



## R&D+ i Strategic Management in a Public Company in the Brazilian Electric Sector

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### Abstract

The purpose of this paper is - by reporting an experience of structuring processes and tools related to the strategic management of R&D in the electricity sector – to show the conditions and potential for improved efficiency, efficacy, and effectiveness in the R&D program set by ANEEL. The methodology is action research. This is because the proposed and tested model is the result of reflection and resolution of critical organizational issues, applied in a public company in the electric power sector. Act No. 9,991 of July 24, 2000 provides for the obligation on the part of concessionaires, permittees, and licensees in the electric power sector to invest part of their operating revenue in research and development (R&D). For the effective implementation of these legal obligations, companies prepare their annual R&D programs, comprising projects that aim at developing innovative solutions for their processes and increasing business efficiency. However, the urgency to comply with the contractual provisions, coupled with the small amount of experience most companies have when it comes to carrying out R&D activities and projects, has led to the gradual formation of a mode of R&D implementation and management that does not favor its optimization and alignment with the goals the utility companies and the sector's own technological development. The approach proposed in this paper consists of structuring the processes and tools related to the management of R&D driven by innovation (R&D+i) and aligned with the business strategy. These processes include the adoption of procedures and tools to manage structured, integrated decision-making flows involved in the innovation process, aiming at full alignment with business goals and objectives.

**Keywords:** strategic management of technological innovation; regulation and governance; technology and innovation funnel; innovation culture; learning and participation; knowledge management.

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## Introduction

Act 9,991 of July 24, 2000 provides for investments in research and development and in energy efficiency by concessionaires, permittees, and licensees in the Brazilian electric power sector. This law establishes the mandatory application of 1% of their annual net operating revenue in R & D and energy efficiency projects. Consequently, the National Electric Power Agency (ANEEL) has published its resolutions regulating the procedures for putting together and submitting such projects and programs.

To comply with these legal obligations, Companhia Energética de Brasília (CEB) prepares an Annual Research and Technological Development Program (ANEEL R&D), consisting of projects aimed at developing innovative solutions to business processes and enhancing its business efficiency. Although eight years have passed during which funds were systematically applied, the current R&D management model does not favor optimizing resources and aligning R&D projects with business strategies.

Having identified a need for course corrections, CEB's R&D management prioritized a study during the ANEEL R&D program's 2006/2007 cycle aimed at making a diagnosis of the R&D management's practices in hopes of restructuring them. The study began in the second half of 2007 and was completed in the first half of 2010, and its authors made up the core team involved in it.

A new R&D management process was developed within the project's framework involving continuous interaction with the company's staff, with a focus on technological innovation and its suitability with CEB's strategy. This process was based on developing a customized R&D strategic management model, inspired by the literature (Cooper et al., 2002a and b; Tidd et al., 2005; Quadros, 2008). The center of the designed R&D management model is an ideation process (identifying priorities, needs, and ideas to meet them) and a technological innovation funnel suitable for projects aimed at finding innovative operating solutions. The model was validated through specific workshops, in 2009, with CEB's top management, followed by developing a computerized system (workflow) that supports the decision-making model; implementing the pilot version; testing; fine-tuning; and validating it, and, finally, training the company's employees on how to use it.

The paper is organized into seven sections, including the introduction. The next section presents an overview of the problems that a preliminary diagnosis identified in the R&D management model for energy distribution companies, including CEB. The third section presents the basics underlying the approach to R&D and innovation management that was

adopted in the project. This approach led to the development of a Technological Innovation Strategic Management Model. This model was the benchmark for establishing the diagnosis of CEB's R&D management practices. Section 4 presents a brief account of the methodological aspects (action research), diagnosis of the practices, and their implications for CEB's current R&D management practices; and sections 5 e 6 summarizes the guidelines and assumptions of the R&D management model at CEB, and the set of routines and electronic tool that were developed for managing the company's R&D and energy efficiency programs. Section 7 presents the authors' conclusions at the preliminary stage, namely, the initial phase during which the company's employees learn how to use the tool.

## The research hypothesis and challenges

### The need to align the r&d strategy management to corporate objectives of the brazilian energy sector

Concession contracts in the electricity sector require that electric power generation, transmission, and distribution companies apply a minimum percentage of their annual net operating revenue (NOR) into research and development (R&D), under the Research and Development Program set up by the National Electric Power Agency

That determination has created an opportunity for R&D in the electricity sector to decentralize and move closer to the needs of its customers and consumers, as well as the objectives of companies in the sector. However, the urgency to comply with contractual obligations, coupled with the small amount of experience most companies have when it comes to carrying out R&D activities and projects, especially in the distribution area, led to the gradual establishment of a R&D implementation and management model that does not favor its optimization and alignment to the utility companies' goals and the sector's own technological development.

Current R&D management practices in most power companies are unable to ensure operating efficiency and improve quality and safety in distribution in the short term, and the development and adoption of technological innovations in the long term (for example, materials, components, and equipment). In summary, these practices can be grouped into four groups of routines:

1. stimulate the supply of R&D projects by outside partners (suppliers, consulting firms, and research institutions, and universities) for a set of broad prioritized areas (energy efficiency, metering, environment, etc.);

2. consideration and decision on the approval of outside projects, for subsequent forwarding to ANEEL, based on a case by case assessment, which emphasizes the merits and achievements of individual projects and their possible contribution to the company;

3. individual monitoring of the implementation of outside projects, based on project supervision systems, and

4. seeking technology transfers arising from projects for electric utilities and/or their suppliers.

This model helped to improve rationality when assessing and making decisions about the distribution companies' projects, especially when it came to "separating the wheat from the chaff", in addition to improving its supervision and ensure that it is, in fact, carried out. However, there are more serious difficulties in the final step: making sure that the projects' results are applied.

Based on the authors' assessment, the current model is impaired by an intrinsic problem, which is the lack of mechanisms for aligning and integrating R&D management to the strategic objectives of the utility companies and those of the regulatory agency, whose aim it is to ensure the electricity sector's technological development and capacity-building. If compared to the practices currently used in industrial corporations that invest substantially in R&D and sustain their competitive advantage through technological innovation, it can be said that the R&D management model used throughout much of the electricity sector is limiting its potential contribution. The model lacks concepts, practices, and key systems, which affect the early management stages, i.e., the generation/motivation for proposing new projects, assessing them and making decisions, and their effective implementation and ability to produce the desired results.

## Theoretical framework

### From managing technology to managing technological innovation in Brazil

The approach proposed in this paper reflects the multidisciplinary progress of knowledge regarding the determinants and characteristics of innovative companies. This progress corresponded to overcoming the linear and sequential approach (OCDE, 1996) to innovation, which saw public academic research and technological research inside the company as the only effective ways to produce or originate technological innovations.

In this view, other critical functions such as planning, operation, and marketing were seen as "channels" for viable solutions "delivered" by R&D. As the R&D effort was the

only considered innovation and patents, its main result, the emphasis in the early conceptual and applied approaches fell on technology and R&D management. In contrast to the linear approach, which still strongly influences the common sense understanding of what innovation is, the systemic, integrated approach adopted herein presents innovation as a learning process, centered on the innovative company, but acting and interacting with various internal and external actors. This more complex view benefited from the advancement of knowledge in the field of innovation studies, which was made possible by the decisive works of economists such as Nathan Rosenberg (Kline and Rosenberg, 1996) and their model of innovation as a chain link, and Chris Freeman (1995), Bengt-Åke Lundvall (1992) and Richard Nelson (1993), which resulted in the development of the National and Local Innovation System.

In Brazil, during the 1990s, a significant amount of work had been done in the field of Technology Management. One of the pioneering works, coordinated by Vasconcellos (1992), referred to the importance of technology management as a tool for boosting a company's competitiveness. In those authors' viewpoint, technology was a critical tool in the quest for competitiveness, based on releasing new products and services and improving existing ones. Therefore, the focus of those studies concentrated on managing the technological and R&D processes. In the authors' view, it was not enough to hire experts and invest in technological development; the scarce resources invested in R&D had to be properly managed (Vasconcellos, 1992). Their concern was focused on organizing and managing R&D as a structured corporate function apart from the others (e.g., production, marketing, purchasing, etc.), although with relevant interfaces with them.

In Brazil, this conceptual model continued to be used as a reference throughout the 1980s and 1990s. It has only been since the 2000s that the discussion about the importance of managing innovation has emerged as a field that integrates and extrapolates technology management or R&D (Tidd et al., 2005). This change has been largely motivated by the perception that technological innovation is also economic in nature, using innovation to apply technological knowledge and the marketing skills, and those of its partners, to generate new products, processes, services, and business (Quadros and Vilha, 2006).

When seen this way, innovation is a process that combines inputs and technological knowledge (technology push) and market knowledge (demand pull) in ways that are not always predictable. R&D, market and operations management are functions that converge and collaborate in creating innovation. Managing this integration from a strategic perspective, and focused on the company's organic growth, is one of the

hallmarks of this approach. Of no less importance, the innovative company is not alone in this endeavor. Innovation is a process in which interaction with customers, suppliers, research institutions, engineering firms, professional training services, and technological and research institutions' services have significant meaning, whether as a source of information or more formalized by means of cooperation agreements (Closs et al., 2012; Suzigan, 2011; Zawislak and Dalmarco, 2011; Carvalho 2010). Therefore, the opportunities offered by the virtuous aspects (or not) of the National (and local) Innovation Systems, including their regulatory size and industrial and technological policies, feature prominently in this approach.

In this decade, however, there has been a shift in the methodological analysis axis that addresses the management of processes related to knowledge, technology, and innovation. The theoretical view, conceptual approaches, and development of innovative process indicators and their management have systematically become more systemic and comprehensive.

