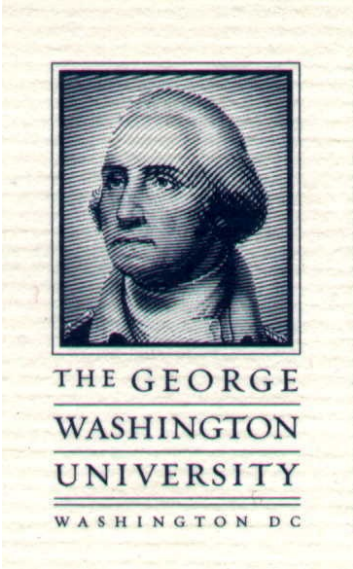


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# EXPANSION SCENARIOS FOR ELETROBRAS IN THE BRAZILIAN ELECTRICITY SECTOR

**By**

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## 1) Introduction

Eletrobras is a mixed economy and open capital stock corporation, with shares traded at São Paulo (Bovespa), Madrid and New York Stock Exchange. Brazilian Federal government holds 52% of its ordinary shares .The company is responsible for 35% of Brazil's total generation capacity, 61,534 km of transmission lines and 257 substations up to 69 kV.

In 2009 Eletrobras set up a target in its strategic plan, to be in 2020, the largest global clean energy company in the world, with profitability comparable to the best companies in the electricity sector.

Since then, some uncertainties that prowled the Brazilian electricity sector (BES), especially, the renewal of concessions contracts for generation and transmission, were clarified. Auctions occurred and Eletrobras started 2013 determined to make feasible its mission to serve the energy markets in an integrated, cost effective and sustainable way.

This paper will present a simple macroplanning tool developed in-company to simulate expansion scenarios for Eletrobras market share and to provide the first financial signals of those expansion.

At first, to situate the reader, it will be presented a historical overview of the BES, emphasizing the main features related to the expansion of the generation and transmission of electricity in the country, as well as some definitions, stakeholders and responsibilities.

In the sequence, it will be presented the impacts that the renewal of concessions is causing in the industry and especially in the Eletrobras companies.

The third part of the paper will deal the idea to develop the simulation tool, assumptions, characteristics and most relevant observations.

Finally, it will be presented the results of simulations of scenarios for the company and their economic impacts like expected investments and revenues. The conclusion will also address the importance of this work for the company on the prospects of the domestic market

## 2) The Brazilian Electricity Sector

The Brazilian Constitution says in Article 21 of the chapter that deals with the general principles of economic activity: "*It is up from Federal Government exploit, directly or through authorization, concession or permit the services and facilities of electricity and energy utilization of watercourses, in conjunction with the States where the hydropower potential are located."*

Historically, the electricity services in Brazil were operated by the government but given the limited investment capacity of the state, the sector went through restructuring resulting in a new institutional, financial and regulatory model.

Implemented changes have impacted the industries in the sectors of generation, transmission, distribution and sale of electricity.

This chapter presents the dimensions of the industry, stakeholders and institutional evolution to the present day in order to familiarize the reader with this economic activity in Brazil.

### 2.1) The Dimension of the Sector

Brazil has an area of approximately 8.5 million square kilometers; it has a privileged nature with a large number of rivers in different regions, capable of generating energy on a large scale. The BES is characterized as a large hydrothermal system in which there is strong hydropower predominance.

It is observed in recent years, however, an increase of thermoelectric and alternative energy sources such as wind farms. The Brazilian generation and transmission system can be considered unique in the world by its characteristics and dimension.

Faced the location of the watershed and the size of the country, hydroelectric plants are installed far from major consumption centers and, consequently, the transmission systems are huge. Known as National Interconnected System (SIN, from its acronym in Portuguese), the SIN is a set of interconnected facilities covering most of the country. The system consists of four interconnected subsystems that have names of geographic regions, although they do not match exactly. Figure 2.1 shows a schematic diagram of the interconnection grid of the country.

