of electric energy services by third parties, through bidding; control and operation of electrical systems in a centralized manner; free access and use of electrical networks; the deverticalization of sectorial activities (generation, transmission, distribution and commercialization); And creation and regulation of energy trading. This model aimed at economic and productive efficiency, with increased capacity of the system, with the opening of the electric energy market to private capital, promoting competition among its various agents. The role of the State would be to assume the political agent and regulator function, shifting its role within the new conception of market (SALGADO; MOTTA, 2005).

With the entry of private companies into the energy sector, it was necessary to establish effective norms to regulate competition and reconcile the functions of energy planning, with the variables that influence private investment such as the credibility of the goals for the expansion of productive capacity and the stability of contract rules (SALGADO; MOTTA, 2005). In this sense, according to Farias and Ribeiro (2014), regulation is

essential to strengthen and stimulate the development of markets, as well as to attract private capital with investment in public services. The modernization of the regulatory framework may increase the efficiency of national economies, increasing competitiveness and adapting to changes, providing security for investors and guaranteeing consumer rights in imperfect markets (FARIAS, RIBEIRO, 2014).

The National Electric Energy Agency (ANEEL) was created by means of Law No. 9,427 of December 26, 1996 and introduced by Decree of Installation 2,335, dated October 6, 1997, having as supervisory body the Ministry of Mines and Energy (MME). The creation of regulatory agencies had the Civil House as a locus of preparation. ANEEL was the first project to create a regulatory agency, and was sent by the Federal Executive to Congress in late 1995, under the model of a conventional autarchy, that is, without decision-making autonomy and structural and procedural requirements that characterize regulatory agencies, being of the Legislative Power, the generation of autonomy (PACHECO, 2006).

According to Pó and Abrucio (2004), the creation of ANEEL is due to the privatization and breakdown of the State monopoly in the infrastructure sectors. In this sense, Prado (2006) argues that such creation is justified by the need to reduce market failures, improving efficiency, since it is through institutions that the "rules of the game" are established (NORTH 1993, FIANI, 2011).

With an institutional format, directors were chosen by the president, approved by the Senate and enjoyed a fixed term, which created credibility for investors (PÓ; ABRUCIO, 2006). Regarding the institutional design, the agencies had autonomy and stability of the leaders, financial, functional and managerial independence, transparency and procedures, as can be seen in Frame 2:

Frame 2: Institutional design of the agencies

Institutional design of the agencies	
Autonomy and stability of the leaders	Fixed and non-coincident terms of office; stability of leaders; Approval by the Legislative Branch, upon argument; Prerequisites regarding qualification of the leaders.
Financial, operational and managerial independence	Special authority without hierarchical subordination; Last instance of administrative appeal; normative delegation (power to issue ordinances); Power to instruct and judge processes; Power of arbitration; Own budget; Frame of own staff.
Transparency	Ombudsman with mandate; Publicity of all acts and minutes of decision; Representation of users and companies.
Procedures	Written justification of each vote and decision of the leaders; public hearings; Board with collegial decision.

Source: Pó and Abrucio (2006).

It can be seen from Frame 2 that agencies work transparently in their actions, and with autonomy. In order to regulate the operation of the electric sector in Brazil, the Ministry of Mines and Energy, the National Council for Energy Policy, is responsible for determining the National Energy Policy, and specifically ANEEL (OLIVEIRA; TOMALSQUIM, 2004). The agency has the objective of regulating and supervising the production, transmission and commercialization of electric energy, in accordance with the policies and guidelines of the federal government (PRADO, 2006). Three types of regulation are practiced by the Agency: technical regulation of service standards (generation, transmission, distribution and marketing); economic regulation (tariffs and market); and regulation of research and development (R & D) projects and energy efficiency (ANEEL, 2016).

ANEEL seeks to promote and enable the full cycle of the innovation chain, encouraging companies around initiatives that have the appropriate scale to develop knowledge and transform ideas, successful laboratory experiments and quality of mathematical models into practical results that improve the performance of organizations and the life of society (ANEEL, 2012). The purpose of ANEEL converge with the study of Bessant and Tidd (2009) regarding the generation of new ideas and their implementation, as well as the application of knowledge acquired by the employees, as Trot reports.