Another important element in the management of science, technology, and innovation literature, and the subject of gradual theoretical and methodological progress over the past twenty years, is the contribution of external sources of knowledge for innovation or innovation networks (in industry and services). Although widely recognized as a hallmark of innovation under the current conditions of competition (Chesbrough 2012a; Chesbrough 2012b; Giannopoulou et al., 2010; Savitskaya, Salmi and Torckeli, 2010; Chesbrough, 2007; Tidd et al., 2005; Nooteboom, 2004), there is as yet little research with an approach oriented towards a study on the diffusion of innovation network management practices (De Medeiros Rocha et al., 2010; Carvalho, 2010), even as there are few companies that adopt a systematic and consistent approach to managing their external innovation sources - either in terms of adopting routines for exploring and selecting sources and partnerships or in relation to the design and management of partnership contracts (Quadros, 2008). One of the distinguishing features of the conceptual model proposed herein is the treatment of these external sources – based on strategic alignment, partner integration, and the management of collaborative inter-organizational relationships – as one of the key elements of innovation and overall corporate strategy.

As important as the other scored dimensions, the strategic management of innovation contributes and advances – relative to the merely restricted approaches to managing technology – to recognize that there is a cultural perspective within the organization subject to interventions: whether to correct, affirm, or stimulate the trajectory in relation to innovation or ensure the quality and effectiveness of this pro-

cess at all levels. This cultural atmosphere acts as a kind of amalgam, cementing relationships that have been established in the dimensions of governance, organizational practices, and people management.

Finally, the proposed model emphasizes the significant role played by applying information technology (IT) in the support of and interface with the (sub)processes of the strategic innovation management model. By facilitating process management and electronically submitting information to support decisions, reduce the time spent in executing the (sub)processes, and enable the sharing needed to promote innovation among the teams, the company's operating areas, and external actors, and also allow for online and remote feedback on outcome of decisions, IT establishes itself as an indispensable facilitator, enabling and promoting interaction and communication between the tools and social processes that are triggered by the decision-making systems and organizational and behavioral practices (Cooper, DeGette and Kleinschmidt, 2002a and 2002b; Quadros and Vilha, 2006).

### **Assessment of Innovation Management Practices in CEB: elements of a model of strategic management of technological innovation**

This section introduces the elements and dynamics of a Strategic Technological Innovation Management model, inspired by the international literature in the field of technology and innovation management (Tidd et al. 2005; Burgelman et al. 2003; Dodgson 2000), as well as the authors' own experience. This model guided the research, diagnosis, and definition of the proposed routines and tools for CEB.

Using the conceptual perspective developed in the previous section, the underlying idea was to have CEB adopt a systematic and orderly process of innovation management, one that is integrated with its corporate strategy. Innovation is a process that involves the entire organization, given that it is the basis of its future support, and infers:

- the full commitment of top management and funding allocation that reflects the priority given to innovation;
- the adoption of specific technological innovation management processes and tools used by the operating areas involved, with emphasis on the R&D, operational, and business aspects;
- the ability to organize for effective project management, and
- the entrepreneurial and leadership ability at the managerial and technical levels.

In view of this model, the essence of technological innovation management involves mobilizing and coordinating the

company's resources and internal actors (R&D, commercial, operations, human resources, finance, and planning) as well as the actors and resources outside the company (customers, suppliers, research institutions, and funding agencies) to explore technological opportunities and the market, aligned with the company's strategic priorities.

Strategic innovation management seeks to strategically structure resources, processes, tools, and organizational practices in a systemic manner, so that innovation is not a spontaneous or random occurrence, but rather a well-oiled, growing, and systematic process. However, there is no blueprint for generating innovation or managing the process. There are no quick and easy solutions. The demands/needs of the innovation manager differ according to company size and the industry in which it operates. Successful innovators customize their innovative management processes according to their priorities and resources.

The Strategic Technological Innovation Management Model discussed herein includes a set of dimensions that are considered essential to structuring models that are appropriate to the priorities and possibilities of each company. In this sense, the model is the conceptual basis for developing a methodology for assessing innovation management practices at CEB. The model comprises the following dimensions:

- processes and tools;
- governance and organization; and
- resources.

For the purposes of this article, we will describe only the processes and tools dimension (Quadros, 2008), because a critical dimension of a company's maturity in managing technological innovation corresponds to the adoption of structured, integrated processes and tools to manage the decision-making flows involved in the innovation process.

The assessment methodology intends to map out and review the company's current model for managing technological innovation and, in this particular dimension (processes, practices, and tools) identify their strengths, weaknesses, and performance gaps and then propose recommendations for designing and implementing a new model.

Adopting the most appropriate tools varies according to the each company's conditions, i.e., according to the characteristics of its competitive environment, the maturity of key technologies, and its financial possibilities. However, according Tidd et al. (2005), all companies wishing to manage their innovation process in a systematic way and aligned with their competitive strategy must have structured practices in place for the following (sub)processes or critical steps in technological innovation management (Figure 1 – annex/supplementary file)

- Mapping/prospecting opportunities and threats, looking to the future, including tools for identifying market opportunities, risks, and technological opportunities, and monitoring the competitive and regulatory environment, aimed at creating an intelligence that guides the generation of new innovation projects. Tools range from subscribing to technological and market information services to developing sophisticated scenarios.

- Ideation corresponds to the transformation of ideas into competitive intelligence/insights that lead to recognized opportunities. This is a critical stage for commencing new projects and services. Tools range from systematization information from suppliers and customers, or even consumers, to organizing ideas banks aimed at gathering input from the company's employees.

- Strategic selection of opportunities, including project portfolio management tools for handling new products, processes, services, and technologies, aligned with the company's strategic goals and objectives. This is the stage in which the programs or projects are defined in light of the company's strategic priorities. Typical tools include balancing graphs and multi-criteria scoring methods. The use of Technology Roadmaps has increased as a way to define technological programs (project sets) aligned with the company's strategic objectives.

- Mobilization of internal and external sources corresponds to the decision-making process that leads either to outsourcing or internalization of R&D and supplementary technological activities; it includes tools for decision-making support such as mapping external and internal skills, negotiating contracts, and assessing the R&D location. In the current competitive conditions, the proper management of outside sources and partnerships for innovation is a significant differential for leveraging innovation capacity.

- Implementation of innovation projects refers to those decision-making processes that ensure that they are properly implemented; it includes decision-making tools for managing business and technological risk such as innovation funnels, which have been expanded to incorporate not only product/process innovations, but also business models; implementing projects (internal or external) is supported through the use of financial support mechanisms and incentives, as well as intellectual property management, which will receive special attention in this project's diagnosis and recommendations.

- Assessment of the innovation management process, including development and implementation of metrics results, process quality, and impact of innovation on the organization, consumers, and environment.



## Method, diagnosis and their implications on current R&D management practices at CEB

Based on the theoretical framework discussed in the previous section, attention is now turned toward CEB, a Brazilian power company. The purpose of the research is to propose the development and implementation of a Strategic R&D Management Model that is fully integrated and aligned with its business goals. This general purpose unfolds in two specific objectives, namely: a visible connection, starting at the planning cycle's earliest stages, between R&D initiatives and practical decision-making to the corporation's strategic objectives, in all of its various dimensions, and the integration of outside partners to the company's operating and technical areas to ensure projects are developed properly and expedite technology transfer.

To assist in preparing the diagnosis on the company's current R&D management practices, twenty-two in-depth interviews were conducted with directors, superintendents, and a significant number of CEB managers. The interviews were conducted on the company premises, recorded, and carried out in two stages, the first one from March 17 and 18, 2008 and the second one from May 13 and 14, 2008 by researchers from the project's Executing Agency and guided by the Strategic Technological Innovation Management model adopted in this paper and introduced in Section 4. The interviews mapped out CEB's current R&D management process and the respondents' perception of how changes in the process could increase its effectiveness from the corporate perspective. The functions covered a broad spectrum of areas that are critical to CEB's integrated business. In the end, information had been collected from eleven managers, eight superintendents, and three directors.

During the interviews, the respondents indicated that the company's vision in relation to R&D is unstructured, resenting strategic direction, and that the direction of this activity is poorly defined (due to the constant turnover in management). Only after 2007 did the new management set a corporate focus: to act strongly in distribution (the company's true core), having the reduction of technical and business losses as its primary objective.

By 2008, the R&D management team consisted of only two employees: a manager and an administrative technician. Today, however, it plays an essential role in operational work, as a facilitator or consultant for developing new projects. The current management team is concerned with the following activities: contacts with researchers and universities; exploration projects; putting together annual cycle portfolios; implementing and monitoring all contractual procedures and the financial execution of R&D projects; designing and coordinating energy efficiency projects; and managing ser-

vice providers that carry out field activities related to the projects. Meanwhile, Project Managers are accountable for technically monitoring R&D projects with outside partners.

One of the difficulties the respondents pointed out was that neither the Board nor CEB's area managers are in the habit of getting involved with R&D routines, namely: exploration projects, putting together portfolios, and so forth. When the board finally does get involved, it is only at a later stage, after the portfolio has already been put together, and only then for the purpose of validating or rejecting initiatives submitted by R & D management, or questioning one or more projects. In other words, CEB's board does not get involved in terms of guiding priorities or setting R&D's strategic guidelines.

One of the reasons for the lack of integration between departments and the staff's involvement with R&D had to do with rationalization and restructuring, which got underway in March 2005. In this process, the company went through two voluntary dismissal programs (in 2005 and 2006), reducing its workforce by almost half (from 1,300 to 700 employees). The remaining employees were overworked, especially with operational work, and had no time to devote to more strategic activities, such as those related to R&D. In turn, R&D's management had problems finding and engaging with potential Project Managers, who were dedicated to and took responsibility for monitoring R&D projects with universities.

An innovation culture is something that needs to be systematically worked on to overcome the utility culture that has taken root in CEB over the years. Until then, there was no effective control with a focus on results and applying the research that had been contracted by the power companies. This situation eventually led to the following situation: research work came to a halt, R&D projects are forgotten, as if locked away in a dusty closet, without proper implementation and continuity. Research was neither being strategically incorporated into the company's routine as a way of adding value to CEB's business nor contributing to the benefit of the consumers who finance R&D projects by paying the tariffs.