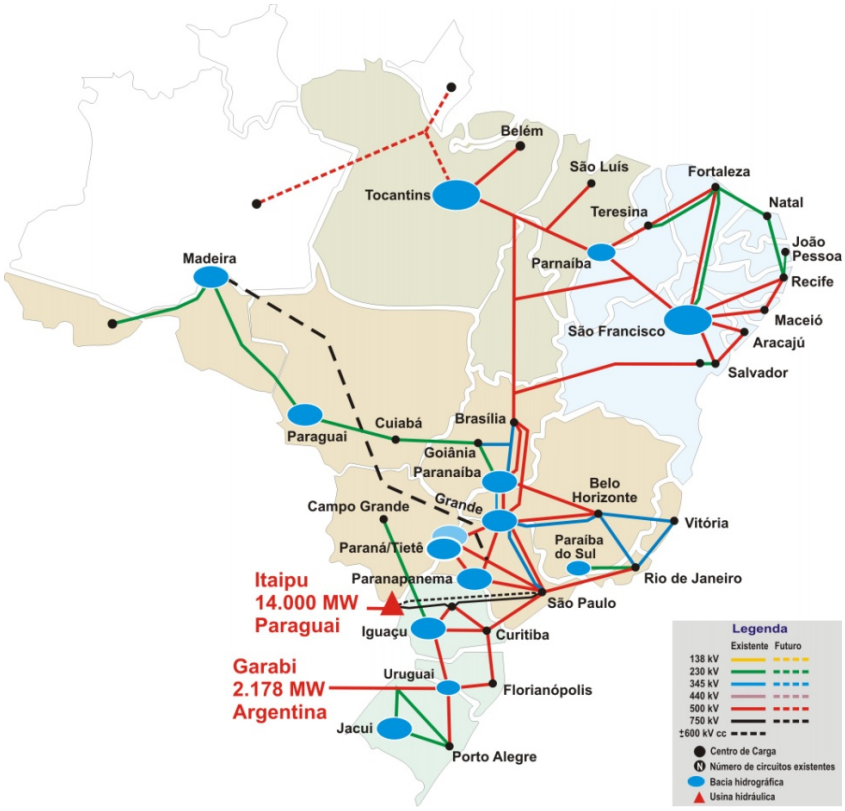


Figure 2.1. - Interconnection Electro Diagram in Brazil - Source: ONS 2012

The installed generation capacity in Brazil was 121.1 GW, according to ANEEL Generation Data Bank in 12/31/2012. It 69.68% of this is hydroelectric participation of various sizes. Thermoelectric plants include different types of fuel: natural gas, coal, diesel oil, fuel oil and biomass, mainly sugarcane bagasse. Considering all sort of sources of energy, there were a total of 2,809 operating plants.

The table 2.1 discriminates projects by type. It is noteworthy that Central Generating Hydropower (CGH) are small plants with installed capacity up to 1 MW and Small Hydroelectric power plants (PCH) consists in 1 to 30 MW plants and reservoir area equal to or less than 3 square kilometers.

| Installed Capacity 2012.12.31 | | | |
|---|---|---|---|
| **Type** | **Quantity** | **Power (kW)** | **%** |
| **CGH** | 407 | 239.855 | 0,20 |
| **EOL** | 84 | 1.886.382 | 1,51 |
| **PCH** | 452 | 4.301.753 | 3,52 |
| **SOL** | 11 | 7.578 | 0,01 |
| **UHE** | 205 | 79.752.660 | 65,96 |
| **UTE** | 1.648 | 32.909.108 | 27,15 |
| **UTN** | 2 | 2.007.000 | 1,66 |
| **Total** | **2.809** | **121.104.336** | **100,00** |

Table 2.1 - Brazil Installed Capacity - Source: ANEEL 2012

It is up to National Electric System Operator (ONS, from its acronym in Portuguese) the coordination and control of the operation of generation and transmission of SIN, under the supervision of the regulator, the National Electricity Regulatory Agency (ANEEL).

This integrated and coordinated operation brings two major benefits. The first one is the exchange of energy between different regions, since hydroelectric plants are located in areas that have different hydrological regimes. Thus when a region is in its rainy season, their reservoir are filled and it can transmit electricity to another region that is in the dry season, it means, empty reservoirs allowing optimum utilization of water, generating electricity and storing water where it is most convenient. The second benefit is the complementarity effect thus operating thermoelectric power plants. Since hydroelectric plants are more abundant and cheaper than fuel (oil, gas, etc.), it has priority to attend the market.

ONS is responsible for the coordination of activity and control of the operation of generation and transmission of electricity in the SIN.

All ONS activities are based on Grid Procedures, which are rules, criteria and technical procedures, organized in tools designed by stakeholders and approved by ANEEL. These activities are divided into three macro functions: planning and scheduling of the operation, real-time operation and administration of transmission services.

As the table 2.2, extracted from the Report Data ONS 2011, there were in Brazil in 12/31/2011, 103,361 km of transmission lines operating in SIN with voltage levels ranging from 230 to 750 kV alternating current and also two 600 kV links in direct current, which are part of the transmission system of the Itaipu power plant. Considering the projects that were scheduled to go into operation, it was estimated that in December 2012, the length of lines in service has exceeded 105.000 km.

| Level (kV) | km |
|---|---|
| 230 | 45.709 |
| 345 | 10.062 |
| 440 | 6.681 |
| 500/525 | 35.003 |
| 600 CC | 3.224 |
| 750 | 2.683 |
| **Total (2011)** | **103.362** |

Table 2.2 - Transmission Lines Operating in SIN - Source: ONS January 2012

This extension is a result of the large distance between the main power plants and load centers. It requires a transmission system integrated and robust to accommodate energy imports and exports between different regions of the country.

The energy distribution companies, which operate at voltages levels lower than 230 kV, are responsible for serving final consumers (home and small business). According to ANEEL, Brazil has currently 63 concessionaires of public distribution of electricity, as well as a number of licensees (rural electrification cooperatives that have gone through the process of framing as licensees of a public service of electricity distribution). Furthermore, the number of consumer units in the country was approximately 73 million in 2012.

### 2.2) The Institutional Evolution of the Sector

It can be considered the history of the BES divided into three main periods that are related below:

#### Ancient Model (until 1995)

By the year 1995, the BES was mainly composed of vertically integrated companies, acting in the generation, transmission, distribution and sale of electricity.

Predominantly state-owned companies such as Chesf, Furnas, Eletronorte, Eletrosul, Copel, Cemig, Cesp, among other smaller state enterprises, had the monopoly of economic activity and the competition was nonexistent.

The state was the funder and since the year 1962, when it was created the Centrais Elétricas Brasileiras S.A - Eletrobras, nominated the funding agency and the planner of the sector, besides acting as holding of federal companies. The government was in that time in a military regime, which contributed to the centralism of essential activities and the country's infrastructure.