As a result of the Brazilian Electricity Sector reform and the creation of ANEEL, the promotion of R&D activities in the electricity sector started occurring under two practices: (a) the creation of CT-ENERG and (b) the obligation of the concessionaires to invest in projects regulated by ANEEL. CT-ENERG is a sectorial electric energy fund that aims to promote R & D of public interest and energy efficiency actions in the final use, not considered by the concessionaires, and may be scientific and technological research projects; experimental technological development; development in basic industrial technology; deployment of infrastructure for research activities; training and qualification of qualified human resources and dissemination

of scientific and technological knowledge. Already, the obligation of the concessionaires to invest in projects regulated by ANEEL has the purpose of fostering and participating in activities of research and technological development, necessary for the electricity sector (Decree No. 2.335/97). In 1998, ANEEL Resolutions no. 242/98 and 261/99 required the application of at least 1% of the Annual Operational Revenue calculated in the previous year from the concessionaires of electricity distribution in R & D projects, and ANEEL Resolution no. 271/01, which also established minimum investment quotas for R & D and energy efficiency projects (ANEEL, 2012).

To fulfill the obligation to invest in R&D, companies should present their projects to ANEEL evaluation, containing information on the expected results and their applicability, expected execution costs and financial return expectation, pertinence of the study to topics of interest to the electric sector, degree of innovation or technological advancement (ANEEL, 2012). After the project is completed, ANEEL evaluates the results achieved and the investments made. When proven by the company, recognized and approved by ANEEL, the investment made in a certain project will be subtracted from the company R&D account and legal obligations (ANEEL, 2012).

With the privatization of the electricity sector in the 1990s, energy distributors assumed the obligation to invest part of NOR (Net Operating Revenue) in R&D, through clauses in concession contracts. With Law n. 9,991 / 2000, the legal framework of ANEEL R&D Program was inaugurated in Brazil, which established that generation, transmission and distribution companies would be included in R&D activities. To this end, networks of partnerships with technology-based companies and research centers of Science and Technology Institutions were created. In an endogenous way, companies structured R&D and innovation management areas to manage the innovation process, from the capture of ideas to the evaluation of technological results and economic benefits (ANEEL, 2012).

Investments in research and development include the mandatory investment by power generation concessionaires, annually of a minimum percentage of 0.25% of their Net Operating Revenue (NOR). For distribution concessionaires, this percentage was 0.1%, and these percentages were related to the first concession contracts. With Law 9,991 / 2000, these percentages were changed and the obligation came to affect more electric power companies. Based on article 1° of this Law, concessionaires and licensees of electricity distribution were obliged to apply, at least 0.75% of NOR in research and development in the electricity sector and 0.25% in Energy Efficiency (EE) in the final use, and the transition period of these percentages should be observed (ANEEL, 2012).

For generation concessionaires, those authorized for the independent production of electric power and the transmission concessionaires were obliged to apply, annually, at least 1% of NOR in research and development in the electricity sector. However, companies that generate energy only from wind, solar, biomass, small hydroelectric and qualified cogeneration installations (ANEEL, 2012) were excluded from this obligation.

Pursuant to Law 9,991 / 2000, as amended by Law No. 12,212, of January 20, 2010, the current minimum percentages to be applied in R&D and EE are presented in Table 1.

Table 1: NOR minimum percentages to invest in R & D and energy efficiency programs

Company	Current phase			Posterior phase		
	Research and development (% of NOR)	Energy Efficiency	Duration	Research and development (% of NOR)	Energy Efficiency	Duration
Generation	1.00	-	Until 12/31/2015	1.00	-	Until 01/01/2016
Transmission	1.00	-		1.00	-	
Distribution	0.50	0.50		0.75	0.25	

Source: ANEEL (2012).

According to article 4 of Law 9,991/2000, the investments in research and development described in Table 1 should be distributed as follows:

- 40% of funds must be collected to the National Fund for Scientific and Technological Development (FNDCT);
- 40% of the resources should be allocated to the execution of R&D projects regulated by ANEEL;
- 20% of the resources must be collected to Ministry of Mines and Energy (MME).

According to item II, of article 5, Law no. 9,991/2000 at least 30% of the aforementioned investments should be allocated to projects developed by research institutions located in the North, Northeast and Midwest regions, including the respective areas of the Regional Superintendencies.