The absence of an innovation culture is confirmed by the ignorance that most CEB employees have when it comes to R&D: a small number of managers and employees have a precise idea of what R&D is and all that it might strategically bring to the company's competitiveness inside and outside of its geographic area (Brazil's capital). In general, CEB still sees R&D as simply complying with a legal obligation, as does the rest of the electricity sector. There is also a kind of prejudice and trauma related to R&D, since its work develops over a longer period of time and the company has problems that need to be solved right away. From the respondents point of view, the company's university partners are more interested

in imposing their theoretical models (many of which have no connection with the company's day-to-day reality) than in solving CEB's practical problems.

In the intellectual property field, the respondents involved in R&D management assessed that the Company's Legal Department is not fully prepared to deal with matters relating to patent protection of products that could be generated from CEB-financed R&D projects. In addition, the R&D manager would have no autonomy to resolve this type of issue and, in turn, the CEB board, when asked, would put itself in that position, like an old impasse on patenting a product. In this example, CEB had not made a timely decision and the product, which had been developed in conjunction with a researcher, through an R&D project approved by ANEEL, had been patented by a Dutch company and, consequently, the technology – jointly developed with the researcher and funded by the company – now risked being sold to CEB.

Due to the lack of skilled manpower, and as a way of supplementing its downsized workforce, CEB hired outside personnel to run their R&D department. Thus, all of the company's R&D projects are now contracted externally. No research and development is done internally (except for energy efficiency projects): the company has no laboratories and no R&D team – a situation that is common in the electricity sector. Also for this reason, one of the obstacles in this field is the difficulty in absorbing and incorporating the skill development of outside partners. Up until the last R&D cycle (prior to 2007), there had been a concern with CEB employees' capacity to absorb knowledge. It was only in the next-to-the-last R&D cycle (2007-2008) that some mechanisms were developed and introduced to retain a portion of the knowledge it had generated. The manager went on to suggest that the proposal of researchers recruited through ANEEL R&D projects include: skill development, joint publications, and participation by CEB employees in seminars, as well as equipment purchases to supply the company's technological infrastructure, especially in the area of microelectronics.

Until then, the company had never held a Public Call for R&D projects and found it difficult to put together a cyclic portfolio and come up with the minimum investment based on its net operating revenue. Prospecting such projects is still carried out informally: through e-mails and phone calls to researchers/institutes that have already developed R&D work for CEB. This difficulty could compromise the quality of the projects and the degree of their alignment with the company's business strategy, because to reach the minimum investment amount required by law, managers end up accepting any R&D project proposal, i.e., projects that are available in the market at the time the portfolio is structured – without being concerned about their adherence to CEB's strategic objectives.

Furthermore, there is still no structured mapping of opportunities and the technological skills of specialists and/or research institutions to help in proposed R&D projects, and the researchers' skills (and those of the research institutions) that could be useful in developing the company's R&D projects are not formally structured and/or made available to the CEB community. Such skills as exist are found with a few company employees who have informal contacts with experts and/or foundations (university authorities), which means that, in the absence of these managers, (through termination or some other reason), such contacts eventually disappear from the company environment.

CEB does not yet have a structured process for assessing its external partners or a methodology for assessing projects. Nor is there a prospecting area to monitor the technological frontier in the power and electricity sector or the company's competitors (by mapping potential competitors' patent situation, for example).

Finally, there are still no incentives for staff being directly involved in R&D, neither in the form of remuneration nor the possibility of professional development, which would encourage potential project managers to consider submitting a proposal that would ultimately add one more task to their workday.

These findings draw attention to the fact that, while CEB is a Brazilian company distinguished by having a formal annual R&D budget to which funds are systematically allocated, the current R&D management model has not contributed to optimizing its resources and aligning its projects to the company's business strategies.

However, considering the scale and example of the industry's best practices (Cemig, CPFL, Eletronorte, and Eletropaulo), although the compulsory allocation of resources to R&D projects is an anomaly in terms of a loss of control over its own strategic decisions, the company should consider using this Act as a lever to meet its needs for growth and sustaining its competitive advantages rather than face it – reductionistically and mistakenly – as a burden or a form of punishment.

## Findings and discussion

### Guidelines and assumptions of the R&D management model at CEB

Quadros and Vieira (2008) reported on CEB's R&D management practices that, in an attempt to diversify its activities in the 1990s, the company's management prioritized power generation at the expense of distribution, a decision that ultimately had a negative impact on its business.

Although it is not the intent of this paper to recount all of the losses the company suffered with this shift in focus, it is worth noting that they were due to the precarious state of its power distribution network, which compromised its efficient use. In addition to the heavy technical and commercial losses in recent years due to an overloaded electrical system and the diversion and theft of energy and components, the factors that most undermine the company's commitment to operating excellence include:

- frequent interruptions in power supply (DEC and FEC);
- absence of productivity indicators;
- lack of business and electric planning;
- inefficiency in information technology;
- weaknesses in billing and collection;
- devalued and obsolete real and personal property.

The company's managerial and strategic choices over a period of almost two decades (1990 and 2000) explain the difficulties CEB has had with ANEEL whenever seeking permission to expand its investments (Quadros and Vieira, 2008). The Agency's rejections made it difficult for the company to improve its system by making its tariff rates more competitive. However, as Quadros and Vieira (2008) point out, it would only be wise to invest in the system with a competitive rate, thus enhancing its investment background.

Moreover, within the Research and Technological Development sector, there are some structural constraints to which power distributors are subject and must be faced daily. Pinheiro (2008) draws attention to the fact that, against an extremely rigid regulatory framework, there are few alternatives available to distributors in the Brazilian Electric Sector (BES) to deliberately and creatively formulate strategies for growing their revenues.

That is due to the deverticalization process that took place when the electricity sector was being restructured, and distributors were prevented from getting involved in other activities in the production chain that were not strictly related to their activity. Furthermore, distributors have no autonomy to raise their rates, as they are set by the government, through ANEEL, by meeting certain requirements related to quality energy indicators, continuity of service, and surveys on consumer satisfaction. However, if distributors were able to derive revenues from activities not necessarily related to the business of power distribution (e.g., pole rental, property sales, patent royalties, etc.), they would have to pass them onto the public through lower tariffs, with their rates being adjusted downwards (Pinheiro, 2008). Next, the increase in demand, by incorporating free consumers, is a measure that requires caution and investments in the distribution network to avoid compromising the qual-

ity of service and supply to the captive market, leading the company to be penalized as providing for in Decree No. 563 (according to this decree the distributors of the Brazilian electrical sector are required to meet 100% of its captive market). Finally, one mechanism that could be controlled by a distributor as a way to augment its revenue is to increase the geographical area of its concession by acquiring other distributors. However, this is not a blueprint measure and does not ensure, per se, the distributor's organic growth and sustained business.

Given this framework, the only possible alternative Brazilian distributors have when it comes to increasing their profitability and produce value for their shareholders and other stakeholders is to adopt strategies associated with operating excellence, i.e., ones that make it possible to improve productivity and operating efficiency. Hence the important role R&D plays, with its focus on incremental innovations and collaborative processes – whether with suppliers or research institutions or other utilities. In this case, incremental innovations designed to improve processes and operational excellence mean providing proprietary technological solutions aimed at reducing costs (operating or maintenance costs or those associated with buying electric power) while increasing the power distribution system's service life (Pinheiro, 2008).

That said, a number of guidelines and assumptions were chosen to guide CEB's R&D Management Model and its planning and management process to standardize procedures, routines, tools, and behaviors that would help enable decision-making, CEB employees' learning, and their integration with outside partners. These guidelines consider aspects that are crucial to CEB, including:

1. the company's need to achieve operating excellence vis-à-vis the low quality of current service provided to consumers in its geographic area and the precarious state of its distribution network;
2. the need to meet the contractual requirements of Act 9,991/2000, while striving to fit within the ANEEL guidelines that regulate and systematize the processes, routines, and tools associated with R&D optimization;
3. the reduced size of the R&D budget; and
4. the need to cooperatively interact with outside partners in science, technology, and innovation (Sati) in view of the growing complexity in knowledge associated with new technologies and, hence, the need for an interdisciplinary approach in the form of collaborative research, while allowing costs and risks to be shared.



Given this reality, the proposed R&D management model should prioritize technologies that enable its operational excellence and, at the same time, is able to satisfy ANEEL's guidelines for research and technological development projects and programs in the electricity sector (ANEEL, 2008). As such, the model should focus on generating and implementing R&D projects aimed at incremental innovation, with a focus on operational improvements in the short and medium term.

Moreover, since CEB's R&D budget (R\$ 5.1 million, covering the 2007-2008 cycle until 2010) is relatively small when compared to that of the major players in the power sector (Eletrobras, Cemig, CPFL, Eletropaulo, and Petrobras), the company must combine two elements to achieve synergy and scale: i) pursue the effectiveness of disbursement on R&D projects, concentrating resources on a few good projects, rather than scattering them among many projects, and ii) at the same time prioritize R&D projects with high implementation feasibility and the ability to generate benefits for CEB.

Another possible alternative to enhancing synergy and scale in R&D while reducing costs and risks is the technological cooperation. The need to maintain long-term organic growth and sustain competitive advantages, coupled with the increasing complexity in knowledge and new technologies, is increasingly apparent and has led companies to seek out partners for technological cooperation. Therefore, the proposed R&D Management Model encourages the development of regional R&D projects with other electricity distributors in their respective area. In addition to concentrating efforts and resources (material, human, financial, etc.), as well as the opportunity to share costs and risks, such collaboration would allow for a more robust portfolio (regional) to be put together in terms of disbursement per project, thereby strengthening it.

## Results

### **A model focused on incremental innovation and the innovation funnel (pipeline)**

The center of CEB's R&D Management Model is an ideation process (identifying priorities, needs, and ideas to meet them) and an innovation funnel suitable for technology projects aimed at finding innovative operational solutions. Innovation management focused on R&D projects is based on an orderly, systematic view that is integrated with the company's sustainable growth strategy.