All the planning was done by the Coordinator group of planning of electrical systems (GSPC), under the control of Eletrobras, with stakeholders organized in specific working groups for each theme as operation, maintenance, energy studies, among others.

The Energy Market was fully regulated and composed only of captive consumers with regulated tariffs in all segments and 100% contracted. The surplus or deficits of energy balance were prorated among buyers.

### Transition Model (1995-2004)

The transition period began in 1995 motivated by the lack of state resources for investment in infrastructure to accomplish the growing demand and consequently, the necessity to open the market as well as deregulation. Liberalization ideas all over the world influenced a series of changes in the industry.

The Concessions Act, Law 8987 of February 13, 1995, may be regarded as the first milestone of this new age. The Law regulates for the electricity sector the Article 175 of the Federal Constitution, which established standards for granting and renewal of existing concessions of public services and the unbundling of electricity services. The main points of the law were:

(i) Requirement that concessions for the provision of services related to electricity were granted through bidding processes;
(ii) Gradual permission to certain electricity consumers that presented significant demand, designated *Free Consumers* that could choose their electricity supplier;
(iii) Creation of the so-called Independent Power Producers (PIE) which by concession, permission or authorization, could generate and sell at their own risk, all or part of their electricity to *Free Consumers*, distributors, traders, among others;
(iv) Grant to free consumers and electricity suppliers an open access to transmission and distribution systems.

On May 25, 1995, through Decree 1503, subsidiaries of the Eletrobras Group entered in a National privatization program (PND). It was the confirmation of the intentions of the Fernando Henrique Cardoso Government to privatize the sector and reduce federal expenses. Already on July 12, occurred the first auction of a public electric energy company, when the Centrais Elétricas do Espirito Santo S.A - ESCELSA was privatized.

This year were also remembered because of the authorization for foreign investments, regulated by Constitutional Amendment 6th to August 15. Previously, all concessions in the electricity sector were held by Brazilian individuals or legal entities controlled by Brazilian individual persons or by the Federal Government. Thus, after many years of state control, the industry went through a movement of liberalization.

The regulatory agency (ANEEL) was created on December 26, through Law 9427. It was up to ANEEL the mission to provide favorable conditions for the electricity market to develop a balance between the agents (players) and the benefit for society. It was established with the primary purpose to regulate and supervise the production, transmission, distribution and sale of electricity in accordance with the rules and the guidelines of the Federal Government. This law also determined that the operation of hydraulic potentials had to be conceived through competition or auction and the concessions granted for consideration.

On August 6, 1997, the Law 9478 established the Energy Policy National Council (CNPE) in order to achieve the indicative planning, propose policies and guidelines for the energy sector. Before this, the electricity sector was fully regulated by the Ministry of Mines and Energy (MME), which operated through the Water and Energy National Department (DNAEE).

In 1998, as a suggesting of the Brazilian Electric Sector Restructuring Project - RESEB the Federal Government enacted the Law 9648, named the Electricity Sector Law. In the Generation segment was introduced the competition and provided the energy trading. The transmission and distribution have still been fully regulated because they are activities with non-compete characteristic and it can be considered a natural monopoly, however for distribution companies, it was allowed to work as traders. The Energy trading, buying and selling activity, became free and the price set by the market, developed by businesses buying and selling, generators, traders and distributors.

This restructuring introduced a model of competition in which guarantee free access to the system, either by new generators or by free consumers, as well as the participation of private investors in auctions for the construction and operation of new power plants, transmission lines and substations and the State as a regulator of the economic activity.

The Law also laid out on the need for establishment of bidding procedures for granting concessions for the construction and operation of power plants and transmission facilities of electricity, the separation of generation, transmission, distribution and marketing (unbundling) and named the BNDES bank as financial agent of the sector, especially to support new generation projects.

Other key events were the creation of the ONS and the Wholesale Energy Market (MAE). The ONS created by Law 9648 and regulated by Decree 2655 was designed as a private company, non-profit and responsible for the operational

management of the generation and transmission of the SIN, while MAE is responsible for accounting, pricing and other contractual matters for electricity that flows through the system managed by ONS.

In 2000, the Decree 3371, of February 24, it was created the Thermoelectric Priority Program (PPT), to diversify the Brazilian energy matrix and to reduce the strong dependence on hydroelectric plants, and to avoid the energy crisis that was coming. It was not enough. The demand increased and the supply did not. Besides that, the country faced an unusual hydrological period with its reservoirs reaching very low levels.

In this scenario of less supply than demand and low inflows, the electricity sector was subjected to a supply crisis that evolved into an energy rationing. This event caused great damages in people's life and in the whole economy. It has raised questions in the implementation of the institutional model and Revitalization Council was established to point those questions and to propose solutions. It was observed that the first institutional changes have not come to be fully implemented, as several companies continued over the state control. There were difficulties and disputes as to the first accountings and settlements of MAE and especially the expected expansion investments did not happen as expected.

The crisis lasted until mid-2002 and during the energy rationing, the goal to reduce the consumption of the residential and industrial reached 20%.

On April 29, 2002, the Federal Government, through Law 10438, later amended by Law 10762 of November 11, 2003, enacted new actions, such as:

- Development of the Subsided Program for Alternative Energy Sources (PROINFA), to create incentives for the development of alternative energy sources such as wind power projects, small hydro - PCH and biomass;
- Establishment of rules for universalization of electricity.