In order to encourage compliance with this legal provision, a company that invests in institutions located in the North, Northeast and Midwest regions will be entitled to a greater appropriation of revenues generated from the commercialization of the results of R&D projects. Another incentive to invest in R&D in the aforementioned regions is the use of a greater amount of resources in the management project, and this additional amount will be calculated based on the investments destined to these institutions and recognized by ANEEL in the previous year (ANEEL, 2012). In this way, it is possible to promote the development of regions through institutions, since one of their functions is to provide incentives (LEMOS, 2013), and also through innovations (SCHUMPETER, 1989).

R&D projects regulated by ANEEL are aimed at the training and technological development of electric energy companies, with the purpose of generating new processes or products, or improving their characteristics (ANEEL, 2012), converging with Schumpeter's (1989) study regarding innovation. They are managed by the company, through its own structure and technological management. The R & D project should be framed in its proposed phase for development within the innovation chain. The maximum duration allowed for an R&D project is 60 months (ANEEL, 2012). Thus, it is observed that innovation is a result of R&D strategies developed by companies through institutions (POSSAS, 1989).

The activities related to the execution of R&D projects are related to the creative or entrepreneurial nature, with a technical-scientific basis, designed to the generation of knowledge or to the innovative application of existing knowledge. The success of a project depends on the technical-scientific qualification of the researchers involved in the execution of the project and the nature of the products regarding scientific creativity and technological innovation. In this way, the transformation of research results into technological innovation is the mainspring of R&D Program regulated by ANEEL (ANEEL, 2012). The innovation performance depends on the perception of opportunities, the skills of the professionals involved in the innovation process (DOSI, 1982), and the application of acquired knowledge (TROT, 2012).

4.2 - Regulatory frameworks relevant to innovation

Pursuant to Law No. 9,991 of July 24, 2000 (as amended by Laws No. 10,438, dated April 26, 2002, No. 10,848, March 15, 2004, No. 11,465, dated March 28, 2007, No. 12,111, Of December 09, 2009, and n° 12.212, of January 20, 2010), concessionaires of public services of distribution, transmission or generation of electric power, permission holders of public services of distribution of electric energy and those authorized to the independent production of electric energy, excluding those that generate energy exclusively from wind, solar, biomass, qualified cogeneration and small hydropower plants, must annually apply a minimum percentage of their Net Operating Revenue (NOR) in Research Projects and Technological Development of the Electric Energy Sector (R&D), according to regulations established by ANEEL.

It is the responsibility of ANEEL regulate investments in research and development (R&D) and energy efficiency (EE), encouraging the constant search for innovations needed to meet the technological challenges of the electricity sector, or promoting the efficient and rational use of energy, associated to the actions to combat energy waste. Frame 3 shows the regulatory frameworks of ANEEL.

Frame 3: Regulatory Frameworks, ANEEL

Year	Framework
Law no. 9,427, of 26 December 1996	Establishes the National Electric Energy Agency (ANEEL), which regulates the regime for concessions of public electric energy services and provides other measures.
Decree no. 2,335, dated October 6, 1997	Is the National Electric Energy Agency - ANEEL, local authority under special arrangements, approves its structure and Regimental Table showing of commissioned positions and roles of trust and takes other measures.
Decree MME no. 349 of November 28, 1997	Approves the Internal Regulation of the National Electric Energy Agency - ANEEL.
Resolution no. 284 Resolution of 09/30/1999	It delegates powers to the Superintendents from Superintendence of Regulation of Electricity Commercialization - SRC, of ANEEL, to practice administrative acts of approval of energy efficiency programs and the standards of the concessionaires, and of Regulation Superintendence of Distribution Services - SRD, for approval of Research Programs presented by the concessionaires.
Law 9,991 / 2000, art. 1	Concessionaires and licensees of electricity distribution were obliged to apply at least 0.75% of NOR in research and development in the electricity sector and 0.25% in Energy Efficiency (EE) in the final use; and it should