The heart of this process is structured in the form of a funnel so that R&D projects, focused on developing technologies and identified as potential opportunities, are qualified

and classified into stages (Gates), supported by a decision point as to whether or not to continue (go-no-go), according to their ability to meet strategic priorities and add economic value to CEB.

In addition, the process includes elements outside of the Funnel (in its input and output) related to supplying inputs to the process and procedures that have to be managed at the end of the innovation process (Figure 2 – annex/supplementary file). The decision-making process includes the following steps:

**Ideation (or Idea Generation):** This is the element that marks the beginning of the innovation process and is characterized by the various channels through which innovation opportunities can be identified and then submitted to the company's R&D Funnel. Channels may be internal and external. Internal channels of idea generation (ideation) are understood as being CEB's R&D team and any superintendents, managers, or employees from other business areas who may want to contribute suggestions. External channels include customers, utility partners, suppliers, and research institutions, as well as any documents produced by prospecting experts and interpreted by CEB's R&D team.

**Ideas Bank:** This is essential to recording ideas focused on technological solutions. As a transitional feature throughout CEB's innovation process, the Ideas Bank is a repository aimed at recording, organizing, and storing ideas submitted by CEB employees: those that have not yet entered the R&D Funnel and those that have not been approved at any of the process Gates, but are thought to be relevant for future use. Having a record of these ideas will allow CEB to revisit and retrieve them at the proper time (i.e., when all of the conditions are in place for their start-up), when the Bank is being updated, and may be used in other opportunities for innovation (see Figures 3 and 4 annex / supplementary files). Moreover, the Ideas Bank will be available for research and read-only access to all CEB employees, allowing them to conduct searches before proposing their suggestions. This will help to avoid duplication of ideas/proposals and also allow employees who are interested in working together to identify potential partners.

**Ideas Filter (Gate 1):** Characterized as Gate 1 of CEB's innovation process, this step consists of reviewing, recording, and making a preliminary assessment of the idea's consistency and feasibility. This first filter will be carried out by the R&D team or the management of the area in which the idea originated. Ideas that pass through this filter will go to Gate 2: Idea Assessment. To support decision-making at Gate 1, the ideas will be submitted to the criterion of originality. This criterion is eliminatory and aims at assessing how the idea/proposal would fit in as a R&D project. This procedure aims

at aligning the selection of ideas to the consolidated methodology set forth in ANEEL's R&D Manual, version 2008 (ANEEL, 2008). The assessment criteria will be scored from 1-5 in all Gates, following the score concepts shown in Table 1. The concept "Inappropriate", referring to the score "1" when the "Originality" criterion is applied, determines that the idea does not fit as a potential R&D activity.

Score	Project Rating
1	Inadequate
2	Insufficient
3	Acceptable
4	Good
5	Excellent

Table 1  
Possible Ratings to be Assigned to Assessment Criteria  
Source: ANEEL R&D Manual 2008

In case of competition for ANEEL R&D resources among the proposals for R&D projects to be selected by CEB's Technology and Innovation Committee (TIC), weights will be assigned to the criteria (the TIC shall be composed of one representative of the Presidency, representatives of the three Directors of the company [Marketing, Engineering and Management] and the Superintendent of the area proponent of the idea / project). The end result will be a list of ranked proposals, indicating their order of priority, i.e., those with the greatest potential of being transformed into R&D activities/opportunities/projects. Otherwise, the grade and the concept of the idea/project will be obtained based on the arithmetic average of the scores given to the assessment criteria by their reviewers. The concepts attributed to the R&D projects, obtained on the basis of their grade, are presented in Table 2. Given that the "Originality" criterion is exclusionary, it must have a score equal to or greater than 3.0 for the idea/project to be approved at Gate 1.

Project Grade (N)	Project Rating
$N \leq 2,0$	Inadequate
$2,0 < N < 3,0$	Insufficient
$3,0 \leq N < 3,5$	Acceptable
$3,5 \leq N < 4,5$	Good
$N \geq 4,5$	Excellent

Table 2  
Project Score in terms of R&D Project Grade  
Source: ANEEL R&D Manual 2008

Idea Assessment (Gate 2): Idea Assessment consists of preparing a proposal or application of the idea, as well as elements of a strategic and technological nature, such as describing the idea and its application; strategic contribution to the solution; its degree of technological attractiveness; its technological feasibility; overhead costs for its development; and terms of reference. This proposal will be submitted to a set of assessment criteria based on merit and feasibility, and then scrutinized by Technology and Innovation Committee at Gate 3 of the innovation process: Internal Approval. To support decision-making at Gate 2, the ideas will be submitted to the Alignment, Costs and Applicability criteria. The main product (document) of the second filter is a Term of Reference, containing the main specifications and CEB's recommendations for developing the project by Brazilian Research Institutions (BRIs). Such BRIs will be prospected through the skills bank by CEB's areas applying for the R&D project.

"Alignment" will be assessed based on the project's degree of adherence to CEB's strategy. Meanwhile, "Cost Reasonableness" will be assessed by economic impact parameters, including: benefits (based on expected return on investment); improved productivity; improved quality of supply; improvement in asset management; reduction of business and non-technical losses; impact on the energy market of the company and/or companies in the sector (demand forecasting); and improving energy efficiency in the energy's supply and end-use. "Applicability" will be assessed based on scope and application potential, especially of the main product, including the type of institution (executing agency, power company, or electricity sector) and its scope (area, segment, class, and number of consumers). Regardless of scope or coverage, applicability should be justified and proven by operational verification (laboratory tests, field, type, or routine tests). Any possible restrictions should be justified in terms of the scope or coverage.

The notice of assessment shall be sent to the author (s) within thirty days from the date of the electronic form's submission.

Approved proposals will be sent to Gate 3 of the innovation process: Internal R&D Project Proposal Approval. This step will define the Project Manager, who may also be the author of the idea. The Manager will act as its sponsor throughout its development and be responsible for finding and selecting an outside partner (Research Institute) to assist preparing and implementing the R&D project. Ideas that are disapproved at this stage will be stored in CEB's Ideas Bank.

R&D Partner Skills Bank: This is a customized information system containing skills and technological opportunities found in Brazil and in CEB's technological areas of inter-

est, with detailed information about the core skills and the current condition of the infrastructure for research and human resources training in Brazilian research institutions. This database will be supplied and periodically updated by CEB's R&D team.

**Internal Approval of the R&D Project (Gate 3):** Internal Project Approval represents a more detailed study of the evidence adduced at Gate 2: Idea Assessment. The Project Manager and his outside partner (Research Institution) consolidate project information (including estimated costs for its development and team composition) onto electronic forms that are available on the R&D project management system, which are then sent to Gate 4 along with the other documents. Decisions at this stage will be made through previously scheduled quarterly meetings (with mandatory attendance) that have been made known to all CEB employees. They will be supported by a set of assessment criteria focusing on relevance and costs, which include: Professional Training, Technical Training, Socio-Environmental Impact, Cost Estimating, and Cost-Benefit Analysis. The goal here is, in conjunction with the Research Institution, to describe, establish, and affirm the solution's assumptions and how they would realistically benefit CEB. This review will consider the description and completion of the following items, listed as suggestions related to the proposed solution: its strategic contribution; its degree of technological attractiveness; the presence of technological synergies at CEB; its technological feasibility; revenue estimates; overhead costs for its development; and description of the project and project team. Some of the approved projects (or all) will then be sent to Gate 4 of CEB's R&D management process: ANEEL Approval (ex-ante). Ideally, the decision made at Gate 3 should be made during a mandatory face-to-face meeting, even though the projects have received approval through CEB's virtual system.

**Project Approval (ex-ante) by ANEEL (Gate 4):** Once approved by the Committee at Gate 3, and jointly reviewed by the Project Manager and his outside partner (Research Institution), the project will then go to Gate 4: R&D Project Approval (ex-ante) by ANEEL. The goal here is to adjust project assumptions and make sure they fit within the "Originality" item established by ANEEL. The focus of this initial review (optional) is to determine the project's fitness as an R & D activity, its relevance to the technological challenges facing the sector, and the reasonableness of investment in light of the expected results and benefits. In addition to the Originality criterion, this ANEEL-conducted assessment will take a close look at the following criteria: Applicability of Results, Relevance, and Cost Reasonableness (OARC). When submitting projects to the Agency for assessment, these criteria will have been previously applied by CEB in its assessment of the proposals.

**Assessment of Contracted Project in Progress (Gate 5):** The purpose of this step is to propose annual, systematic monitoring of any project contracted by CEB's Technology and Innovation Committee, anticipating ANEEL's final assessment. This monitoring will be provided through reports (technical, physical, and financial execution) and a set of indicators to assess the preliminary results.

**Project Solution:** This step will mark the final phase of the R&D management process and consists of final adjustments to the solution, which had been flagged at Gate 5: Assessment of Contracted Project in Progress, to make it available to CEB.

**Intellectual Property Management Procedures:** The purpose of this step is to systematize the procedures related to intellectual property rights arising from the project's solution(s). It consists of preparing the Innovation Report for assessment and/or commencement of procedures for patenting the solution. Therefore, the R&D team will support the management of activities related to intellectual property rights of any solutions arising from the company's R&D projects and formalize the procedures for patenting them. An electronic form will handle the interface between applicant users, the INPI portal, and the main international patent databases (USPTO, ESP@CENET, etc). In addition to allowing quick access to INPI's system, the goal is to structure and streamline search procedures using domestic and international databases. Above all, though its purpose is to systematize management procedures and routines, this electronic form will act as a guardian of CEB's memory and learning in the field of intellectual property with regard to its R&D projects.

**Assessment of the Management Process and R&D Project Results:** Final assessment is laid out in the Research and Technological Development Program Manual for the Electric Power Sector (2008 version), is mandatory, and is the prerogative of ANEEL. It will be carried out by a review panel selected by ANEEL (consisting of at least three reviewers).