### Effective Model (2004 to present)

Under Lula government, changes and improvement were introduced in 2004 by the Law 5081, of May 14, 5163 to July 30, 5175 Aug. 9 and 5177 of August 12, which laid the foundations of existing sectorial model.

At this stage, observing the difficult faced by private companies as a provider of the development of the electricity sector, a mixed model with state participation was

intended. The role of the grantor of the MME was restored and the responsibility for planning the expansion of the electricity sector was taken over by the state. The functions of regulation, mediation and supervision of ANEEL were reformulated, the ONS governance emphasized on its independence and it was created the Energy Research Company (EPE) to provide studies and researches designed to support the planning of the energy sector.

It was created the Electricity Monitoring Committee (CMSE) to continuously monitor the supply conditions and the performance of the system and also was created the Energy Trading Chamber (CCEE) replacing the MAE with additional assignments.

This new model introduced two environments for energy trading: Trading Regulated Environment (ACR) and the Free Trade Environment (ACL). The ACR has its operation in a purchasing pool in which the buyers are distributors and selling agents are traders, generators, independent producers and compounders which participate in auctions. In the ACL the trade is free between agents.

Another important change in 2004 was the criteria used to grant new generation projects. Until then, the winner of the auction was who proposed the most value for the grant (the use of public property). After the new rules, the investor who offered the lowest price for sales of future production plants it was going to be the winner.

Eletrobras and its subsidiaries were excluded from the National Privatization Program (PND) and Eletrosul, a subsidiary of Eletrobras, which was unbundled for privatization, resulting in only a transmission company was allowed to resume its investments in power generation.

Since 2004, Brazil has been conducting a series of auctions of generation and transmission and Eletrobras has been fundamental in the success of the development of the power sector, participating in almost all infrastructure projects, either corporately or in public-private partnerships.

The current model has been presenting constant evolution since 2004 without changing its pillars, which are:

- ✓ Ensuring the security of electricity supply;
- ✓ Promoting social inclusion (Universal service);
- ✓ Promote the affordability tariff.

It should be noted, however, that between 2010 and 2012, the country experienced a period of uncertainty related to the end of the generation and transmission

concessions because the new rules were not defined. The issue will be addressed in the next chapter because of its great importance in the context of this paper.

### 2.3) Players and their functions

The diagram shown in Figure 2.2 provides an understanding of the players in the current model of the BES and their inter-relationships.

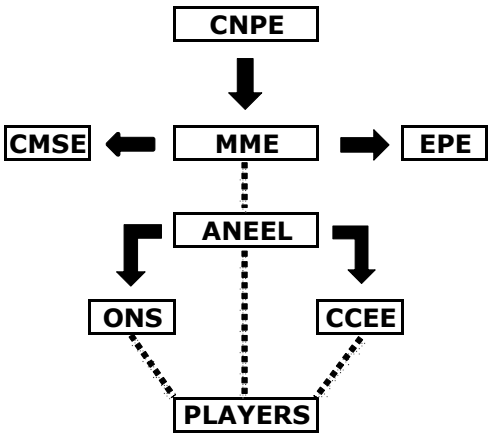


Figure 2.2 - Agents and Industry Relations

**CNPE – National Council for Energy Policy:** It is a council linked with the Presidency responsible for the country's energy policy ratification. It is up to CNPE, among others, suggest measures to ensure the fulfillment of electricity demand considering the planning of long, medium and short term. The Council can set priority and indicate for auctions, projects that have structural and strategic characteristics of public interest.

**MME – Ministry of Mines and Energy:** It is responsible for creating and implementing policies in the energy sector in accordance with the guidelines set by CNPE. It represents the granting power of the Union.

**CMSE – Monitoring Committee of the Electricity Sector:** It operates under the direct coordination of the MME and it serves to monitor and continuously assess the continuity and security of electric energy supply throughout the country. It is up to the committee follows the development of generation, transmission, distribution and sale of electricity, as well as activities related to natural gas, oil and its derivatives.

**EPE – Energy Research Company:** It is a federal public company, linked to the MME and it is focused on providing services for study and research to support the

planning of the energy sector. It was founded in 2004 to centralize all studies relating to the planning of the expansion of the Brazilian energy sector. The EPE is the main source of information for this paper and further it will have some details explored.

**ANEEL – Brazilian Electricity Regulatory Agency:** It is the regulator and oversight of the sector that has been following the policies and guidelines of the Federal Government. The agency is responsible for auctioning the granting of generation and transmission, on behalf of the MME. Its inception in 2004 is a milestone in the current model.

**ONS – Electricity System Operator:** It is a private, nonprofit and supervised company regulated by ANEEL. It is responsible for coordinating and controlling the operation of generation and transmission of the National Interconnected System - SIN, as well as by managing the purchase of the transmission facilities of electricity. ONS works in conjunction with EPE, providing subsidies and elements necessary for the development of the planning activities of the sector.

**CCEE – Electricity Chamber:** It is a private, nonprofit company, under the regulation and supervision of ANEEL. It was also created in 2004 in succession to the MAE, and it has incorporating activities and becoming the institution responsible for enabling the commercialization of electricity in SIN.

**Other Players:** The set of companies and institutions that hold or are somehow involved with the electricity assets. They are: Generating, Transmission Companies, Distributors, Traders, Importers, Exporters and Consumers. Among then, there is Eletrobras, which is the most relevant player to this work and one of the most important of the country.