	be noted the transition period of these percentages (ANEEL, 2012).
Law no 9,991/2000, art. 4	Investments in research and development should be distributed as follows: - 40% of the resources must be collected to the National Fund for Scientific and Technological Development (FNDCT); - 40% of the resources should be allocated to the execution of R&D projects regulated by ANEEL; - 20% of the resources must be collected from the Ministry of Mines and Energy (MME)
Law 9,991 / 2000, art. 5, item II	At least 30% of the aforementioned investments should be earmarked for projects developed by research institutions located in the north, northeast and center-west regions, including the respective areas of the Regional Superintendencies.
Resolução n ° 271 of 07/19/2000	Establishes for the concessionaires and permission holders of the public electricity distribution service, the criteria for applying resources in actions to combat electric energy waste and research and technological development of the Brazilian electric sector.
Resolution 502 11/26/2001	Approves the Manual of Research Programs and Technological Development of the Brazilian Electric Sector.
Resolution no. 352 of 08/24/2001	Extends the term for the collection of R&D resources allocated to the National Fund for Scientific and Technological Development (FNDCT)
Resolution ANEEL no. 185 of 05/21/2001	Establishes criteria for calculation and application of resources for Research and Development, as well as Energy Efficiency, by concessionaires, licensees and authorized companies in the electric energy sector.
Normative Resolution n° 219 of 04/11/2006	Approves the Manual of the Research Programs and Technological Development of the Electric Energy Sector, version 2006, as well as approves the inclusion of changes in the Manual of Accounting of the Public Service of Electric Energy, changes the art. 7 of ANEEL Resolution 271 of July 19, 2000 and paragraph. 1 of article 1 of ANEEL Resolution 185 of 05/21/2001.
Normative Resolution No. 233 of 10/24/2006	Establishes the criteria and procedures for the calculation, application and collection, by concessionaires, permission holders and authorized, the resources provided for in the Law no. 9,991, dated July 24, 2000.
Law no. 9.991/2000, amended by Law no. 12,212, of January 20, 2010.	Minimum percentages of NOR to invest in R&D programs until 12/31/2015: generation: 1% of NOR; transmission: 1% of NOR; distribution: 0.50% of NOR. Since 01/01/2016: Generation: 1% of NOR; transmission: 1% of NOR; distribution: 0.75% of NOR. Source: ANEEL (2012).
Normative Resolution no. 408 of 08/03/2010	Changes the art. 5 and includes articles 17 and 18 in the Normative Resolution no. 316 of 05/13/2008, correcting the name of the Manual of Accounting for the Electricity Sector (MCSE) and allowing companies, regardless of the commercial venture start-up, to anticipate investments in R & D projects, for future compensation. * In the period prior to the publication of Law 9.991 / 2000 for some concessionaires, they had specified specific mandatory R & D investment clauses in their concession contracts.
Normative Resolution no. 495 06/26/2012	Approves the Manual for Auditing of Energy Efficiency and Research and Technological Development Programs of the Electric Energy Sector governed by Normative Resolutions 176/2005 and 219/2006, and its previous regulations.

Source: ANEEL (2016).

It can be seen from Frame 3 that the regulatory frameworks related to ANEEL show the importance given to R&D projects and to promotion of innovation. The concern of the Agency with this theme began in 2000, and continued in the following years, advancing and establishing new criteria for the generation of R&D and innovation in the electricity sector, either in process improvement, or new products and actions of employees of partner companies. In this way, by means of institutions and their characteristics as rules (NORTH, 1993), habits, examining the need for strategies (SELZNICK, 1996), and the changes that can be made over time

(MEYER; ROWAN, 1972), the electricity sector is developing, and innovating in their processes of energy generation.

4.3 – ANEEL R&D program and its impact on a power generation company

The impact felt by an energy generation company as ANEEL actions regarding regulation and incentives and promotion of innovation in the sector are reported below.

4.3.1 - Understanding ANEEL institutional role

According to the interviewee:

"ANEEL is the regulatory agent of the energy sector. Talking specifically about research and development (R&D), ANEEL sets the regulatory framework for the management of R&D program and, more recently, has proposed some specific themes of projects through Strategic R&D Calls.. Thus, the action of ANEEL has an impact on the program adjustment and direction of investments". The words of the interviewee refer to the functions of institutions, such as providing incentives (LEMOS, 2013) and determining the rules to be followed (NORTH, 1993; FIANI, 2011).