Although the final assessment is ANEEL's responsibility, a final assessment step will be done internally at the end of the R&D project implementation period by CEB's innovation process managers for the purpose of confirming the effectiveness of decisions made and actions undertaken concerning the company's innovative activities. To do so, they will assess the results of R&D projects and the overall quality of the innovation management process.

The R&D team will produce all assessments and analyses that will assist in this process. However, the Technology and Innovation Committee will review indicators to assess the process and results of the R&D projects. After consolidating

the assessments and analyses, the R&D team will release the results to the CEB employees who are involved with the projects and schedule meetings to review the indicators used to assess project results and the company's innovation management process.

This step is concerned with systematizing the overall assessment process (CEB) and its results (ANEEL). From CEB's point of view, the goal will be to make certain that the decisions made and actions taken have been effective in carrying out the process and scope of the project results. This step will include metrics and indicators related to the solution's results for CEB as well as the process quality. From ANEEL's perspective, the final assessment of the results, as well as the analysis of the main product, will also take the scored OARC criteria into account, along with an analysis of secondary products: job training (number and type of monographs, dissertations, and theses, participation in postgraduate courses as a regular student), technological capability (technological infrastructure, scientific-technical publications, and intellectual property products), socio-environmental impacts, and possible unplanned results.

6.2 - Development of a computerized system for operating the new model: IT as a mediator of the social processes triggered by the decision-making processes

Validating this R&D strategic management model was made through extension courses and workshops in 2009, involving CEB's top management, followed by preparing the computerized system (workflow) that provides support to the model. In the first half of 2010, a pilot version of the system was implemented – with the support of senior management and other CEB employees – containing tools for managing R&D, testing, fine-tuning and validation, and training for disclosing the new model.

Such a system is installed in the company's server and access is only possible through CEB's Intranet. E-mails sent by the platform use CEB's e-mail server, which only sends messages to addresses with the specification: user@ceb.com.br . This is necessary because a set of electronic messages is sent to those involved in the proposal and decision-making process: the author(s) of the idea, the R & D team, and the members of the Technology and Innovation Committee (approvers), in which there attributes in the system (or lack of them within the deadlines set by the system manager, i.e., by R&D management) placed by the users to make it more dynamic and efficient.

The structuring of R&D's strategic computerized management will take over the completion of certain electronic forms, which will communicate with a database. Information on every idea, proposal, or project and each user will be

permanently stored in this database. Logging into the system will be done by means of a user name and password, which users will be create during their first login.

The idea is that the system operation will be carried out by three groups in three different steps. The first step involves registering the ideas and systematically monitoring the results of suggestions made by the users (Figures 5 and 6 – annexes / supplementary files). The second step concerns managing the computerized system, which is carried out by a dedicated R&D team (Figure 7 – annex / supplementary file). The third step takes place at the Gates, through assessments by the Technology Committee (Figure 8 – annex / supplementary file).

An important feature that platform managers have access to (in the space dedicated to Workflow Management) is the ability to add or delete approval criteria used by the Technology Committee. These criteria may be accompanied by explanatory texts, which will assist the gatekeepers (decision makers) in assessing proposals. It is also possible to define the weights of each criterion in this area, as well as the Gates, and the specific role it plays (as per Figures 9 and 10 – annexes / supplementary files).

A set of information can be configured for each Gate that may impact assessment dynamics and speed (Figure 11 – annex / supplementary file), which are: the approval percentage required for each Gate; defining whether there is a need for a meeting between the gatekeepers to validate ideas/proposals submitted by company employees; the deadline for data input by idea creators; and date of the meeting (should the need for a mandatory meeting between gatekeepers be scheduled on a particular Gate).

It is also possible to register R&D topics of interest to CEB in the system that do not necessarily fit in with or are implemented through ANEEL R&D resources, but are, nevertheless, aligned with the company's competitive strategy and implemented through its own budget.

This electronic tool, i.e., the innovation funnel, is designed to create a dynamic interface between bidders, decision makers, and R&D managers because a set of electronic messages will be sent to those involved in the decision-making process: the author of the idea, the R&D team, and the members of the Technology and Innovation Committee (approvers). These e-mails inform the author that his/her suggestion has been successfully registered in the system and was sent to the approvers for review and validation. In turn, these e-mails also inform the approvers (the R&D team and Technology and Innovation Committee) that a new idea has been registered in the system, so it should be accessed to make the necessary assessments at Gates 1, 2, 3, and 5 (as per

Figure 8 – annex / supplementary file). As the deadline for completing the assessments approaches, approvers receive automatic messages reminding them of the need to access the platform/funnel and complete the assessment. These messages also report the percentage or numbers of approvers who have already assessed the idea.

After the decision-makers have completed their assessments, a new set of electronic messages will be sent to the author of the idea (creator), the R & D team, and the members of the Technology and Innovation Committee (approvers). These e-mails will let the author know that his/her suggestion/proposal/project has been assessed by the approvers, so the system needs to be accessed again to satisfy the requirements of the next steps with new and/or supplementary information (if necessary, using new document templates that are available for the corresponding phases) to continue the assessment process. Next, the e-mails also notify the approvers that the idea/proposal/project has reached its approval quota, and, therefore, has migrated to the next step, requiring monitoring and/or allocating new data/information.

That way, the system allows the author to systematically and visually track the progress and status his/her idea/proposal as it makes its way along the decision-making flow. It also helps the decision-makers and R&D managers to monitor their decisions' assessment and validation.

### **Managing internal policies to stimulate participation**

The conceptual approach that underpins CEB's new R&D management model assumes that the innovation culture is an amalgam of the combination of three key organizational dimensions: governance, organization, and people management (Quadros, 2008). People management is a fundamental pillar for fostering an innovative culture within the company. It sends a clear message to the employees regarding its genuine commitment to innovation through tangible and intangible signals. Direct and indirect compensation are by no means insignificant tangible incentives in the short and medium term, but they are not enough to create and internalize core skills within the company.

Moreover, company policies related to professional qualifications, support, and learning play a key role in the long run in terms of building and strengthening the company's technological expertise, which, in turn, enhances its competitive position.

In CEB's case, if financial rewards are not feasible, the people involved in R&D projects, now and/or in the future, ought to be appropriately rewarded (and/or encouraged) with compensatory training and professional development policies.

CEB's R&D people management strategy should also be guided by encouraging professional training in technological research. The company, through its top management, should encourage and reward its employees involved in R&D projects and who are enrolled in post-graduation, master's, and doctoral programs; who have had scientific-technical papers, monographs, dissertations, and/or doctoral theses published in areas and/or professional journals of interest to the electricity sector; project managers that were responsible for enhancing the area's infrastructure; and employees whose projects resulted in intellectual property assets or the registration of software or industrial design patents.

Rewarding through positive reinforcement can be achieved by speeding up the careers of those involved with R&D and should be included in CEB's Career, Job, and Salary Plan or by providing them with opportunities for learning and/or sharing experiences with peers by funding their participation in domestic and/or international conferences (either as a participant or as an exhibitor when there is no confidentiality clause involved), time off to participate in post-graduate training, specialized courses in their area of expertise, and visits to industry trade shows.

Innovation Awards are recommended as a way of publicly recognizing those employees involved with CEB's R&D projects and who have produced results that benefited the company. The CEO, Directors, and Superintendents' participation at the awards ceremony are crucial to acknowledging top management's commitment to creativity and innovation.

Finally, the R&D team will be charged with the task of planning routines that lead up to the "CEB Innovation Award," taking into account the criteria that will assist in selecting candidate projects; describing the award system and classifying projects into categories; defining the prerequisites and enrollment period; convening the judges' panel; selecting candidate projects; negotiating the Innovation Awards budget with CEB's top executives; planning the awards ceremony; and developing indicators for the final assessment and review of process quality.

### **Concluding remarks**

Although the R&D strategic management model, and the workflow system that supports it, has only recently been installed at CEB and is still in the early learning phase, the company's experience thus far confirms that there is a great potential for improving the efficiency, efficacy, and effectiveness of ANEEL-regulated R&D programs. It is defined as R&D effectiveness its contribution to achieving the goals of operational excellence, improving the quality and safety in energy distribution and the development and incorporation of new technologies that contribute to greater efficiency and



sustainability in electricity distribution. This potential will be unleashed as individual companies, and the electric power system as a whole, adopt, mature, and improve R&D management systems aimed at generating and disseminating innovations.

Fundamentally, the proposed model is a feature that helps the company to structure and systematize support to R & D+i, as it establishes a minimum structure of governance with previously defined rules and a decision-making flow; identifies the people who will make up committees that participate in it (whether in decision-making, managing the model's routines, or project implementation); establishes frequency and deadlines for actions; provides a user manual; and systematizes standardized electronic forms for project submission.

It also promotes discussions that assist in identifying critical issues and technology/business gaps faced by various areas in the company, building consensus among participants concerning the primary needs and how to address them, and becoming a benchmark for coordinating the company's R&D work. Its graphic form facilitates understanding and an internalized view of the decision-making flow, helping to spread a common language within the company related to R&D+i management and improve communication among the technical, business, legal, regulatory, and R&D areas.

Therefore, more than complying with a law pertaining to the Brazilian Electricity Sector and eluding an ANEEL regulatory risk, the most important contribution of this model (workflow) for managing R&D +i at CEB is its social construction, given that the model assumes that innovation is a process that should involve all employees within the organization, especially its top management. Meanwhile, the R&D middle managers will play a key role in the processes that trigger the creation of knowledge in the company (related to R&D +i), as to processes needed for its management and involve senior management and other technical areas (front-line employees), putting middle-up-down management in place (Nonaka and Takeuchi, 1997).

Strategically placed to facilitate information flow (vertical and horizontal) within the company, the idea of middle-up-down management is that – to make a qualitative leap, getting a mandate that incorporates strategic roles into its routine and therefore enriching the content and scope of its work – this revitalized management will add value to the CEB's business while gaining a dynamic, vital role in this process.