**Eletrobras – Centrais Eletricas Brasileiras**: It was founded in 1962 to promote studies, projects, construction and operation of power plants, transmission lines and substations designed to provide electricity in the whole country. As presented in the previous section, institutional changes have made the company lose many of its functions to organs such as EPE and ONS.

According to the 2012 management report, the company is the largest in the segment of electricity in Latin America, with a total power of 42,333 MW (35% of country's total), and 89.2% of this are sources with low emission of greenhouse gases

(84.3% from hydropower, 0.2% wind / solar and 4.7% from nuclear plants). The company has 55,118 kilometers of transmission lines (52% of the national total), in high and extra-high voltage level from 230 kV to 750 kV. In the distribution segment, the company caters directly by its subsidiaries more than 3.6 million customers through a network of 199,935 km.

Eletrobras has played an important social role administering government programs such as the Energy Saving Program (PROCEL), the National Program for Universal Access and Use of Electricity (Luz Para Todos) and the Incentive Program for Alternative Sources of Energy (PROINFA). The Company structure is spread throughout Brazil where seven generation and transmission companies are controlled, including 50% of Itaipu, six distribution companies, a research center and a holding company. The company is currently involved in 73 partnerships for developing new ventures through Special Purpose Entities (SPEs). Figure 2.3 below presents the configuration in December 2012.

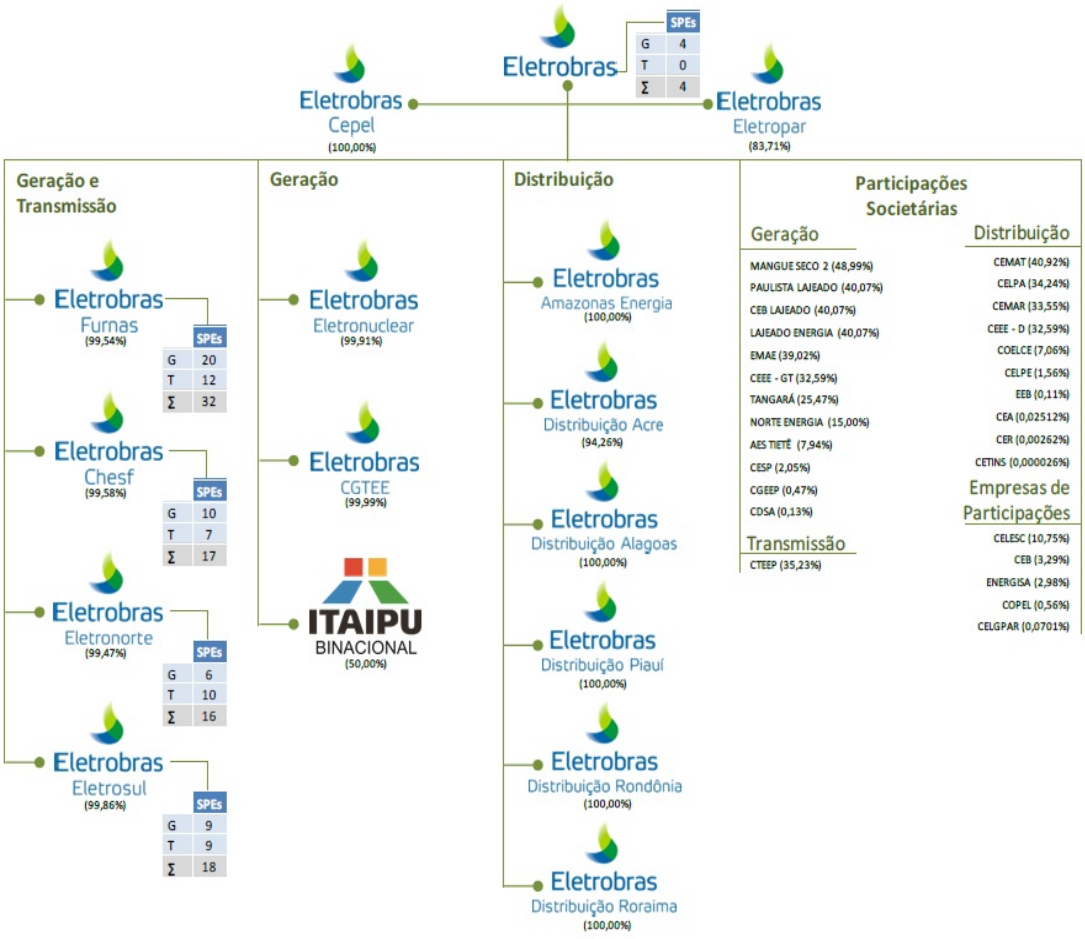


Figure 2.3. - Eletrobras Diagram - Source: RA 2012 Eletrobras

## 3) The Case of Concessions

Despite the consistency of the regulatory and institutional evolution of the BES, some gaps, like the uncertainty about the renewal of the concession contracts of generating, transmission and distribution companies, remained in this process.

The concessions imbroglio began at the transition between the electricity institutional models. At that time, many plants, transmission lines and substations that were operating without contracts, became regularized after the assignment of the first concession.

It was guaranteed 20 years contracts without the possibility of extension. Until then, many concessions were made by decree and without clear definitions of rights and duties of dealers and the major companies were operating verticalized in all industry segments.