4.3.2 - Company position compared to the regulatory frameworks and resulting projects

"The Company has always fast adaptation to changes in regulatory framework. In cases where we understand that the amendment will promote retrocession, we work with the class associations in order to promote a discussion about the theme. A change promoted in 2012 eliminated the initial evaluation process of the projects, increasing the company risks, since we no longer have the signage of ANEEL on the requirements of the projects (mainly originality) We started a discussion at ANEEL, which culminated in the hiring of a project to identify the main themes of investment in R&D. The project aims to identify themes and subthemes for investment in projects". In this way, it is understood that ANEEL, as an institution, may modify its determinations over time (MEYER; ROWAN, 1972), but that their actions can also reduce uncertainty and risk (LEMOS, 2013), approving the execution of research about the sector, as well as following the results (AGUIAR, 2009).

4.3.3 - Role of ANEEL in the promotion and innovation orientation in the electricity sector

"ANEEL has very important role in this process. We understand that ANEEL acts as a facilitator either in proposing strategic issues (and that will face the challenges of the sector), or approaching the different agents that have common interests. "Thus, it is noted that new opportunities are afforded by ANEEL as institution, as Nelson and Winter (1982) explain.

4.3.4 - ANEEL impact on actions in the company and competitors

"The regulatory framework and its amendments have the same impact on companies of the sector. We were not able to identify any situation where only some agents have been benefited or harmed." Through the manager words, it is observed that the Agency is in favor of a transparency attitude that registers in its institutional design.

5. Conclusions

The objective of this study was to "review the actions that ANEEL has currently developed with the aim of encouraging innovation in the Brazilian electrical matrix and its impact on an energy generation company." It was verified that ANEEL, in addition to regulating the Brazilian electric sector, seeks to promote innovation in the sector through institutions. This occurs by means of Law 9.991/2000, which obliges the NOR in R&D.

In order to comply with the obligation to invest in R&D, companies must submit their projects to the ANEEL evaluation, containing information on the expected results and their applicability, expected execution costs and financial return expectation, relevance of the study to topics of interest to the electric sector, degree of innovation or technological advancement.

ANEEL actions regarding R&D started in the year 2000 and have advanced over time. The Agency still has actions for the development of specific regions in Brazil as north, northeast and central-west. R&D projects governed by ANEEL are intended for training and technological development of electric power companies, with the aim of generating new processes or products, or improvement of their characteristics. The activities related to the implementation of R&D projects concern to creative or entrepreneurial nature, with a technical-scientific basis, and aimed at the generation of knowledge or innovative application of existing knowledge.

Regarding the impact the ANEEL actions exert on businesses that generate energy, it was realized that the Agency impacts on the program adjustment and direction of investments to be made. Regarding regulatory frameworks, the company seeks to adapt quickly to changes and relies on the institutions to conduct its R&D projects. ANEEL plays the role of facilitator both in proposing strategic themes as approaching different actors with common interests.

By means of the presented results, the objective is to take a first step toward the understanding of the innovation process in Brazilian electricity sector. In this sense, from the theoretical relations between institutions and innovation, it was shown that those are capable of influencing an innovative process.

Although there is scientific and methodological rigor, the study has limitations. The first limitation is that the interviewee was chosen for accessibility and convenience. Regarding the methodological limitations, one has to use the qualitative approach, which can rely on the researcher's interpretation. As for the theoretical limitations, there was a lack in studies related to institutional theory and the electric energy sector.

As suggestions for future work, it is also proposed to investigate the impact of ANEEL actions on transmission and distribution companies, so that the impact of the institutions on the innovation of the electric sector as a whole can be known.