In the long run, fostering an environment that stimulates an innovation culture by laying out a systematic registration routine (registration, organization, storage, and periodic review) of ideas for technological and organizational solutions

– which may become opportunities for R&D projects that fit within the ANEEL program, as well as innovation opportunities on topics of interest to CEB but not necessarily allocated to the R&D-ANEEL budget, but rather a formal budget CEB budget – is also a learning experience that goes far beyond simple compliance with a legal-contractual obligation.

Finally, this model provides elements for delving more deeply into a topic that has been little explored by public authorities with regard to strategic R&D+i management of public companies that operate in industries deemed to be of national interest.

## References

- ANEEL – Agência Nacional de Energia Elétrica (2008). Manual do Programa de Pesquisa e Desenvolvimento do Setor de Energia Elétrica. Brasília: ANEEL. 67p..
- ANTONY, S.D.; JOHNSON, M.W.; SINFIELD, J.V.; ALTMAN, E.J. (2011). *Inovação para o Crescimento: ferramentas para incentivar e administrar a inovação*. São Paulo: Makron Books.
- BOSCAINI JÚNIOR, C. R.; Oliveira, Paulo Cezar de (2008). *Metodologia de Avaliação e Priorização de Projetos de P&D para Eletronorte*. Monografia apresentada ao curso de especialização em Gestão Estratégica da Inovação Tecnológica no Setor de Energia Elétrica. 26p.
- BURGELMAN, R.A.; Maidique, M.A.; Wheelwright, S. (2003). *Strategic Management of Technology and Innovation*. McGraw-Hill/Irwin Press, New York.
- CARVALHO, F. P. (2010). "Cooperação e alianças para a inovação e o desempenho das empresas brasileiras". SALERNO, M.; DE NEGRI, J.A.; TURCHI, L. M.; MORAIS, J. M. (Eds). *Inovação: estudos de jovens pesquisadores brasileiros (Vol.2)*. São Paulo: Editora Papagaio (466 pp.).
- CHERCHIGLIA, L. C. L.; Meira, D. M. (2008). *Geração de Projetos de Inovação Tecnológica nas Distribuidoras Brasileiras de Energia Elétrica*. Trabalho apresentado no XVIII Seminário Nacional de Distribuição de Energia Elétrica- SENDI 2008, 06 a 10 de outubro, Olinda - Pernambuco – Brasil. 12p.
- CHESBROUGH, H. (2007). Why companies should have open business models. *Sloan Management Review*, vol. 48, n. 2, pp. 22-28.
- CHESBROUGH, H. (2012a). *Inovação Aberta: com criar e lucrar com a tecnologia*. Porto Alegre: Bookman. 241p.

- CHESBROUGH, H. (2012b). Modelos de Negócios Abertos: como prosperar no novo cenário da inovação. Porto Alegre: Bookman. 220p.
- CLARK, K.B.; Wheelwright, S.C. (1993) Managing new product and process development: text and cases. New York: The Free Press.
- CLOSS, L., Ferreira, G., Soria, A., Sampaio, C., Perin, M. (2012). Organizational Factors that Affect the University-Industry Technology Transfer Processes of a Private University. *Journal of Technology Management & Innovation, North America*, 7, feb. 2012. Available at: <http://www.jotmi.org/index.php/GT/article/view/art238/684>. Date accessed: 05 Apr. 2013.
- COOPER, R. G.; Edgett, S.; Kleinschmidt, E. J. (2002a). Optimizing the stage-gate process: what best practice companies are doing? Part 1. *Research Technology Management*, v. 45, n.5.
- COOPER, R. G.; Edgett, S.; Kleinschmidt, E. J. (2002b). Optimizing the stage-gate process: what best practice companies are doing? Part 2. *Research Technology Management*, v. 45, n. 6.
- DE MEDEIROS Rocha, M., Alves Lima, G., De Jesus Lameira, V., Quelhas, O. (2012). Innovation as a Critical Success Factor: an Exploratory Study about the Partnership among University with Pharmaceutical Industry in Brazil. *Journal of Technology Management & Innovation, North America*, 7, sep. 2012. Available at: <http://www.jotmi.org/index.php/GT/article/view/art273>. Date accessed: 28 Dec. 2012.
- DINIZ, J. H.; Cherchiglia, L. C. L.; Carvalho, A. M.; Quadros, S.V. T. De; Turra, J. E. M. G.; Abreu, M. De S. (1999). Trabalho apresentado no XV SNPTEE - Seminário Nacional de Produção e Transmissão de Energia Elétrica. 17 a 22 de outubro de 1999. Foz do Iguaçu – Paraná – Brasil. 6p.
- DODGSON, M. (2000) The Management of Technological Innovation; An International and Strategic Approach, OUP, Oxford.
- FIGUEIREDO, P., Loiola, E. (2012). Enhancing New Product Development (NPD) Portfolio Performance by Shaping the Development Funnel. *Journal of Technology Management & Innovation, North America*, 7, dec. 2012. Available at: <http://www.jotmi.org/index.php/GT/article/view/art280/722>. Date accessed: 05 Apr. 2013.
- FREEMAN, C. (1995) The 'National System of Innovation' in Historical Perspective, in *Cambridge Journal of Economics*, vol. 19, n. 1, February 1995, pp. 5-24.
- GIANNOPOULOU, E., Yström, A., Ollila, S., Fredberg, T., Elmquist, M. (2010). Implications of Openness: A study into (All) the Growing Literature on Open Innovation. *Journal of Technology Management & Innovation, North America*, 5, nov. 2010. Available at: <http://www.jotmi.org/index.php/GT/article/view/rev8/587>. Date accessed: 05 Apr. 2013.
- KLING, S. J. e Rosenberg, N. (1986), "An Overview of Innovation", in R. Landau e N. Rosenberg (eds.), "The Positive Sum Strategy – Harnessing Technology for Economic Growth", Washington, DC, National Academy Press.
- LIMA, L. O. S. de; Martins-Filho, M. A. R. (2008). Proposta de Avaliação de Resultados de Programas de P&D na Eletronorte. Monografia apresentada ao curso de especialização em Gestão Estratégica da Inovação Tecnológica no Setor de Energia Elétrica. 35p.
- LUNDEVALL, B. (1992). National Systems of Innovation - Towards a Theory of Innovation and Interactive Learning. Printer, London.
- MENEZES, E., Carvalho, R. (2009). Impacts of New Technologies on Free-To-Air Tv Industry: Lessons from Selected Country Cases. *Journal of Technology Management & Innovation, North America*, 4, dec. 2009. Available at: <http://www.jotmi.org/index.php/GT/article/view/art135>. Date accessed: 10 Jan. 2012.
- NELSON, R. (ed.). (1993) National Innovation Systems: A Comparative Analysis. New York: Oxford University Press.
- NONAKA, I.; Takeuchi, H. (1997). Criação do Conhecimento na Empresa. Rio de Janeiro: Elsevier. 358p.
- NOOTEBOOM, B. (2004), Inter-firm collaboration, learning & networks - An integrated approach, Routledge, London.
- OECD (1996) The Knowledge-Based Economy, [OCDE/GD(96)102], Paris, OECD.
- QUADROS, R. (2008). Aprendendo a inovar: padrões de gestão da inovação tecnológica em empresas brasileiras. Texto apresentado na VIII Conferência Nacional da ANPEI, 30 p.
- QUADROS, R.; Vieira, G. (2008). Gestão Estratégica da P&D na CEB – Companhia Energética de Brasília. III Relatório Quadrimestral. 47p.
- QUADROS, R.; Vilha, A. M. (2006). Tecnologias de Informação no Gerenciamento do Processo de Inovação. *Revista Fonte – PRODEMGE – Companhia de Tecnologia da Informação do Estado de Minas Gerais*, Ano 3, N°. 6, Minas Gerais, jul/dez, pp. 129-133.

RATINEN, M. (2012). Analysing Changes in Electricity Industries Against Actors and Technologies: Utility to Business Transformations in Denmark, Germany, Finland and Spain. *Journal of Technology Management & Innovation, North America*, 7, jul. 2012. Available at: <http://www.jotmi.org/index.php/GT/article/view/art254>. Date accessed: 05 Apr. 2013.

RODRIGUES, N.; Frade, L. C. S.; Carvalho, J. M. de; Santos, A. M. da C. (2008). Prêmio Muiraquitã de Inovação Tecnológica da Eletronorte - Uma ação de Incentivo à Criatividade e Inovação. Trabalho apresentado no XVIII Seminário Nacional de Distribuição de Energia Elétrica- SENDI 2008, 06 a 10 de outubro, Olinda - Pernambuco – Brasil. 12p.

SAVITSKAYA, I., Salmi, P., Torkkeli, M. (2010). Barriers to Open Innovation: Case China. *Journal of Technology Management & Innovation, North America*, 5, dec. 2010. Available at: <http://www.jotmi.org/index.php/GT/article/view/art171/595>. Date accessed: 05 Apr. 2013.

SOARES, F. R.; Quadros, R. (2007). Avaliação do Processo de Gerenciamento de Portfólio de Projetos de P&D: Caso CEMIG. Trabalho apresentado no XII Seminário de Gestão tecnológica – ALTEC 2007, Buenos Aires, outubro. 16 p..

SUZIGAN, W.; Albuquerque, E. da M. e; Cario, S. A. F., (2011). Em busca da inovação: interação universidade-empresa no Brasil. Belo Horizonte: Autêntica Editora.

TAKAHASHI, S.; Takahashi, V. P. (2011). Estratégias de Inovação: oportunidades e competências. Barueri (SP): Editora Manole.

TIDD, J., Bessant, J.; Pavitt, Keith. (2005) *Managing Innovation: integrating. technological, managerial organizational change*. 3 ed. McGraw-Hill, New York.

VASCONCELLOS, E. (Org.) (1992). Gerenciamento da tecnologia: um instrumento para a competitividade empresarial. Editora Edgard Blucher, São Paulo. 330p.

ZAWISLAK, P., Dalmarco, G. (2011). The Silent Run: New Issues and Outcomes for University-Industry Relations in Brazil. *Journal of Technology Management & Innovation, North America*, 6, jun. 2011. Available at: <http://www.jotmi.org/index.php/GT/article/view/art195/623>. Date accessed: 05 Apr. 2013.

