An overview of the network for research and development (R&D) on public policy of the Brazilian electricity sector

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ABSTRACT

A public policy consists of an intentional course of action that is implemented in order to achieve a goal. On the other hand, public policy networks are a relatively stable set of independent relationships, which bind a variety of actors who share common interests in reference to a policy. The Law 9,991/2000 established the regulatory framework of public policy on R&D in the energy sector, delegating the responsibility for implementing this policy to ANEEL and to FINEP. In order to implement this public policy two sub-networks were formed under the coordination to ANEEL and FINEP and the conjunction of their actions constitute a larger R&D network addressed to promote the development of the Brazilian electricity sector. Thus, the target of this paper is to present an overview of the network of public policy on R&D of the Brazilian electricity sector and identify some of its dimensions, such as the number and type of actors, structure and degree of institutionalization, and role and type of relationship predominate among its participants. As a result of the analysis one can conclude that there was a notable mobilization of actors and financial resources in this network. However, the R&D Program network regulated by ANEEL is more efficient than the CT-Energ network, despite equal resources earmarked by law for both because of differences in how the two institutions coordinate investments. One explanation for the low investment in CT-Energ could be due to the Brazilian Federal Government expenditure restrictions, which were imposed to facilitate primary surplus targets. It is also important to highlight that network coordination by ANEEL generated mostly incremental innovations in the process, what it may find explanation in the degree of the technological maturity of the electricity sector. Note also that the network for R & D policy, especially the Program regulated by ANEEL, has sought to encourage the involvement of industry in the innovation process, aimed at enhancing the generation of product innovations and consequently to increase the quantity of Brazilian patents. Data prove that the actions of the network for R&D of the electricity sector have been meaningful. However, it is observed that CT-Energ needs to broaden its actions. Furthermore, the actions of both networks (R&D Program regulated by ANEEL and CT-Energ) should be more integrated in order to avoid redundancies and gaps in policy.

PREFACE

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INTRODUCTION

The public policy networks are a relatively stable set of independent relationships, which bind a variety of actors who share common interests in reference to a policy. (BÖRZEL, 1997)

A network policy can exert distinct functions, including exchange and resource mobilization, coordination of activities, and cooperation in the formulation, management and legitimacy of public policy.

Thus, the target of this paper is to present an overview of the network of public policy on R&D of the Brazilian electricity sector, and identify some of its dimensions, such as the number and type of actors, structure and degree of institutionalization, and role and type of relationship predominate among its participants.

The work is divided into five sections, excluding the introduction and conclusion. The first section presents an overview of public policies, addressing aspects of formulating and setting the agenda of the Government.

Section 2, in turn, deals with issues related to public policies for science and technology (S&T), presenting how they originated and became important in governments. In this context it is necessary to emphasize the importance of the Vannervar Bush's report, which established a paradigm of science and technology policy.

Section 3 presents the main landmarks in the development of public policies for science and technology in Brazil since the creation of CNPq (National Council for Scientific and Technological Development) in 1951 until the Program to Accelerate Growth of Science

in 2007. Also in this section, we address aspects of the macroeconomic context and the creation of a regulatory framework for R&D policy of the Brazilian electricity sector.

Next section 4 brings the concepts and dimensions of the policy network and its role as a mechanism to mobilize political resources in situations where they are dispersed between public and private sectors.

Section 5 details the network of R&D policy of the electricity sector, its basic structure of operation, its main actors and the results achieved since its creation. Based on the evidence reviewed, it appears that the sub-network coordinated by ANEEL has generated, in large part, incremental innovations in the process, probably due to the maturity level of electricity sector.

Finally, the conclusion provides an analysis of results of R&D network of the electricity sector. This network is shaped around two basic axes, the CT-Energ and ANEEL R&D Program, both of which have achieve significant results. The number of actors and the whole structure of S&T involved, and the amount of financial resources employed are remarkable. However, some actions are necessary to broaden the investment sub-network formed around the CT-Energ, whose investment has been restricted due to the curtailment of budgetary resources from the federal government of Brazil, tied to the goals of primary surplus. Moreover, there is room for greater integration between the network players.

1. PUBLIC POLICIES

1.1. Public policy as a social learning process

A public policy consists of an intentional course of action that is implemented in order to achieve a goal. (THEODOULOU, 1995)

According to Hall (1993 *apud* Bonafont, 2004), the process of policy-making is a social learning process, understood as a deliberate intention to set goals and techniques of public policy according to past experience and new information.

The social learning model assumes that there are several ways to understand the problems, and the selection of one idea over another is the result of debate and persuasion about how understanding public problems and forming ways to solve them. This agreement breaks the model of rational choice, which preaches the existence of a unique way to understand the problems and set policy goals. (BONAFONT, 2004)

Understanding public policy, as a social learning process still requires a break with perspectives that define the process of policy-making as the result of competition among interest groups. Although the interests are important, they by themselves do not explain the policy outcome, because they are conditioned by the ideas available and by the institutional structures.

1.2. Public policy formulation and setting the agenda for Government

According to Kingdon (1995), the formulation of public policy involves the following processes: 1) the establishment of an agenda, 2) the specification of alternatives from which choices are made, 3) a final choice among these alternatives determined by a vote of the legislative or presidential decision, and 4) the implementation of this decision. The author points out that the success in one of the processes does not necessarily imply the success of every process.

A major issue in setting the government agenda is to understand why some issues are prioritized while others are neglected. The establishment of the governmental agenda focuses on three explanations: problems, policies, and visible participants (KINGDON, 1995).

Some problems receive more attention than others by government authorities as a result of both the means in which actors are aware of situations (indicators, and feedback-focus events), and the ways in which these situations were defined as a problem. The recognition of problems is a critical step for setting agendas, and the chances of an issue becoming relevant increases when it is associated with a major problem.

In turn, developments in the political sphere are also powerful agenda setters. Participants perceive changes in the national political atmosphere; elections bring to Congress new politicians and political parties; and various types of interest groups pressuring the government with their demands. (KINGDON, 1995)

The entry of one question in agenda setting is also due to the visible actors, which are those that receive considerable attention from the press and the public and includes the president and his senior advisors, key members of Congress, the media and actors related to the election process (political parties and campaign committees). On the other hand the invisible actors are academics, career bureaucrats and congressional staffers. The visible actors set the agenda and invisible actors have greater power to influence the choice of alternatives.

Thus, one can conclude that elected politicians and visible actors are influential in the formulation of agendas, but do not necessarily succeed in imposing their will in terms of specification or implementation of alternative decisions.

On the other hand, invisible participants (communities of experts) generate alternatives, proposals and solutions, and their target is planning and evaluating or setting the budget together for the bureaucracy and its employees.

The choice of alternatives for public policy pass through the following filters until an approach is decided: a) the alternatives are generated and filtered in the dynamics of public policy and b) the involvement of participants relatively invisible (specialists in the area of their specific policies).

The best way to understand the emergence of alternatives for public policy is to see it as a selection process, analogous to the natural selection process where ideas emerge initially, wildly colliding with each other, generating new ideas and forming combinations and recombinations.

The dynamics of the problems, government policies and the policy itself each have their own lives. However, sometimes these three dimensions converge, appearing like a "window of opportunity" that will provide input on the agenda of the decision. Therefore, as the three elements - problem, public policy proposals and receptivity in the political sphere -

are connected, the greater the probability that an item becomes a priority in agenda decisions. (KINGDON, 1995)

The following sections will address issues related to public policies for science and technology, presenting them as they originated and gained ground in the government, including in the Brazilian context.

2. PUBLIC POLICY FOR SCIENCE AND TECHNOLOGY (S&T)

2.1. A brief history

For a long time, science and technology were seen as disconnected universes that operated according to logic and independent individuals. From the late nineteenth century it becomes clear the proximity between scientific rationality and industrial progress. The internalization of the scientific method by the industry to generate new technology emerges as a decisive factor that made the leap in productivity and the emergence of important innovations that characterized the Second Industrial Revolution, whose most striking examples are the chemical and electromechanical.