At this point, it is important to remember that at the transition phase, it was sought to liberalize the electricity sector and the focus was mainly to unbundle and privatize companies, so it was expected that the consumers might perceive indirectly benefits through investors paying higher prices for plants to be exploited.

The privatization process has been interrupted in 1995, when the government tried to bid Furnas, one of the largest companies of the country, controlled by Eletrobras. This fact has created a “regulatory limbo" and the benefit that would be generated for the company with the competition in the energy market was partially lost. In addition, in the following period, the government was concerned about the viability of energy and transmission lines auctions and the case of concessions was left aside. New contracts were signed considering the possibility of 20-year of extension.

After years nothing has been done to solve the problem of several contracts approaching the year 2015. A series of questions appeared. *What would be done? Would be renewed the concessions of the assets? But in this case investment could be depreciated, so what is the cost that would occur this renewal? Or is it better to return the assets to the Union and to make a new bid? But who would be interested in operating and maintaining these old projects? And what is the cost to maintain? And in any other situation covered, what about the companies and their employees who were involved in this vast business network?* As an illustration, Chesf (6.000 employees) had around 90% of its assets in this uncertainty situation.

To illustrate, it would expire between 2015 and 2017, 22,431 MW of installed power, 85,000 km of transmission lines and 233,000 MVA, something equivalent to 20% of generation and 82% of their transmission of the country.

Parallel to this problem, many generating companies, especially state-owned Eletrobras Group, had energy contracts maturing from 2012 and without a definition from the government for the commercialization of this energy in the last years of their contracts. The 15,000 MW of this plants would be unsold between 2012 and 2013 at the average tariff of 95 R$ / MWh causing great expectations in all agents.

After too much pressure and few debates, noting the increased pressure from agents, the government decided to seize the opportunity to solve the imbroglio of concessions with some measures, announcing a 20% off in electricity tariff. On September 11, 2012, it was adopted the Provisional Measure - MP 579 which provided for the granting of generation, transmission and distribution of energy, and reduction in industry charges and energy tariff.

The MP-579 brought two possibilities for dealers:

**Option 1)** The end of the concession contract at the date of maturity (period 2015-2017). The dealer would receive compensation for assets not depreciated and the plants would be auctioned again with a regulated tariff.

**Option 2)** The early renewal of concessions in 2013. In this case, regardless of the maturity date of the contract, the dealer would receive compensation for assets not depreciated (calculated by the same methodology of option 1) and it would sign a new contract receiving a regulated tariff to provider Operation and Maintenance Services.

As the objective of this paper is not the issue related about reduction of tariffs, it will not be addressed the MP 579 items related to this subject. The reader may consult various sources on the internet, especially on the ANEEL website. In addition, there will not be treated on issues relating to the distribution segment of energy, since this were not addressed in MP and also it is not part of the scope of the simulation of the expansion of Eletrobras.

The MP 579 is regulated by Presidential Decree 7805 of September 14, 2012 and defined that companies interested in accepting the early renewal of concessions should manifest until November 1st of the same year, but main issues for analysis of the feasibility of this proposal and the new tariffs and the amount of compensation for

investments not yet amortized, were only released on the eve of the deadline for accepting the offer (Ordinances MME 578 and 579 of 31 October 2012 and Interministery Ordinance 580 of November 1, 2012).

As might be expected, the uncertainty between the disclosure of MP 579 and Ordinances enlightening, affected severely the bonds of energy companies in the stock market which reached record losses of 25% in the first days after the MP and this fear by losses came to be confirmed with the release of the amount of claims in new tariffs.

In an interview for Reuters agency on October 16, 2012, Eletrobras Board, Jose da Costa Carvalho, said that estimated studies preview that the company would reduce its revenue by up to 8 billion Reais per year on the renewal process early and conditional plants from the electricity sector. Additionally, the executive already presented plans to reduce spending and managerial improvements in the company in exchange losses, which signaled the company's position as the acceptance of the proposal of the Government (its controller).

By the way, it is important to note that state owned enterprises, as Cemig, Copel and CESP did not accept the proposal by the Government anticipation. These firms belong to states where the local government is opposed to the federal government, which has led some analysts to speculate about political interference in economic decisions.

Eletrobras accepted the option for early renewal of concessions and due to the proposed methodology for calculating compensation recorded impairment loss of R$ 10 billion, recognized in the balance of 2012 published in March 2013. The partial financial statements of the company in 2013 show that the forecast revenue loss has been confirmed as expected, especially in Chesf and Furnas.

On January 11, 2013, it was enacted the Law 12783 effecting the MP 579 and other legal instruments addressing the renewal of concessions and the intended reduction in electricity tariffs.

## 4) Planning and Expansion of the Brazilian Electric Sector

The major electricity companies have accepted the anticipation of the renewal of concessions and even those, which do not, are getting their revenues going down drastically. The uncertainty about the future and low cash flows realizes that the expansion of the sector may be threatened.

At this point, it is necessary to brief some issues about the planning of expansion for generation and transmission in Brazil. Distribution sector is a compulsory activity with inherent demands of each regional company. Moreover, in the author's point of view this is not the Eletrobras focus of expansion.