APPENDIX IMAGES AND FIGURES

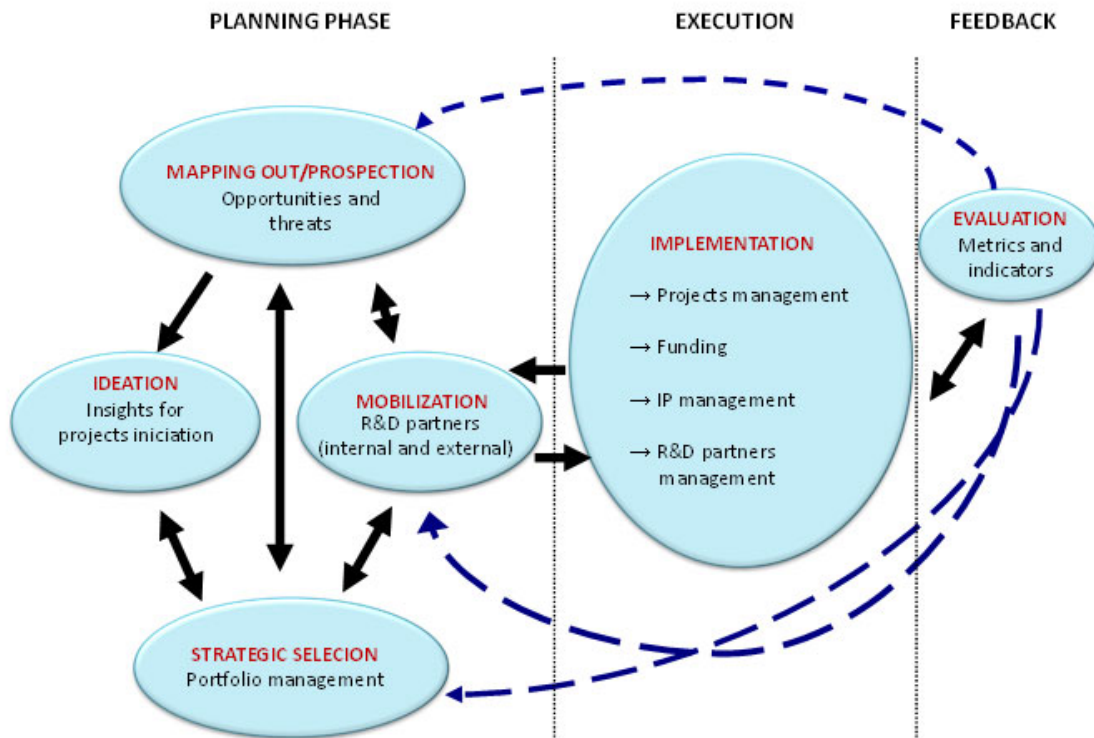


Figure 1: Model of Strategic Management of Technological Innovation Processes and Tools. Source: Quadros (2008).

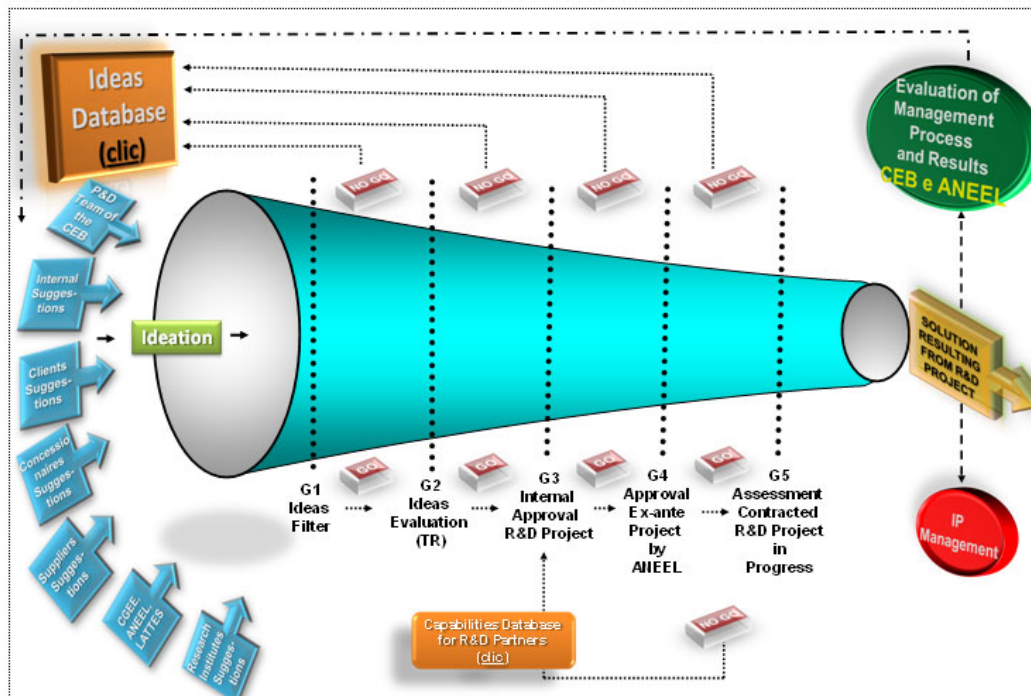


Figure 2: General Flow of Decisions of the Strategic Management Process R&D Projects of the CEB. Source: Elaborated from survey data, 2010.

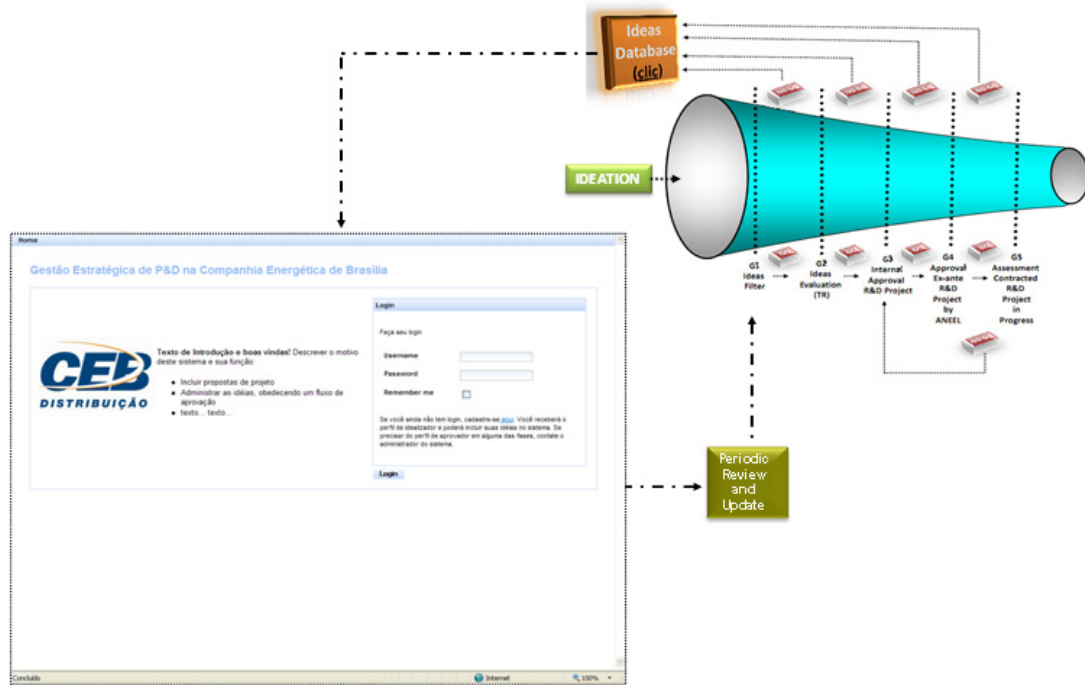


Figure 3: Periodic Review and Update of the Ideas/Proposals Bank for R&D Projects of the CEB  
Source: Elaborated from survey data, 2010.

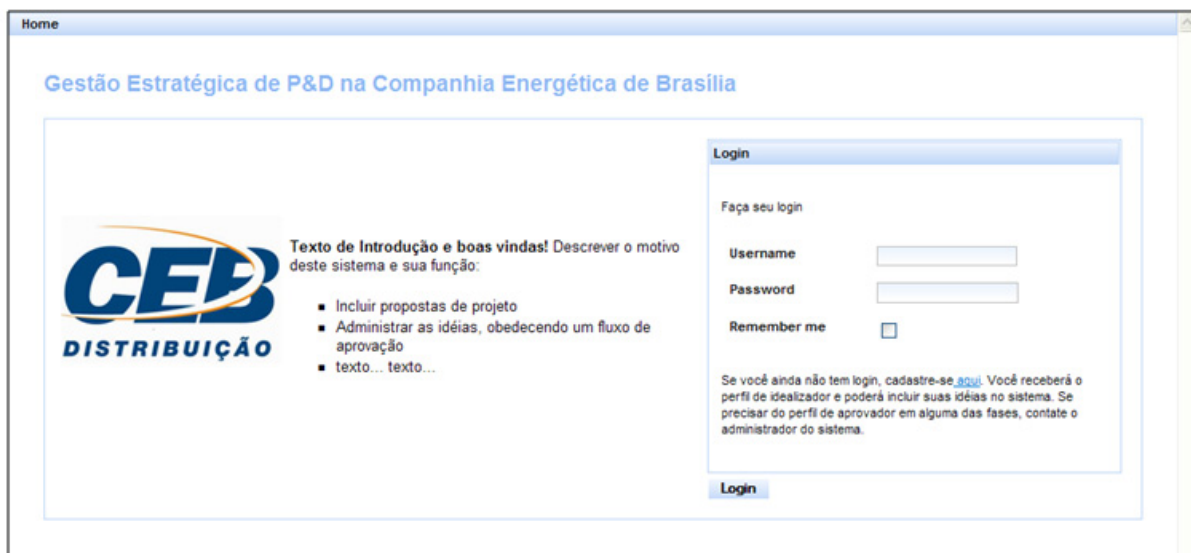


Figure 4: System (Workflow) for Strategic Management of R&D Projects of the CEB  
Source: Elaborated from survey data, 2010 (There is no English version for this electronic tool).