However, the addition of issues related to science and technology to government accountability is relatively recent. It was from World War I, when many research institutions were created to coordinate scientific research in the context of the war effort that the relationship with the State's scientific activity began to narrow. (CONDE, 2004)

During this period, surveys were developed in order to adapt military technology to civilian needs of war. One example was the tank, resulting from the adaptation of a cannon or a tank of gas usage from the progress made in chemical science to civilian life.

In the period before World War II, the state acted as a protector, patron, client and director of science. The closer relationship between state and science accelerated in the postwar period, settling more firmly to the time of World War II. At that time the military

research led to the development of the first atomic bomb and became a source of new technologies that came to be used extensively in civilian life, such as atomic energy, radar, jet airplanes, and computers, among others.

It was after World War II, with the creation of governmental institutions and implementation mechanisms and procedures for coordination that, in fact, these interventions became organized, planned and institutionalized. (CONDE, 2004)

The scientific policy is then understood as a set of measures taken by the government for, on the one hand, encouraging the development of technical and scientific research and, on the other hand, exploring their results to achieve overarching political goals.

2.2. Paradigm of S&T policy - report of Vannevar Bush

At the end of World War II, unlike the demobilization of scientists that occurred after World War I, there was a science mobilization in an articulated and systematic way in order to seek advantages and benefits of research activities to achieve economic and social objectives nationally and internationally. The most significant and representative document of this change was the report "Science, the Endless Frontier" written by Vannevar Bush, U.S Director of the Office of Scientific Research and Developments during the war. (STOKES, 2005)

Bush's report established a vision of how the United States could maintain its investment in scientific research when the war was over. This document recommended the establishment of a national body with the task of supporting and encouraging basic research, scientific education and developing of a national policy specifically focused on scientific activities.

As a result of Bush's recommendations in 1950, the U.S. created the National Science Foundation (NSF) and by the end of the 50s, most industrialized countries had created organizations with the same goals (to subscribe researchers and laboratories, to guide research and to allocate resources in priority sectors) (CONDE, 2004)

The report "Science, the Endless Frontier" brought questions about the compatibility to set strategic directions for research and about the instruments with which they must operate a policy of S&T. In Bush's view, basic research and applied research should have a natural separation. For him the "applied research invariably drives out pure research" whether the two are mixed. Bush believed that basic research should be properly insulated in order to avoid premature considerations about its usefulness. In this way one would be a powerful generator of technological progress, as the applied research and development were converting basic science discoveries into technological innovations to meet the needs of society. (STOKES, 2005)

One could say that the report "Science, the Endless Frontier" established a paradigm of science and technology policy, spreading the conception of innovation's dynamics later called the linear model of innovation, which dominated thinking about S&T.

3. BRAZILIAN PUBLIC POLICY FOR S&T

3.1. Major landmarks

The systematic funding of science in Brazil began to occur in 1951 with the creation of two national agencies: *Conselho Nacional de Desenvolvimento Científico e Tecnológico* - CNPq (National Council for Scientific and Technological Development) and *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* - CAPES (Coordination for the Improvement of Higher Education).

From the late 1960s, the structure of the sector of Brazilian S&T bounded by efforts undertaken by government planning, whose initial marks were the inauguration of the *Financiadora de Estudos e Projetos* - FINEP (Research and Projects Financing), in 1967, and the creation of the *Fundo Nacional de Desenvolvimento Científico e Tecnológico* - FNDCT (National Fund for Scientific and Technological Development). The FNDCT was established

by Decree-Law 719/69 and re-established by Law 8,172/91. (VELLOSO FILHO; NOGUEIRA, 2006)

In 1972, the sector was organized in a systematic way, and thus outlined the –*Sistema Nacional de Desenvolvimento Científico e Tecnológico* - SNDCT (National System for Scientific and Technological Development), whose goal was to promote greater integration of activities relating to S&T undertaken in the country. The SNDCT, whose overall coordination fell to CNPq, was then formed by all organizational units that used government resources to conduct planning, supervision, coordination, encouragement, enforcement or control scientific and technological research. (VELLOSO FILHO; NOGUEIRA, 2006)

So, an extensive administrative reform was conducted in order to implement an overall strategy for Brazil's development, organized by centralized economic planning. The Basic Plans for Science and Technology were included in the three *Planos Nacionais de Desenvolvimento* – PNDs (National Development Plans), established, respectively, for the periods 1972-1974, 1975-1979 and 1980-1985. (SALLES FILHO, 2002)

In 1984, with World Bank resources, it deployed *Programa de Apoio ao Desenvolvimento Científico e Tecnológico* -PADCT (Support Program for Scientific and Technological Development). The program, coordinated by CNPq, was conceived as an instrument of policy to supplement government resources in funding S&T, based on a model that required the consideration of national resources to World Bank resources. However, due to increasing scarcity of public resources, the PADCT, that only should complement public spending on S&T, became a major source of funding of S&T in Brazil. (BARRELLA, 1998)

Despite the original speech to support priority sectors and to strengthen the linkages with the productive sector, in practice, PADCT seems to have been conceived in the conceptual framework of the linear system of innovation. The loans granted were directed more to basic research than to applied research. Moreover, the participation of private agents in the products generated was scarce. One could say that this form of resource allocation relied on the logic that the basic and applied research would necessarily lead to socioeconomic processes of innovation. (BARRELLA, 1998).

In 1985, Decree 91,146 established the Ministry of Science and Technology (MCT). Among his responsibilities include: development of scientific and technological assets, the

policy of cooperation and exchanges concerning the property of technological assets, the definition of national policies for science and technology and innovation, information technology, R&D, and the coordination of sector policies. (MCT, 2010)

FINEP and CNPq were incorporated into MCT's structure, which went on to coordinate the work of implementing the programs and actions aimed to consolidate the National Policy for Science, Technology and Innovation.

In 1993 the Law 8,661 was published encouraging the companies to carry out R&D. This law was only effective between 1994 and 1998, since it was modified by Law 9,532/97, which reduced its benefits making it ineffective.

The Law 8,661/93, repealed by Law 11,196/2005 (Law of Good) stipulated that Industrial Technology Development Programs - PDTI and Agriculture Technology Development Programs - PDTA, would boost the technological capability of industry and agriculture. Companies prepared projects for PDTI / PDTAs and submitted them to the approval of the MCT, with aims to generate new products or processes, or improve them, through R&D with implementation periods not exceeding five years under a favorable tax regime. (PACHECO, 2007)

The S&T policies implemented showed an asymmetry of the system, where the strengthening technology of the companies did not follow the success of graduates. This dimension has always been the weak part of the model and its weakness, instead of conducting the review of policies, strengthened its "academic" side. (PACHECO, 2007)

According to Pacheco (2007), several factors contributed to the fragility of the business side of Brazilian technology policy: (a) the dynamics of import substitution, (b) economic instability, of the ’80s and ’90s; (c) economic policies addressed in the short-term, (d) the fiscal fragility; (e) the crisis of the state productive sector and privatization; (f) small-scale of private national groups; (g) the weak cooperation between enterprises; (h) low international insertion of Brazilian company and foreign subsidiaries; (i) the absence of a system of non-university research institutes, (j) the inadequacy of the institutional apparatus of the S&T policy.

The main objective of the 1999 Brazilian reform, which culminated with creation of a set of sectorial funds, was to overcome the historical disconnection between the policy of S&T and industrial policy, coupled with the proposal for a resource mobilization in order to overcome the instability of public spending on S&T.

The sectorial funds are financing instruments for research, development and innovation projects in Brazil whose model of operation was based on the experience of CT-Petro (Sectorial Fund Oil and Natural Gas), the first sectorial fund created in Brazil, whose purpose was to integrate the participation of universities, research centers, providing complementary tools for innovation support. (PACHECO, 2007)

The sectorial funds were created with a view to radically change the financial landscape of the Brazilian S&T sector, and to modify the relationship of MCT and its agencies (CNPq and FINEP) with other sectorial agencies of the Federal Government.