References

- ANEEL. (2012). Agência Nacional de Energia Elétrica (Brasil). Manual do programa de pesquisa e desenvolvimento tecnológico do setor de energia elétrica / Agência Nacional de Energia Elétrica. – Brasília: ANEEL.
- APOLINÁRIO, F. (2012). Metodologia da ciência: filosofia e prática da pesquisa. 2 ed. São Paulo: Cengage Learning.
- AREND, M.; CARIO, S. A. F.; ENDERLE, R. (2012). Instituições, inovações e desenvolvimento econômico. Pesquisa & Debate. Revista do Programa de Estudos Pós-Graduados em Economia Política, Vol. 23, n. 1.
- BARDIN, L. (2009). Análise de conteúdo. Lisboa: Edições, Vol. 70.
- BAUER. M. W.; GASKEL. G. (2003). Pesquisa qualitativa com texto, imagem e som. Um manual Prático. 2 ed. Editora Vozes. Petrópolis. RJ.
- BERGER, P. L.; LUCKMANN, T. (1996). A construção social da realidade: tratado de sociologia do conhecimento. Petrópolis: Vozes.
- BERNINI, E. J. (2010). Painele: perspectivas para o ambiente regulado. Cenário e tendências. Governança corporativa e governança pública no ambiente de negócios regulados: reflexões para o caso do setor elétrico brasileiro. Palestra proferida em Seminários de Energia Elétrica Agências reguladoras: papel e atuação no setor elétrico. São Paulo, 2010. Available in: http://www.abdib.org.br/arquivos_comite/bernini_negocios-regulados.
- BESSANT, J.; TIDD, J. (2002). Inovação e empreendedorismo: administração. Bookman Editora, 2009.
- CONCEIÇÃO, O. A. C. (2002). Instituições, Crescimento e Mudança na Ótica Institucionalista. Teses FEE. Porto Alegre.
- CONCEIÇÃO, O. A. C. (2012). Há compatibilidade entre a “tecnologia social” de Nelson e a “causalidade vebleniana” de Hodgson? Revista de Economia Política, Vol. 32: pp. 109-127.
- CRESWELL, J. W. (2010). Projeto de pesquisa: métodos qualitativo, quantitativo e misto. 3. ed. Porto Alegre: Artmed.
- CROSSAN, M. M.; APAYDIN, M. (2010). A multi-dimensional framework of organizational innovation: a systematic review of the literature. Journal of Management Studies, Vol. 47: p. 1155-1191.
- DIMAGGIO, P. J.; POWELL, W. W. (2005). A gaiola de ferro revisitada: isomorfismo institucional e racionalidade coletiva nos campos organizacionais. Revista de Administração de Empresas, Vol. 45: pp. 74-89.
- DOSI, G. (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Reserch Policy, pp. 147-162.
- DOSI, G. (1988). The nature of the innovative process. In: DOSI, Giovanni et all (ed.). Technical change and economic theory. London: MERIT, pp. 221-238.
- DOSI, G. (1984). Technical Change and Industrial Transformation. Palgrave Macmillan UK.
- EDQUIST, H. (2005). The Swedish ICT miracle-myth or reality? Information Economics and Policy, Vol. 17: pp. 275-301.
- FARIAS, P. C. L.; RIBEIRO, S. M. R. (2014). Regulação e os novos modelos de gestão no Brasil. Revista do Serviço Público, Vol. 53: pp. 79-94.
- FIANI, R. (2011). Cooperação e conflito: instituições e desenvolvimento econômico.