The BES, historically, was designed to meet the increased energy consumption, even in the event of long periods with low inflows. However, in recent years a questionable "environmental conscience" has been restricting floods, and consequently the construction of large dams and thus reducing the ability to regularize the supply of energy. The immediate impact should be encouraging the development of alternative sources, but in fact, what has happening is the growth of thermal plants (expensive and polluting). Moreover, the main water potentials are concentrated in the northern region of the country, far from load centers and therefore requiring intensive investments in transmission lines and substations.

The studies of transmission expansion and technical, economic feasibility and socio-environmental for generation, support the achievement for auctions. The market research provides the inputs for its studies, establishing the projected energy demand, in monthly terms by subsystems.

The supply expansion planning includes a reference scenario for the generation expansion and major interconnections between subsystems in a ten-year horizon, thus meeting market forecasts. The transmission expansion is robustly designed for all players to access the grid system and then enabling competition in the generation and commercialization of electricity.

EPE is the company responsible for centralizing those studies and its main public report is the Ten Year Expansion Plan (PDE), which presents a guide to actions and decisions related to solving the balance between economic growth projections and the expansion of supply with adequate cost bases in technical and environmentally sustainable.

The result of the generation studies involving hydrological data, market research, forecasting future plants, auctioned plants, existing plants and in parallel, the possible transmission configurations that optimize the system is the major source of information for this paper.

The latest version of the report is the 2012-2021, which is used as the first planning information for companies.

The table 4.1 shows the expected electricity consumption in the country, registering an increase of 54.7% over the period.

| Year | Eletric Energy Consumption (TWh)* |
|---|---|
| 2012 | 500,1 |
| 2016 | 619,0 |
| 2021 | 773,8 |

(*) including autoproduction

Table 4.1 - Forecast of electricity consumption in Brazil - Source PDE-2021

The graph (figure 4.1) shows the forecast growth of installed capacity in the country. It is noticed a 57% growth supporting the increase in demand for electricity.

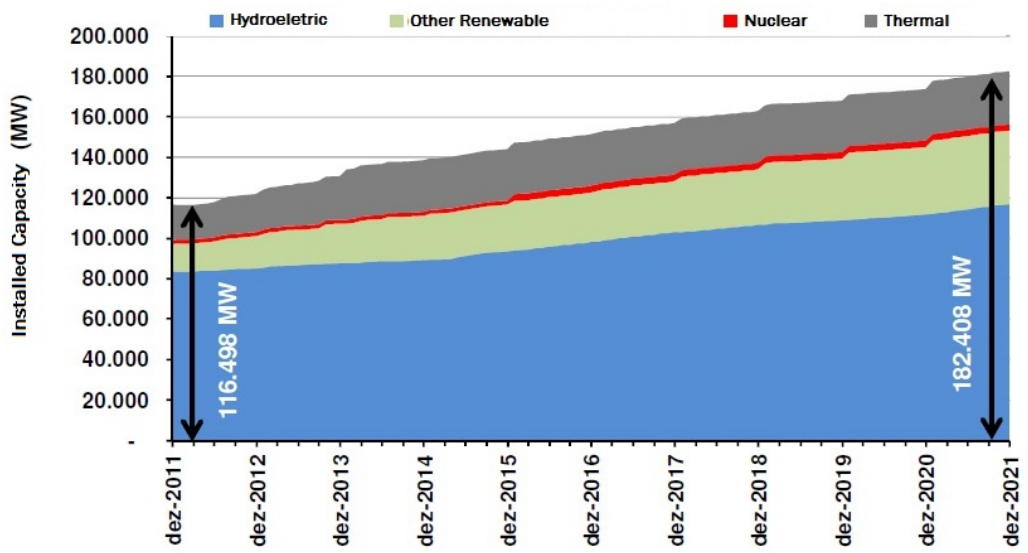


Figure 4.1 - Forecast increase in installed capacity in Brazil - Source: PDE 2012

Tables 4.2 and 4.3 present the estimated expansion of transmission lines (km) and transformation (MVA) respectively from 2012 to 2021.

| Transmission Lines | ±800 kV | 750 kV | ±600 kV | 500 kV | 440 kV | 345 kV | 230 kV | TOTAL (km) |
|---|---|---|---|---|---|---|---|---|
| **Operating at 2011** | - | 2.683 | 1.612 | 34.851 | 6.679 | 10.063 | 45.349 | **101.237** |
| **Evolution 2012-2021** | 7.325 | - | 4.750 | 26.889 | 113 | 337 | 8.318 | **47.732** |
| **Evolution 2012-2016** | - | - | 4.750 | 21.547 | 47 | 337 | 7.874 | **34.555** |
| **Evolution 2017-2021** | 7.325 | - | - | 5.342 | 66 | - | 444 | **13.177** |
| **Estimated 2021** | 7.325 | 2.683 | 6.362 | 61.740 | 6.792 | 10.400 | 53.667 | **148.969** |

Table 4.2 - Increase of Transmission Lines (km) - Source PDE 2012-2021

| Substations | 750 kV | 500 kV | 440 kV | 345 kV | 230 kV | TOTAL (MVA) |
|---|---|---|---|---|---|---|
| **Operating at 2011** | | | | | | **232.877** |
| **Evolution 2012-2021** | 1.500 | 49.331 | 2.433 | 5.676 | 19.396 | **78.336** |
| **Evolution 2012-2016** | 1.500 | 38.168 | 2.433 | 5.577 | 16.803 | **64.481** |
| **Evolution 2017-2021** | - | 11.163 | - | 99 | 2.593 | **13.855** |
| **Estimated 2021** | | | | | | **311.213** |

Table 4.3 - Increase of Substations (MVA) - Source PDE 2012-2021

The value of investments is consolidated by PDE per segment, and a brief analysis in chapters that address the expansion of generation and transmission arrive at the estimated R$ 147.3 billion.