According to Pacheco (2007), the period from 1999 to 2002 had few precedents with regard to the creation of policies to encourage innovation by the Brazilian federal government. The creation of sector funds was indisputably a policy of great impact on the state investments in R&D. Nowadays there are seventeen sectorial funds in strategic areas like energy, telecommunications, petroleum and biotechnology.

Another important measure taken by the Government to improve the performance levels of R&D was the Innovation Law, approved in December 2004 and regulated by Decree 5,563 on October 11, 2005. This law was designed in order to promote innovation in private companies and encourage partnerships between universities, research institutes and companies, and to facilitate hiring researchers attached to universities.

In 2005 Law 11,196 (Law of Good) was published, which provides for tax incentives for technological innovation. The Innovation Law and the Law of Good constitute the regulatory framework that enables the provision of economic support in Brazil.

More recently, some other incentive measures for ST&I implemented by the Brazilian government were: a) the Program to Accelerate Growth of Science, launched in 2007, which foresaw an investment program of 41 billion dollars by 2010 and a target to increase investment in R&D to 1.5% of GDP, and b) Productive Development Policy (PDP), launched

in 2008, which includes spending and fiscal targets for key sectors such as IT, biotechnology and energy. One of those goals was to increase private spending in R & D to 0.65% in GDP in 2010.

3.2. The R&D policy of the Brazilian electricity sector

3.2.1. Understanding the Brazilian electricity sector - macroeconomic aspects

The development of the Brazilian electricity sector has been influenced by the Brazil's continental size and its enormous hydropower potential, where significant economies of scale resulting from the construction of huge hydroelectric dams, led to the creation of an interconnected system of power transmission, in which the utilities shared the costs of transmission lines. (FERREIRA, 2000)

Brazil implemented a centralized model with distribution's regional monopolies, followed by the development of a "centralized dispatch" that maximized the efficiency of hydroelectric power facilities. This centralized system, besides being considered the most efficient model in technical and economic terms also converges to the growth model boosted by state that prevailed in Brazil after World War II.

With the import substitution model, the public sector became responsible for investments in capital-intensive infrastructure but of the low return, they were natural monopolies.

Although the centralized model seemed to work reasonably well, it was not fully comprehensive in that, while theoretically it left only to state governments the responsibility for electricity distribution, the governments of the richest regions (south and southeast) have withstood the centralized model and implemented aggressive program investments to create their own generation and transmission assets. (FERREIRA, 2000)

The centralized system also included the *Departamento Nacional de Águas e Energia Elétrica* – DNAEE (National Department of Water and Electric Power), responsible for

distributing the grants for the generation, transmission and distribution of electricity. However, according to the old model, there was no need to request bids for the distribution of grants. The DNAEE also had no role in setting rates for the sector, their participation being further reduced after 1975, when the Ministry of Finance started to deal with the readjustment of rates as part of efforts to control inflation. (DIAS, 1988)

Because of the centralization of planning and operation and in some way also of financial resources invested, the power sector grew rapidly in the end of the 1960s and 1970, reflecting the growth in the economy as a whole, while continuing to subsidize industrial consumers.

In early 1980 the centralized model began to show signs of economic and financial weakness. The centralization of planning and the ease of obtaining financing meant that investments were not submitted to a previous analysis of discounted cash flow.

Moreover, as there was a guaranteed return on assets, there was no incentive for increased efficiency. The companies of electric utilities, like other state enterprises in other industries, had no control over their operational costs, which is particularly damaging, given the different nature of investments, maintenance costs and returns involved in the different activities of generation, transmission and distribution of electricity.

In 1982, Brazil experienced a severe fiscal crisis and high economic stagnation, due the collapse of international funding that followed Mexico's default on its foreign debt. Consequently, to alleviate the effects of the crisis, the utilities reacted by reducing their investment programs as demand fell and increased borrowing costs. However, this reaction proved to be insufficient, given the need of investments for maintenance and minimal expansion necessary. Thus, most of the companies had no choice but to expand lending activities and increase their leverage.

As the government did not allow a proper adjustment of rate, nor allowed the compensation mechanism via CRC (Accounts Results to Compensate), companies could not rely their funding on sovereign guarantee, regardless of their own microeconomic efficiency. Thus, financing costs soared at the same time that loans became the main source of capital.

The crisis was worse in state companies, because they were used to finance the states' budget deficits when state commercial banks faced difficulties in the early 1980s. In some cases, these companies were used to hire employees with high salaries, who were not employed in the company and were lent to other government agencies without compensation.

In early 1990, the centralized model that still predominates, with its many failures - economic inefficiency, vulnerability to financial setbacks and high debt service - gave evidence that this was not the best way forward. Thus began the search for a new operating model, and the first move in this direction was the approval of Law 8,631/93. This law defined a new formula for setting charges based on cost structure of companies and was designed to reflect the needs of cash flow, rather than constitute an arbitrary target for return on assets.

Initially the Law 8,631/93 was not effective in helping the recovery of the real value of the charges, since the Itamar Franco decided that one's readjustment should be below the inflation rate to benefit the population. At that time, at least from a technical standpoint, the privatization process had already started, but with a limited commitment to implementing more aggressively.

The restructuring and privatization of the electricity sector only occurred after 1995, when it was approved the Law 8,987 (Concession Law), which provided the general rules for the bidding of concessions in several infrastructure segments, including the electricity sector. It also set the rights and obligations of concessionaires and recognized the need of a regulatory and charges system that guaranteed the economic and financial equilibrium of the concession.

To complement the base established by Law 8,987, the Law 9,074, was approved in mid-1995 that established several principles regarding the renewal of concessions, including: (a) the old concessions could be renewed or the new ones granted after the dismemberment of generation, transmission and distribution; (b) the charges should be based on the cost structure of each segment of the electricity market; and (c) the charge of supply should be divided into separate and visible costs of generation and transmission power.

The constitutional amendments of 1995 were also important for the privatization process, because they ended the public monopolies in telecommunications, distribution by

pipelines and in the oil sector, and abolished the distinction between Brazilian companies of domestic and foreign capital, opening up a path for privatization of the mining and electricity generation. (PINHEIRO; GIAMBIAGI, 2000)

However, it was necessary to create a new model for the privatization of power generation assets, as well as to create an appropriate environment for the stimulation of new private generation projects. The challenge, therefore, was to create a decentralized and functional model that was effective even if some industry participants did not implement their privatization. In this context, emerged the *Mercado Atacadista de Energia* – MAE (Electricity Wholesaler Market) and the *Operador Nacional do Sistema Elétrico* - ONS (National System Operator).

In 1995 and early 1996, the federal government privatized its two distribution companies (Escelsa and Light) and at the end of 1996, the first distributor company of a state government, CERJ in Rio de Janeiro, was privatized. Since then, several state enterprises were privatized.

Privatization of energy companies gained weight with the Law 9,427 on December 26, 1996, which established the Brazilian Electricity Regulatory Agency (ANEEL), a government agency under a special scheme, linked to the MME.

ANEEL, who succeeded DNAEE was instituted for the purpose of regulating and supervising the production, transmission and marketing of electric energy in accordance with the policies and guidelines of the Federal Government, ensuring the operation in a balanced environment that allows companies to achieve solid results, while at the same time, provide affordable charges for consumers.

The regulatory model implemented in the Brazilian electricity sector was inspired in international experience, marked by policies to introduce a competitive environment in the generation and commercialization of electricity and implement new forms of regulation in the segments that remain as natural monopolies (transmission and distribution).

Among the powers given to ANEEL by Decree 2,335/1997 is to stimulate and participate in the activities of technological research and development needed for the electricity sector.

Finally, Law 9,991 on July 24, 2000 established the regulatory framework of public policy on R&D in the energy sector, delegating to ANEEL and to FINEP the responsibility for implementing this policy.