- GODOY, A. S. (1995). Introdução à pesquisa qualitativa e suas possibilidades. *Revista de administração de empresas*, Vol. 35: pp. 57-63.
- HODGSON, G. (2002). The evolution of institutions: an agenda for future theoretical research. *Constitutional Political Economy*, Vol. 13: pp.111-127.
- LEMOS, D. C. (2013). A interação universidade-empresa para o desenvolvimento inovativo sob a perspectiva institucionalista- evolucionária: uma análise a partir do sistema de ensino superior em Santa Catarina. Tese (doutorado) - Universidade Federal de Santa Catarina, Centro Socioeconômico. Programa de Pós-Graduação em Administração. Florianópolis, SC.
- LEMOS, C.; LASTRES, H. M. M.; ALBAGLI, S. (1999). Inovação na era do conhecimento. *Informação e globalização na era do conhecimento*. Rio de Janeiro: Campus, pp. 122-144.
- LOSEKANN, L. D. (2003). Reestruturação do setor elétrico brasileiro: coordenação e concorrência. Tese de Doutorado. Universidade Federal do Rio de Janeiro.
- LUNDVALL, B., BORRÁS, S. (1997). The globalizing learning economy: implications for innovation policy. Brussels: European Commission, Directorate General XII – Science, Research & Development.
- MALERBA, F.; ORSENIGO, L. (1997). Technological regimes and sectoral patterns of innovative activities. *Industrial and corporate change*, Vol 6: pp. 83-117.
- MEYER, J. W.; ROWAN, B. (1977). Institutionalized organizations: formal structure as myth and ceremony. *American Journal of Sociology*, Vol. 83: pp. 340-363.
- NELSON, R. R.; WINTER, S. G. (1977). In search of useful theory of innovation. *Research policy*, v. 6: pp. 36-76.
- NELSON, R. R.; WINTER, S. (1982). *An evolutionary theory of economic change*. Estados Unidos: Harvard U. P.
- NORTH, D. (1993). Desempenho econômico en el transcurso de los años. Conferência de Douglass C. North em Estocolmo, Suécia, 9 de dezembro de 1993 - Prêmio Nobel de Ciências Econômicas.
- OLIVEIRA, R. G.; TOLMASQUIM, M. T. (2004). Regulatory performance analysis case study: Britain's electricity industry. *Energy Policy*, Vol. 32: pp. 1261-1276.
- PACHECO, R. S. (2006). Regulação no Brasil: desenho das agências e formas de controle. *Revista de Administração Pública*, Vol. 40: pp. 523-543.
- PINTO, S. R. R.; MAISONNAVE, P. R. (2012). Inovação e investimentos no setor elétrico brasileiro sob a ótica de gestores de R&D. *RAI: revista de administração e inovação*, Vol. 9: pp. 04-27.
- PÓ, M. V.; ABRUCIO, F. L. (2004). Gênese e indefinições da accountability nas agências reguladoras brasileiras: o caso da Anatel e da ANS. *Encontro Anual da Anpad, Anais...Vol. 28*.
- POSSAS, M. L. (1989). Em direção a um paradigma microdinâmico: a abordagem neo-shumpeteriana. *In: AMADEO, E. J. Ensaio sobre economia política moderna: teoria e história do pensamento econômico*. São Paulo: Zero.
- PRADO, O. (2006). Agências reguladoras e transparência: a disponibilização de informações pela Aneel. *Revista de Administração Pública*, Vol. 40: pp. 631-646.
- ROGERS, E. M.; SHOEMAKER, F. F. (1971). *Communication of Innovations: a cross-cultural approach*.
- SALGADO, L. H.; MOTTA, R. S. (2005). Marcos regulatórios no Brasil: o que foi feito e o que falta fazer.
- SCHUMPETER, J. A. (1989). *Teoria do desenvolvimento econômico*. São Paulo: Abril Cultura.
- _____. J. A. (1984). O Processo da Destruição Criadora. *In: SCHUMPETER, J. A. Capitalismo, socialismo e democracia*. Rio de Janeiro: Fundo de Cultura.
- _____. J. A. (1961). *Teoria do desenvolvimento econômico*. Fundo de Cultura.
- SCOTT, W. R. (2001). *Institutions and organizations*. Thousand Oaks-CA: Sage.
- SELZNICK, P. Institutionalism “old” and “new”. *Administrative Science Quarterly*, Ithaca, Vol. 41: pp. 270-277.
- STAKE, R. E. (2000). Case studies. *In: DENZIN, N. K. (Edit.); LINCOLN, Y. S. (Edit.). Handbook of qualitative research*. Thousand Oaks: SAGE.
- TOLBERT, P. S.; ZUCKER, L. G. (2007). A institucionalização da teoria institucional. *In: CLEGG, S. R.; HARDY, C.; NORD, W. (Orgs.). Handbook de estudos organizacionais*. São Paulo: Atlas.
- TRIVINOS, A. N. S.(1992). *Introdução à Pesquisa em Ciências Sociais: a pesquisa qualitativa em educação*. São Paulo: Atlas.
- TROT, P. (2012). *Gestão da inovação e desenvolvimento de novos produtos*. Porto Alegre: Bookman.
- VAN DE VEN, A. (1986). Central problems in the management of innovation. *Management Science*, pp. 590-608.

- ZALTMAN, G.; DUNCAN, R.; HOLBECK, J. (1973). *Innovations and Organizations*. New York: Wiley Interscience.
- ZAWISLAK, P. A. (1996). Uma abordagem evolucionária para análise de casos de atividade de inovação no Brasil. *Ensaio FEE*, Porto Alegre, Vol. 17: pp. 323-354.
- ZHUANG, L. (1995). Bridging the gap between technology and business strategy: a pilot study on the innovation process. *Management Decision*, Vol. 33: pp. 13-21.
- ZYSMAN, J. (1994). How institutions create historically rooted trajectories of growth. *Industrial and corporate change*, Vol. 3: pp. 243-283.