**Nova Idéia**

Título \*

Descrição \*

Problema original \*

Alinhamento Estratégico \*

Tema Estratégico \* Seleccione o Tema Estratégico

Cliente Interno \* Seleccione o Cliente Interno

\* campos obrigatórios

Próximo Cancelar

Figure 5: Step I - Idea Database for R&D projects of the CEB.  
 Source: Elaborated from survey data, 2010 (There is no English version for this electronic tool).

Cliente Interno \* Gerencia de P&D e Eficiencia Energetica

\* campos obrigatórios

**Gerenciador de documentos desta Idéia**

Documentos Anexados

Nenhum Arquivo Anexado encontrado

Anexar novo arquivo

Nome: Pre-projeto

Arquivo: C:\Documents and Settings\ Browse...

Anexar

Modelos de Documentos disponíveis para esta fase do funil

**Status e Aprovações**

Esta idéia está na fase de "G1 - Filtro de Idéias". Ela está sob avaliação das 3 pessoa(s) responsáveis pela aprovação da sua idéia. Nesta fase é necessário a aprovação de no mínimo 57.00%, ou seja, de 2 aprovador(es) para passar para a próxima fase do fluxo. Caso 2 aprovador(es) reprove(m) sua idéia, ela voltará para a fase "Ideação", com histórico dos comentários dos aprovador(es) abaixo e daí você poderá ampliar as explicações, complementando as informações nos documentos e aprimorar sua idéia, observando estes comentários. Após esta complementação, você poderá reenviar a idéia para aprovação novamente.

Histórico das Avaliações Anteriores dos Aprovadores (0)

Não foram executadas avaliações desta idéia.

Salvar Apagar Cancelar

Salvar e Enviar para Aprovação

Figure 6: Step I - Idea Database for R&D projects of the CEB.  
 Source: Elaborated from survey data, 2010 (There is no English version for this electronic tool).

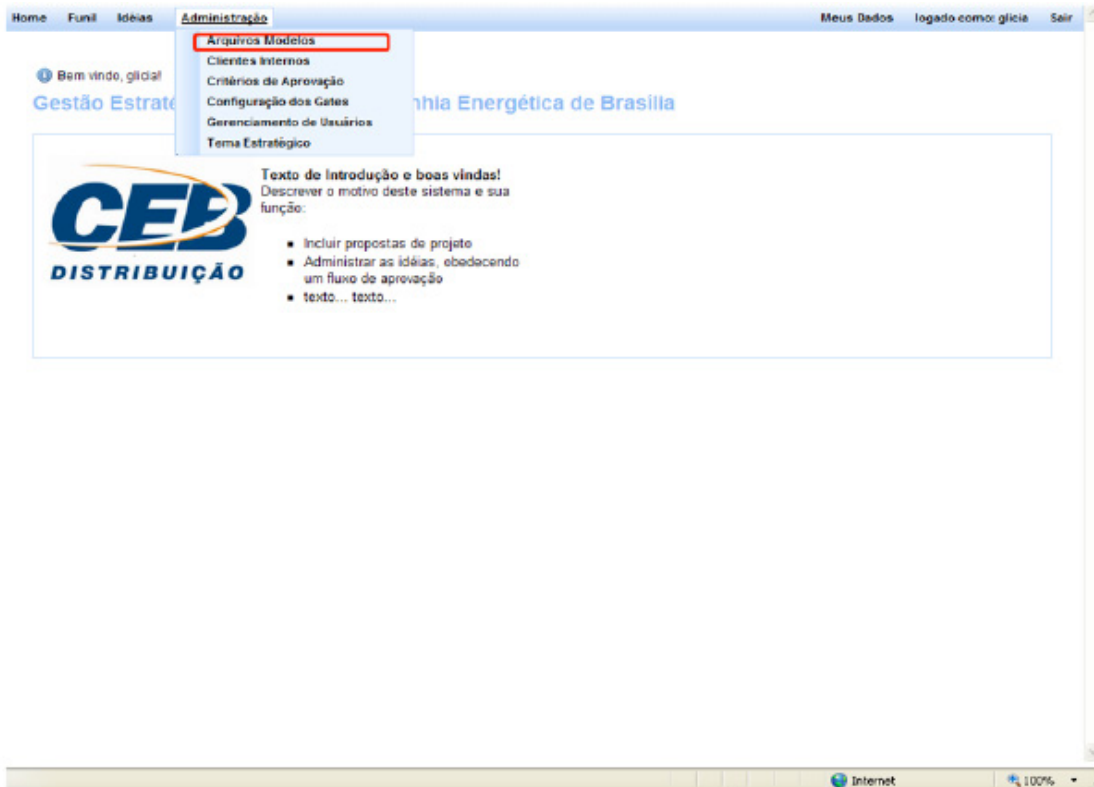


Figure 7: Step 2 - Management of the System by R&D Team of the CEB  
 Source: Elaborated from survey data, 2010 (There is no English version for this electronic tool).

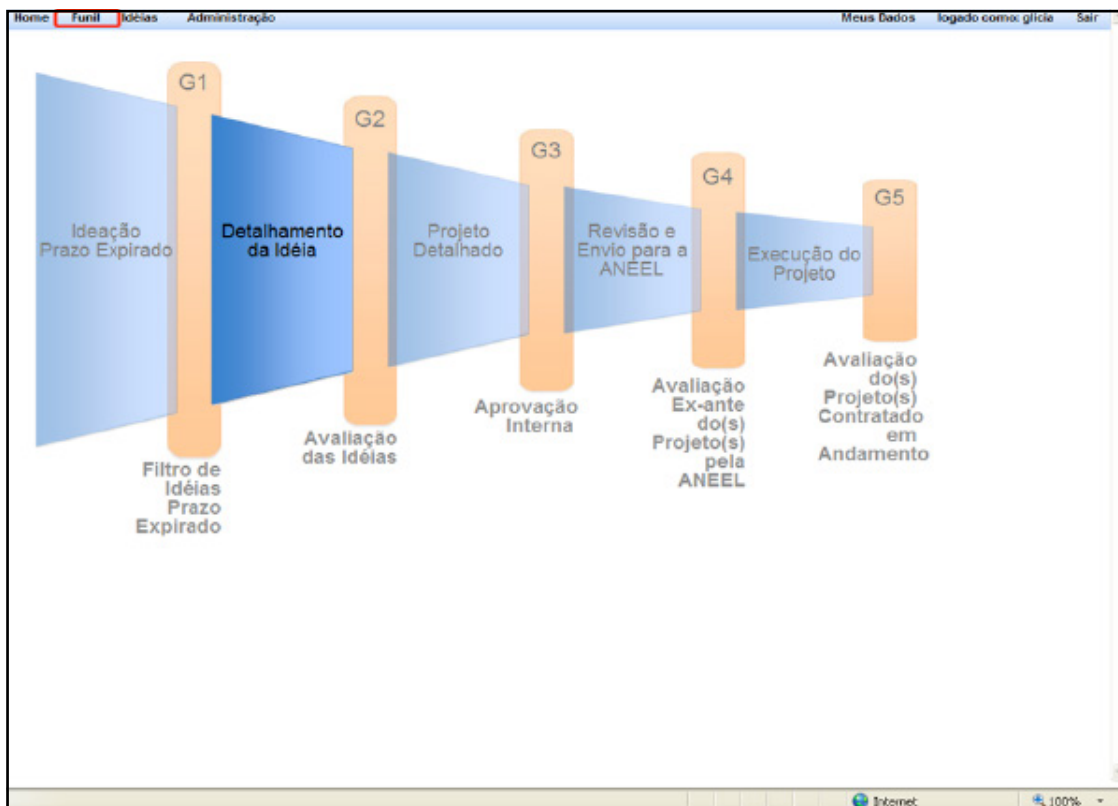


Figure 8: Step 3 - Innovation Funnel and Gates for Assessment by Technology Committee of the CEB  
 Source: Elaborated from survey data, 2010 (There is no English version for this electronic tool).

Home Funil Idéias Administração Meus Dados logado como: glicia Sair

Lista de Critérios de Aprovação (5)

Critério	Peso na Avaliação	Gate Aprovação	Action
Originalidade	17	G1 - Filtro de Idéias	<a href="#">Editar</a>
Alinhamento Estratégico do Projeto	0	G2 - Avaliação das Idéias	<a href="#">Editar</a>
Razoabilidade dos Custos	0	G2 - Avaliação das Idéias	<a href="#">Editar</a>
Aplicabilidade	0	G2 - Avaliação das Idéias	<a href="#">Editar</a>
Relevância e Custos	0	G3 - Aprovação Interna	<a href="#">Editar</a>

Novo Critério de Aprovação

Internet

Figure 9: Definition of Criteria for Evaluating Ideas/Proposals for R&D Projects of the CEB  
 Source: Elaborated from survey data, 2010 (There is no English version for this electronic tool).

Home Funil Idéias Administração Meus Dados logado como: Sair

Nome critério\*

Texto de Ajuda\*

Peso na avaliação

Gate de Aprovação\*

\* required fields

Save Delete Cancel

Figure 10: Definition of Criteria for Evaluating Ideas/Proposals for R&D Projects of the CEB  
 Source: Elaborated from survey data, 2010 (There is no English version for this electronic tool).

Home Funil Idéias Administração Meus Dados logado como: Sair

Nome: G1 - Filtro de Idéias

Percentual de Aprovação: 1 100 57

Reunião Mandatória

Data Máxima de Input de dados\*: 21/05/2010

Data da Reunião\*: 26/05/2010

\* campos obrigatórios

Salvar Cancelar

Done Internet

Figure 11: Setting Assessment Gates of the CEB

Source: Elaborated from survey data, 2010 (There is no English version for this electronic tool).