3.2.2. Context of the creation of the current regulatory framework of R&D in the electricity sector

The 1990s saw a propitious environment for changes addressed to increasing the competitiveness of the electricity sector - on one hand, the privatization of energy companies; on the other hand, the reform undertaken at the end of the decade, which brought changes in the design of public policies for Science and Technology (S&T), trying to create a joint action between S&T and industrial policies, and allied to the proposal of a resource mobilization in order to overcome the instability of public expenditure on S&T.

The privatization of electricity companies, which occurred from the mid-1990s, was linked to the need to expand investments in the maintenance and expansion in the sector, to increase levels of economic efficiency and competitiveness of energy companies, to create a suitable environment for new private projects of generation, and to improve the quality of services provided by energy companies.

In turn, in the context of S&T reform, the Law 9,991/00, current regulatory framework of incentive policy to R&D in the energy sector, obligates all the concessionaires, permittees and authorized companies in the electricity sector to invest in research and development and efficiency energy.

Through this law, electricity generating, transmitting and distributing companies began to be obligated to invest at least 1% of their Net Operating Revenue (NOR) in R&D, with the exception of distributor companies, whose percentage of investment is at least 0.5% of its NOR. The funds will be distributed as follows:

a) 40% should be applied directly by the companies in R&D projects of its interest, according to regulations established by ANEEL;

b) 40% should be collected to FNDCT to fund the actions of the Energy Sectorial Fund (CT-Energ) and;

c) 20% must be collected to the MME, to fund studies and research in planning the expansion of the energy system.

Decree 3,867 on July 16, 2001, regulated Law 9,991/00, defining that resources addressed to CT-Energ should finance scientific research and technological development in the electricity sector and energy efficiency projects for end-use. Besides, the decree ordered the establishment of a Steering Committee for CT-Energ that should be responsible for identifying and selecting priority areas for the application of resources and monitoring the implementation of scientific research and technological development, evaluating their results annually. (FINEP, 2010)

The CT-Energ is focused on encouraging research and innovation aimed at finding new alternative energy generation at lower costs and better quality; developing and enhancing the competitiveness of national industrial technology, increasing international exchange of R &D; training human resources and promoting national technological capability.

In turn, regulation of investment of resources that are under the supervision of ANEEL takes place through the Handbook of the Program for Research and Technological Development of Power Sector (Handbook for R&D), which establishes guidelines for the development of R&D projects by energy companies. Since the publication of the law 9.991/2000, four manuals were enforce for R&D, and currently was approved by Normative Resolution 316 on May 13, 2008 (ANEEL, 2010)

The Handbook for R&D establishes procedures for submission of projects, the allowable expenses in its implementation; form of submission of these projects to the Agency and its approval, the monitoring of the implementation and supervision; accounting of expenditures; the areas of investment permitted and issues regarding intellectual property outcomes.

One observes that the policy for R&D in the electricity sector is structured around three pillars:

1) Development of projects, focused on the implementation of solutions to face the technological and market challenges of electricity power companies;

2) Development of projects in energy, with emphasis on the relationship between the direct R&D expenditure of firms and the definition of a comprehensive program addressed to the long-term challenges of the sector, encouraging greater competitiveness of Brazilian industrial technology.

3) Conducting studies and research for an enlarged energy system as well as inventory and feasibility studies required for the better use of hydropower potential.

The functions performed by ANEEL, MME and FINEP, entities responsible for the implementation of public policy on R&D in the electricity sector, appear complementary and define the outline of a network, which will be detailed below.

4. NETWORK OF PUBLIC POLICY - CONCEPTS AND DIMENSIONS

According to Börzel (1997), the public policy networks are a relatively stable set of independent relationships, which bind a variety of actors who share common interests in reference to a policy. They exchange resources to pursue these shared goals, assuming that cooperation is the best way to achieve common goals.

The concept of policy networks has a wide variety of applications. One concerns its use as a specific form of governance, i.e. as a mechanism to mobilize political resources in situations where these resources are dispersed among public and private actors. (BÖRZEL, 1997)

The concept of networks often draws attention to the interaction of many separate, but interdependent organizations that coordinate their actions through the interdependence of resources and interests. Actors interested in making certain public policies and that have the resources (material and others) required for the formulation or implementation decisions, unite to share those resources.

The exchange of resources among the network actors are determined by its structure of governance that, in turn, differs in degree of intensity, normalization, standardization and frequency of interaction between the actors in this network.

According to Börzel (1997), policy networks are only an analytical model about how different actors are located and interact in a policy's sector, and what are the results of this interaction.

Some authors as Wellman *apud* Börzel (1997) extrapolate the use of networks as an analytical concept, shifting the unit of analysis of the individual actor to the set of interrelationships that constitute the inter-organizational network.

Networks reduce the transaction costs in situations of complex decision-making, as they will provide a common knowledge base, experience and normative orientation. Furthermore, they can balance the power asymmetries, providing additional channels of influence through formal structures (BENZ *apud* BÖRZEL, 1997)

According to Bonafont (2004), one goal of network analysis is to identify and classify the plurality of ways to address and manage public policies at the sectorial level in contemporary societies.

Classifying a network of public policy implies the need to analyze some of its dimensions such as number and types of actors, structure and degree of institutionalization, its role, type of relationships that prevail among the participants and so on. (BONAFONT, 2004)

The number of actors (organizations and individuals) determines the network's size, being this variable needed to capture the dynamics of the setting process of public policy and to analyze the distribution of power in the mid- and long-term in the political system. Actors can be defined in the following levels of analysis:

a) Universe of actors - a group of public and private actors interested in a specific policy area;

b) Political community - actors interested in a particular sector or subsector;

c) Networking policies - set of transactions and relationship exchanges that occur among actors who belong to one or several political communities, in order to achieve targets and balance the political outcome.

The networks analysis creates an understanding that the differences among them cannot only be explained from the characteristics of public and private organizations, but also from the structure and degree of institutionalization of relations among the participating organizations. (BONAFONT, 2004)

Another important dimension to be taken into account in the analysis of networks refers to the type of actors that compose it. The participation of groups in the process of setting public policy depends on both the willingness of their members to mobilize and defend their interests against the concrete problems, as the organizational structure, degree of professionalization, dependence on their members regarding the functions they play and recognition of governmental authority as a genuine actor to represent collective interests.

In turn, the state's ability to achieve its political objectives depends on the development of a stable normative framework, through regulation, eliminating the normative dispersion and defining the goals to be achieved in the mid- and long-term. (BONAFONT, 2004). The definition of objectives eliminates part of the discretion of public and private actors and represents an advance to ensure the planning of actions.

A policy network can have different functions, among which we can cite the access to the process of decision-making, consultation and exchange of information, exchange and resource mobilization, coordination of activities and cooperation in the formulation, management and legitimization of a public policy. The functions that are performed on each political network have a decisive influence on the type and intensity of relations among the actors involved.

Network is also characterized by their patterns of behavior and in each political subsystem a type of pattern dominates. The guidelines are set from the attitudes, preferences, interests, education and social origin of the participants, closely related to the degree of institutionalization of the network and the rules of the game that define the relationships among the participants.

The institutional context in which to develop the actions of a network has a decisive influence on the way in which decisions are made and the content of those decisions. The structure or degree of institutionalization of a network refers to formal and informal aspects, shared among participants. The institutional context, therefore, refers to the degree of stability of the "game rules" that define relations of power in public and private organizations in each political subsystem.

Some important variables for defining the structure of a network are: its size; barriers to new entry; type of participation (voluntary or mandatory); the connection type (ordered or chaotic); the frequency and duration of the relationship; stability; the nature of relationships (conflict, cooperation, competence); density and multiplicity; division and differentiation into subgroups; type of coordination of tasks performed. (VAN WARDEN, 1992 *apud* BONAFONT, 2004)

The structure or degree of institutionalization of the network influences the type of functions it performs, reduces the uncertainty associated with the process of developing policies, and contributes to the ideological orientation of public policies.

Finally, the relations of power - which may be more or less symmetrical, be dominated and controlled by the state or organize themselves in favor of a specific social group - is defined from the degree of autonomy from state organizations that participate in the process of setting public policies. (BONAFONT, 2004)

It is important to highlight that, although the typologies developed through network analysis is a useful and effective tool to describe the process of setting public policies, they alone cannot explain the causal relations that link the network with the political outcome.

According to Bonafont (2004), the typologies define questions like: who are the actors participants in the process of setting public policies; what kind of relations prevail among them, and what factors determine behavior patterns of the actors involved.

In turn, the analysis of these issues allow us to confirm assumptions about the determinant factors of the dynamics of continuity and change of public policies, as well as the share of power in each political subsystem.

5. NETWORK OF PUBLIC POLICY FOR R&D IN THE BRAZILIAN ELECTRICITY SECTOR

5.1. An overview

The network of public policy for R&D in the Brazilian electricity sector fits in to the typology called political community by Marsh & Rhodes (1992 *apud* Bonafont, 2004). Few actors and a high degree of integration constitute political communities.

Political communities develop multiple functions: (a) control the agenda, (b) define problems, (c) formulate strategies, (d) make decisions, and (e) make management of public policies. The activities are developed over a specific institutional framework, which is defined as a rules' game.

In the networks called political communities the problems are understood from a technical perspective and not political, based on criteria of effectiveness and efficiency (BONAFONT, 2004). Political communities are transformed into communities of experts who know the problems, have the resources and carry out activities aimed at achieving effective solutions to society as a whole.

The network of public policy of R&D in the electricity sector derives it structure from the publication of Law 9,991/00. In the field of policy formulation, the National Congress, the MCT and the MME emerge as main actors. In the field of policy implementation, ANEEL, FINEP and CNPq, emerge as central players, the last two being MCT' development agencies.

This network is still permeated by other adjacent actors such as: energy companies (distributors, generators and transmitters), universities, technology centers, equipment manufacturers of the electricity sector, the *Centro de Gestão e Estudos Estratégicos* - CGEE (Center for Management and Strategic Studies) and *Empresa de Pesquisa Energética* – EPE (Company of Energetic Research).

The following section will provide a description about the key players of the R&D network in the Brazilian electricity sector, which is responsible for implementation of this public policy.

5.2. The network and its actors - connections and intersections

The network of public policy for R&D in the electricity sector is structured around two basic axes, constituting two sub-networks: on the one axis, the CT-Energ, with its actions of support mid- and long-term research, implemented by FINEP and CNPq; on the other axis, the R&D Program regulated by ANEEL, which aims to encourage energy companies to seek solutions to solve their technological and market challenges.

Figure 1 shows network relationships for R&D in the Brazilian electricity sector and the links among their main players ANEEL, FINEP and CNPq.

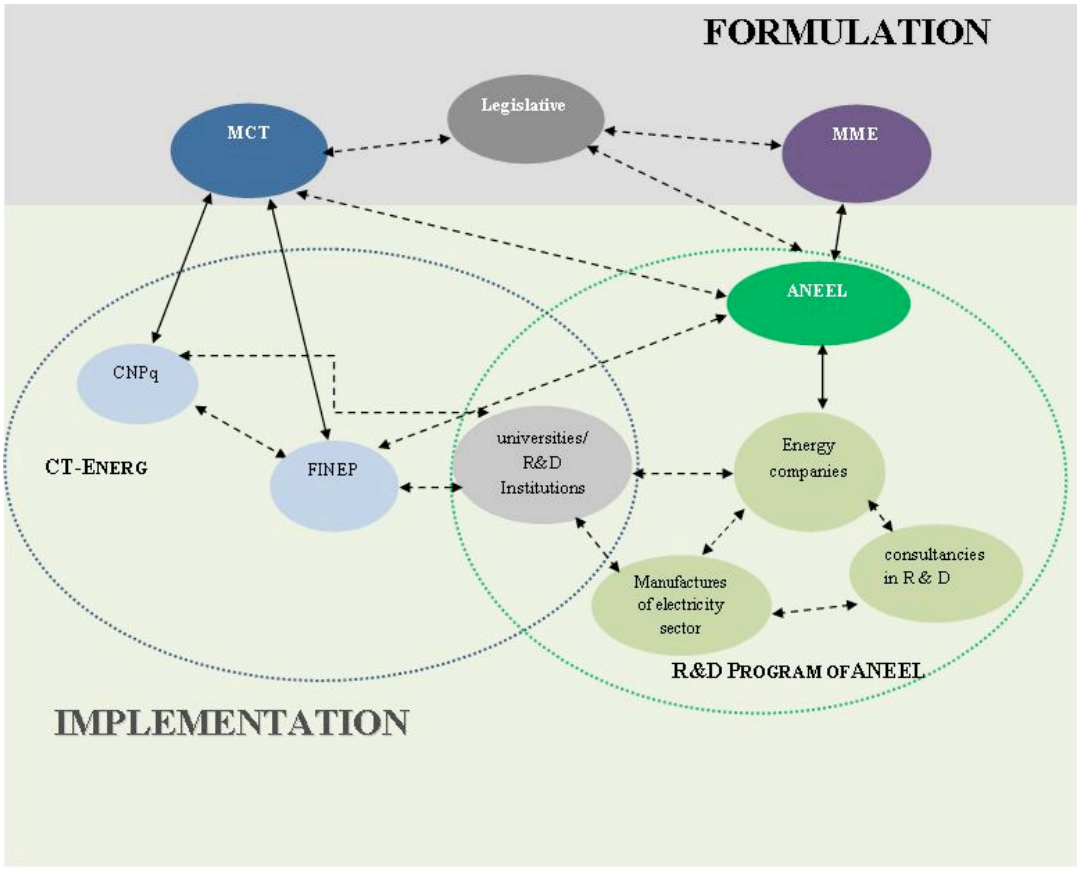

Figure 1 - Network of R&D public policy in the Brazilian electricity sector

The sub-network constituted under the action of CT-Energ has as main actors FINEP and CNPq. FINEP is dedicated to the promotion of projects of public support for science, technology and innovation in companies, universities, technological institutes and other public or private institutions. In turn, CNPq is an agency for the promotion of scientific and technological research and training of human resources for research in the country. These two agencies, together, have played a key role in applying the resources of the CT-Energ.

Other actors also permeate the action of this network, such as Brazilian institutions of R&D recognized by MCT and universities accredited by the Ministry of Education (MEC). Public and private enterprises compose the network also, being encouraged to participate technically and financially in the implementation of projects supported by CT-Energ, especially requesting the development of new products, processes and services of universities and research centers. (FINEP, 2010)

In turn, the sub-network formed throughout the R&D program regulated by ANEEL has as a central actor the Agency itself who was responsible for encouraging and participating in research and technological development needed to the power sector.

Besides ANEEL, companies of energy sector, universities, R&D institutes, manufacturers of equipment in the electricity sector and consulting firms in R&D work as actors in this sub-network. Energy companies act as proponents of the projects, bringing their demands to solve technological gaps. The universities and R&D perform projects and the manufacturers and consulting firms of R&D work as partners in this process, transferring their know-how and supporting the research.

Therefore, one notes that the two sub-networks have an intersection of actors. Universities and R&D institutes are present in both maintaining an important role in this context.

Moreover, it is important to highlight that the conjunction of the actions of these two sub-networks form a larger R&D network, showing up as an opportunity for synergy of actions addressed to promote the development of the Brazilian electricity sector.

In the sense to enlarge the network synergy, two other institutions should have more active participation in this network: CGEE and EPE.

One of the purposes of CGEE is carrying out prospective studies in science and technology related with productive sectors, and to assess economic and social impacts of policies, programs and projects of science and technology.

In turn, EPE aims to provide studies and research addressed to the planning in the energy sector such as electricity power, oil and natural gas and its derivatives, coal, renewable energy, energetic efficiency, and so on. (BRAZIL, 2004)

Thus, both studies of EPE and the CGEE could support the operations of the CT-Energ and R&D Program of ANEEL, assisting in the construction of guidelines for the implementation of those policies.

The next section will present some results of the R&D network, represented by the action of CT-Energ and R&D Program of ANEEL.

5.3. Some results of R&D network

5.3.1. Network CT-Energ

According to data provided by FINEP, the CT-Energ published until December 2010, seven Public Calls intended to fund development projects in R,D&I sector electricity. All public calls published under CT-Energ and its targets are presented in Box 1.

Year	Public Call	Target
2002	Bidding CT-Energ/Innovation - FINEP 01/2002 - SF	Supporting technological innovation in the productive chain of the energy sector, developed by universities or research institutes interested in the transfer of results of its research activities to the business sector.
2002	Order CT-Energ - Company - FINEP 02/2002	Select companies or consortia of companies willing to apply financial resources together with funds from the CT-Energ in a project or portfolio of applied research projects to be developed in partnership with universities or Brazilian research centers.
2003	Public Call CT-Energ/RBT - MCT/FINEP 01/2003	Select proposals for financial support to R&D projects of equipment and products of interest to the productive chain of the electricity sector, aimed at the competitive substitution of imports of goods.
2003	Public Call CT-Energ - MCT/FINEP 02/2003	Select proposals for financial support to projects of dissemination and scientific education in museums and science centers on the production and efficient use of energy.
2005	Public Call MCT/FINEP - CT-Energ-Technology demand side - 01/2005	Select proposals for financial support to projects of technological development on the demand side in the electricity sector (conservation and end use of energy)
2006	Public Call MCT/FINEP - CT-Energ - Renewable Energy - 01/2006	Selecting proposals for financial support to projects of technological development and innovation on renewable energy sources (wind and solar photovoltaic)
2008	Public Call MCT/FINEP - CT-Energ - Electricity Power- 01/2009	Selecting proposals for financial support to projects of R, D & I related to increase technological capability on issues of interest of electricity sector (generation, transmission and distribution)

Box 1 - Public Call - CT-Energ/year
Source: FINEP (data of December 2010)

Besides the direct actions of CT-Energ previously presented, Transverse Actions published four public calls, focusing on supporting actions of interest of the productive chain of electrical energy. Transverse Actions are strategic programs of the MCT focused on the Industrial, Technological and Foreign Trade Policy (PITCE) of the Brazilian Federal Government that utilize resources from various Sectorial Funds simultaneously. Each Sectorial Fund contributes 50% of its resources to such actions. (FINEP, 2010)

Box 2 presents the Public Call for Transverse Actions' FNDCT addressed to support the development of actions of interest of the electricity sector and purpose of each one.

Year	Public Call	Target
2004	Public Call MCT / FINEP - Transverse Action - RBT 01/2004	Select proposals for financial support to technology R&D projects for equipment, products and services of the productive chains of oil and natural gas and electricity in order to boost competitive substitution of imports.
2005	Public Call MCT / FINEP - Transverse Action - RBT 05/2005	Select proposals for financial support to technology R&D projects for equipment and products of the productive chains of oil and natural gas and electricity in order to boost competitive substitution of imports.
2006	Public Call MCT / FINEP - Transverse Action - BIODIESEL - 10/2006	Selecting proposals for financial support to technological R&D projects for improving processes of purification of biodiesel and its effluent.
2006	Public Call MCT / FINEP - Transverse Action - RBT 12 / 2006	Select proposals for financial support to technology R&D projects for equipment and products of the productive chains of oil and natural gas and electricity in order to boost competitive substitution of imports.

Box 2 - Public Call - Transversal Actions focused on the productive chain of energy by year
Source: FINEP (data of December 2010)

Summing the resources contributed by FINEP and CNPq's fellowships the CT-Energ invested until November 2010 about R$ 35 million in 77 projects. Figure 2 shows the resources employed by CT-Energ by years for the development of R,D& I.

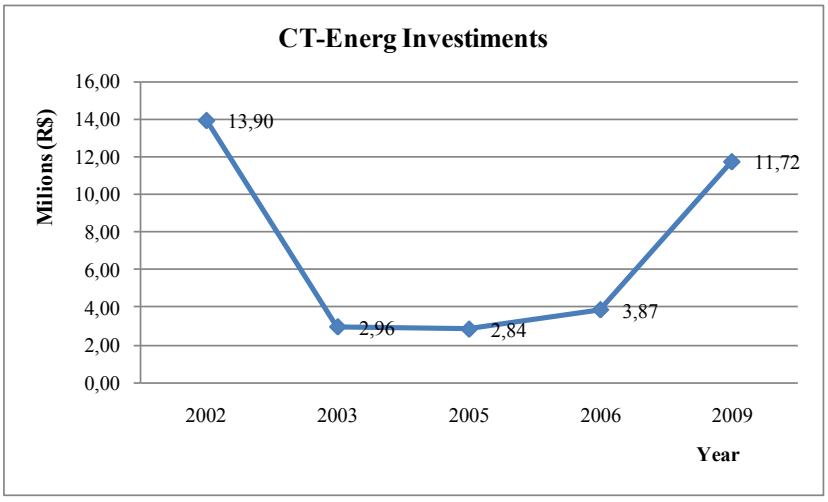

Figure 2 - CT-Energ investments by year
Source: Finep Data (December 2010)

In turn, Transverse Actions, focused on supporting the productive chain of the electricity sectors, invested about R$ 27 million in 85 projects as shown in Figure 3.

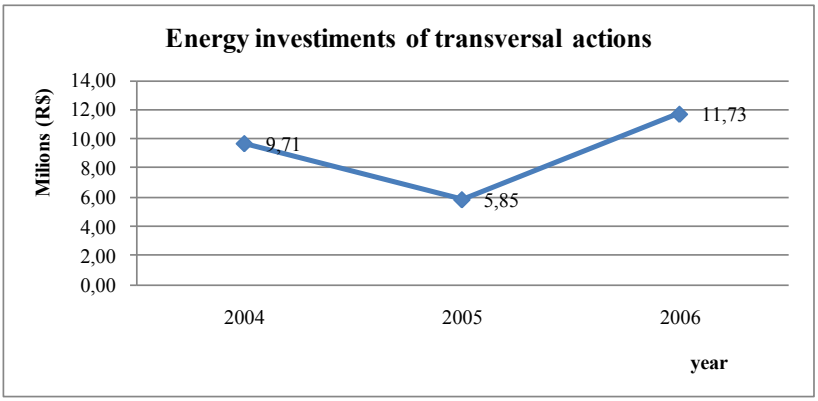

Figure 3 - Investments by year of Transverse Actions focused in productive chain of power
Source: FINEP (data of December 2010)

The network of the CT-Energ, including the Transverse Actions focused on supporting the energy's productive chain, mobilized about 70 players, such as universities, R&D institutes, technology parks and others.

In turn, in regards to the allocation of resources among the geographic regions of Brazil, the south and southeast regions received more resources from the CT-Energ and Transverse Actions focused on energy chain were. However, as showed in Figure 4, about 27% of resources were directed to the North, Northeast and Midwest, not fulfilling the requirement of Law 9,991/2000 that determines that at least 30% of resources regarding this Law must be allocated to projects developed by research institutions located in those regions.

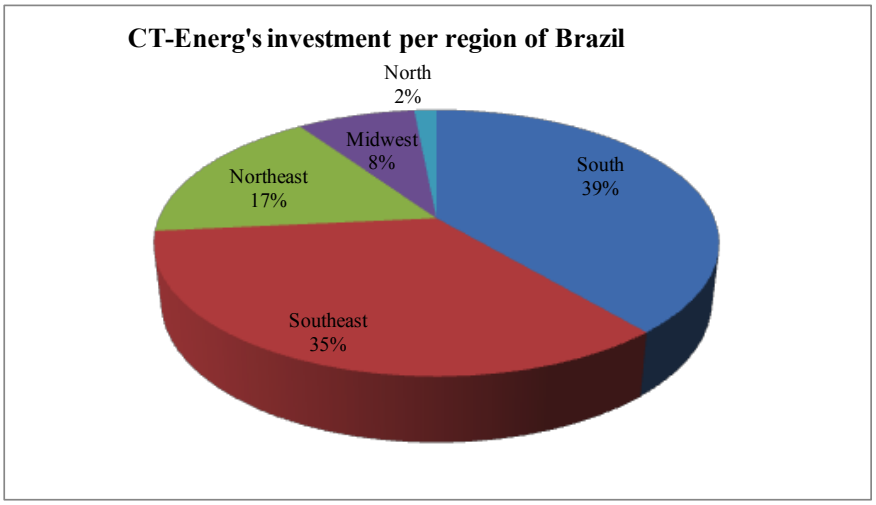

Figure 4 - CT-Energ's investment by region of Brazil
Source: Finep (data of November 2010)

Next section will present some results of the sub-network coordinated by ANEEL, which regulates the mandatory investments in R&D done by electricity companies.

5.3.2. R & D Program regulated by ANEEL

The history of the R&D program regulated by ANEEL is divided into two phases: the periods before and after the publication of Normative Resolution 316/2008, which gave validity to the current Handbook for R&D Program of the Electricity Power Sector (Handbook for R&D - issue 2008).

The Handbook for R&D - issue 2008 is, therefore, a watershed Program regulated by ANEEL, and changed the paradigm that prevailed until then. With the new Handbook, projects of R&D, before then approved ex-ante, now will be evaluated ex post, and recognition of investment in R&D made by energy companies will occur after completion of the projects, when their results will be analyzed based on the criteria of originality, applicability, relevance and reasonableness of costs.

It is emphasized that the purpose of changing the rules was to optimize the investment by increasing the level of responsibility of the energy companies over the process of

technological innovation in the electricity sector. Moreover, the change also aimed to expedite the start of project implementation, hitherto characterized by delays in ANEEL assessments.

Because the Handbook for R&D - issue 2008 came into force in May 2008 and the first projects began in September 2008, few projects were completed so far. Thus, the following data, for the period after 2008, represents only estimates, based on information provided to ANEEL by energy companies through the R&D management system of ANEEL.

In turn, data from the period before 2008 are on projects already approved by ANEEL contained in its database (management system of R&D).

5.3.2.1. Period prior to May 2008

From publication of the Law 9,991/2000 until the issue of the Handbook for R&D - issue 2008 (in May 2008), three handbooks were enforced: the first addressed the investment cycle 1999-2000, the second, called Handbook for R & D - issue 2001 and the third, titled Handbook for R&D - issue 2006.

These handbooks provided: (a) procedures for submitting projects to ANEEL; (b) allowable expenses in its implementation; (c) procedures of submission of these projects to ANEEL; (d) procedures of monitoring the implementation and supervision; (e) procedures of expenditures accounting; (f) areas of investments permitted; (g) issues regarding intellectual property and so on.

A common point in these three manuals is the fact that investments in R & D made by energy companies were approved ex ante by ANEEL. At the end of project implementation, the ANEEL evaluated whether the investments were made in accordance with previously approved and imposed penalties in cases of non-conformities.

As one result of the action of the network formed around the program regulated by ANEEL, one can highlight the investment in R&D projects in this period. About 2,400 projects were approved, representing an investment of about R$ 1.4 billion. The figure 5 shows the distribution of investments in R&D by year in R&D projects.

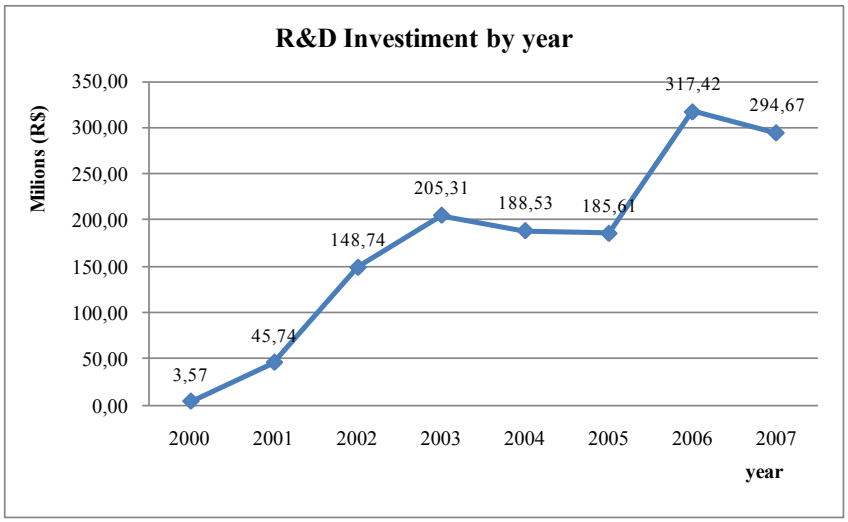

Figure 5 – R&D investment by year (ANEEL Program)
Source: ANEEL (data from November 2010)

Most parts of R&D projects have been developed in partnership between universities and S&T institutes. As a result of these partnerships, the network of R&D mobilized about 800 actors, including energy companies, S&T institutes and other companies like equipment manufacturers for the electricity sector and consulting firms in R&D. Table 1 illustrates the number of actors involved per classification.

DESCRIPTION	QUANTITY
Energy companies	180
S&T Institutions (ICTs)	335
Others companies	288
TOTAL	**803**

Table 1 - Number of actors involved
Source: ANEEL (management system R & D)

The next section provides data for the period after May 2008 when the current Handbook for R&D - issue 2008 came into force.

5.3.2.2. Period after May 2008

The Handbook for R&D - issue 2008 changed the previous paradigm of the program regulated by ANEEL. From this Manual, the investments in R&D made by energy companies would be recognized only ex post, i.e. after its completion.

R&D investments only will be recognized, after evaluation of its deliverables by ANEEL, if the expenditures made in projects meet the criteria of originality, relevance, applicability and reasonableness of costs.

The Handbook for R&D - issue 2008 gave greater flexibility in implementing the projects, and the companies do not need prior approval from ANEEL to initiate its R&D projects.

Since the publication of the Handbook for R&D - issue 2008 the energy companies have submitted 658 projects to ANEEL, of which, by the decision of firms, 452 are carried out, representing an estimated investment of R$ 700 million. Figure 6 shows the distribution by theme of the projects presented to ANEEL.

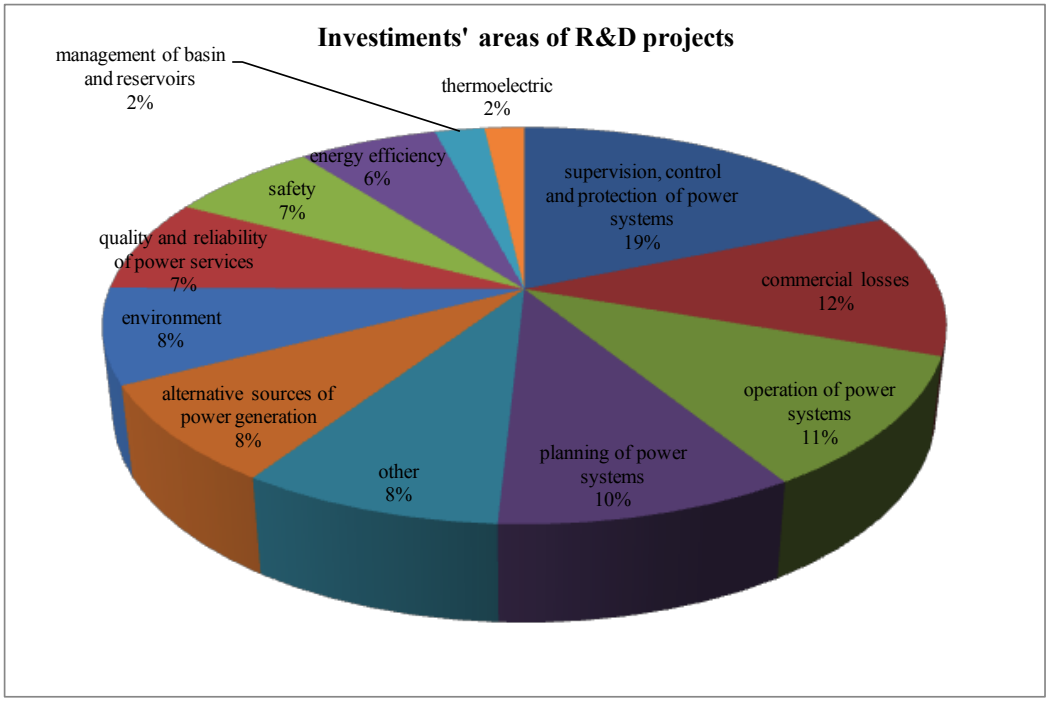

Figure 6 - Projects submitted to ANEEL / theme (regulated by Handbook for R&D – issue 2008)
Source: ANEEL (data of January 2011)

As expected, results from R&D projects presented to ANEEL, it is estimated that mostly incremental innovations will be generated, as shown in Figure 7.

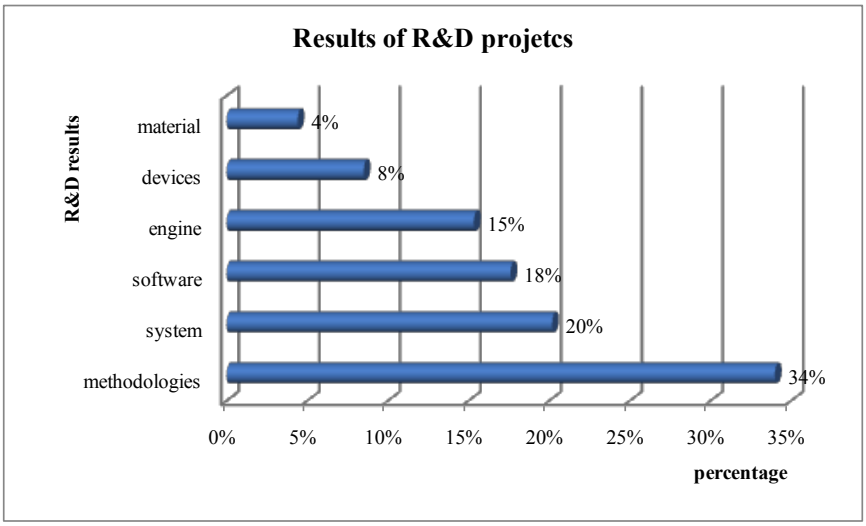

Figure 7 - Expected outcomes of the projects of R & D
Source: ANEEL (data of January 2011)

As determined by ANEEL, an R&D project can last from 6 to 60 months. Most of the projects presented to the Agency have a duration of 13 to 24 months. Figure 8 shows the estimated duration, in months, of the projects submitted to ANEEL over the regulation of Handbook for R&D- issue 2008.

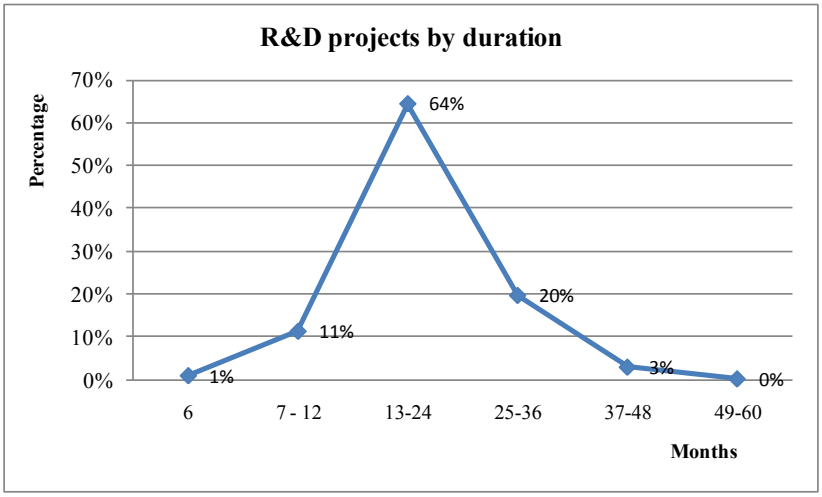

Figure 8 - Number of R&D projects/duration in months
Source: ANEEL (data of January 2011)

Regarding intellectual property rights, ownership of the results of R&D projects and revenue from the sale of these results may be traded freely between energy companies and entities involved in project implementation, according to the established legislation.

In order to boost the creation of patents in the electrical sector, ANEEL introduced in the Handbook for R&D - issue 2008, the possibility of appropriation by the energy companies of part of the revenues from the commercialization of intellectual property rights.

For companies of the sectors of distribution and transmission of electricity, the revenues from the commercialization of the results of R&D projects, which were not intended to universities or R&D institutions, will be shared with society in the process of charge revision, in the ratio 50% -50%.

Moreover, as a way to boost the targeting of resources to the north, northeast and mid-west regions of Brazil, and thereby to stimulate the development of these disadvantaged regions, ANEEL enlarged the ratio of revenues to 70% from the commercialization of intellectual property rights that could be appropriated by energy companies that make a greater investment in those regions.

It is observed with the data presented that this network has mobilized a significant amount of resources and actors, improving the innovation system of the electric power sector.

CONCLUSIONS

The concept of policy network model allows us to analyze the results of the mobilization of political resources in situations where these resources are dispersed among the public and private actors. Policy network is only an analytical model about how different actors interact and are located in a political sector, and what are the results of this interaction. (BÖRZEL, 1997)

One could say that the network built around the R&D public policy of the electricity sector is a network-type political community, whose characteristic is the fact that the

problems are understood from a technical perspective, based on criteria of effectiveness and efficiency.

This network began to be structured in an institutionalized form from the publication of Law 9,991/00, regulatory framework of the creation of the CT-Energ and of R&D Program regulated by ANEEL.

The two main actors in this network are FINEP and ANEEL that coordinate, respectively, the actions of two independent, but integrated sub-networks, around a common framework and some actors in common.

As a result of the action of these two sub-networks formed around the R&D policy of the Brazilian electricity sector, a notable mobilizing of actors and financial resources occurred. The sub-network coordinated by ANEEL has mobilized about 800 actors, including the energy companies. The CT-Energ, in turn, mobilized about 70 actors, including universities and R&D institutes.

The sub-network of R&D Program, regulated by ANEEL, mobilized a much larger amount of resources that the sub-network of CT-Energ, although the resources earmarked by law for the two actions are exactly alike. Until 2010, the resources employed by the CT-Energ and by the Transverse Actions focused on supporting the actions of interest to the productive chain of electricity represented about 4.5% of the resources mobilized by the R&D Program regulated by ANEEL until 2007. One explanation for the low investment of CT-Energ can be the restriction of resources imposed by the Brazilian Federal Government addressed to increase the primary surplus targets.

About 70% of projects presented to ANEEL on the regulation of Handbook for R&D - issue 2008 are focused to generate process' incremental innovations (methodologies, systems and software), which may be influenced by the degree of the technological maturity of the electricity sector. About 77% of these projects will be performed in until 24 months.

Note also that the network for R&D policy, especially the Program regulated by ANEEL, has sought to encourage the involvement of industry in the innovation process, aimed at enhancing the generation of product innovations. In addition, efforts have been made in order to increase the creation of Brazilian patents.

It follows therefore that some results of this network that has been building up for ten years, have been effective. However, it is observed that the actions of the sub-network of the CT-Energ need to be expanded. Furthermore, there should be greater integration between the actions of the two sub-networks (CT-Energ and R&D Program of ANEEL), in order to promote greater synergy.

Data prove that the actions of the network for R&D of the electricity sector have been meaningful. However, it is observed that CT-Energ needs to broaden its action. Furthermore, the actions of both networks (R&D Program regulated by ANEEL and CT-Energ) should be more integrated in order to avoid redundancies and gaps in policy.

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