Two other important reports are the Extension and Reinforcement Program (PAR) and the Transmission Expansion Program (PET) that uses a shorter time horizon and a greater amount of detail compared to the PDE.

It should be noted that, currently, in practice what has occurred are authorizations for all projects related to PAR and auctions for projects in PET, which is fully understandable due to the volume of investment involved and within each group of projects. In general, the PAR contain small works such as retraining of transmission lines, increased capacitor banks, reactors, transformers, etc., while the PET brings more expressive works such as the implementation of new transmission lines and substations in some cases even amounts of billions of Reais. The last major transmission lines in the country were the Tucuruí-Macapa-Manaus (1,826 km) and the Madeira River Transmission System (5,404 km).

In the generation segment, the expansion can be divided into three basic blocks:

- **Structuring Projects:** In this group is fitting into the large hydroelectric dams planned for the country, with its complex studies are usually carried out by a mix of private and state enterprises under the supervision of EPE for later auction. The last examples were procured in the country in Belo Monte Plants (11,233 MW), Teles Pires (1,820 MW), Santo Antonio (3.150 MW) and Jirau (3,450 MW) and due to the large investment participation of Eletrobras, representing the State, it was considered necessary and mandatory in order to the viability of the business. The performance of Eletrobras occurred through its subsidiaries participating in consortia.
- **Not Structuring Projects:** Those smaller enterprises also studied with the coordination of EPE, but due to the less need for huge investments and risks

associated with smaller projects, the state's participation has not been mandatory at the bidding process.

- **Other Business Enterprises:** These are other generation projects that do not have a building linked to an auction. It means, small power stations, wind farms, solar and thermal. According to its private nature, the studies are confidential and it limits the disclosure to only macro-consolidated information on PDE. In some situations, entrepreneurs invite state companies to be minority partners in the business.

In both segments, generation and transmission, win the auctions, the bidder that offers the lowest tariff for the service itself and not the amount to construct the project. Transmission lines and substations are grouped in the auction to be paid by Annual Revenue (RAP) and in generation the criterion is the value of energy sales to the captive market (distribution) expressed in R$ / MWh. In some cases the grantor stipulates the percentage of the energy that can be directed to the free market, and this is one of the main variables in the feasibility study phase of the project.

## 5) Simulation Model

In the past, the expansion of the energy sector was studied, planned and executed by Eletrobras and there was not much concern about the future in the company until the market liberalization; Even in the beginning of the free market era, it seems that the state-owned companies had the "reality shock" only when the conditions for the renewal of concessions were defined.

In this scenario, the necessity for more projections models became critical, in Eletrobras, for instance, the process of long-term planning was non-existent and even for the short and medium term it was based only on issues like the budget.

One of the difficulties was that the number of subsidiaries of Eletrobras (15 in 2012); Companies are almost completely independent in the decision-making process and uses a lot of different tools and models resulting to the holding the responsibility to identify overlaps and do the consolidation of numbers.

This complex task began to be simplified adopting a single tool to capture the projected financial statements and cash flows considering only contracted investments and using a simulator to preview the impact of new business, thus avoiding political problems such as select an specific company to participate in a structural project.

The ultimate goal was a simple tool that provides in a macro-level, finance projections according to various types of simulations, mainly the development of new business in generation and transmission. Following it will be presented the steps of the development of the investments module of the simulator.

## 5.1) Development - Stage 1

The first step was the research in reports published by EPE: PDE-2012-2021 and PET 2013-2017. These EPE's reports have a year (at least) delay between the preparation and publication, so it was necessary to update with information provided by ANEEL.

It were listed all projects that have not yet been auctioned, totaling 18 new hydropower (19,454 MW) and 78 new transmission lines (18,202 km). Due to the difficulties in separate the substation projects added that sometimes those projects are auctioned together with their respective transmission lines, it was listed only the major substations related to the transmission of Belo Monte Plant.

The generation expansion discriminates only biggest UHE's projects, thus the alternative energy sources projects are identified by the total values in the period (13,250 MW). It was not accounted the thermal expansion in the country because this should not be a goal of Eletrobras as its strategic plan.

According to the expansion of the transmission, it was verified the summary tables of PDE 2012-2021 was higher than the detailed projects list in the report by an amount of 5,000 km and 10,000 MVA and this is mainly due to the fact that some projects are still being studied such as the transmission associated with Tapajos Plants.

The PDE studies uses current values but does not mention the date base. It was considered that the values were from December 2011. As for PET, investments are also presented in constant values, but already detailed by project and using ANEEL price data banks from 2004 to 2012.

Excluding some identified auctions and considering that PDE investment was updated until December 2012 using the IPCA (inflation index), resulted in the following values presented at table 5.1.

| New Investiments PDE 2012-2021 adjusted | | |
|---|---|---|
| UHE's (19.454 MW) | R$ | 70.430.390.246 |
| Renewable Power Plants (13.250 MW) | R$ | 51.690.526.873 |
| Transmission Lines (18.202 km) | R$ | 15.147.019.145 |
| Substations (8.572 MVA) | R$ | 10.062.705.026 |
| **Total** | **R$** | **147.330.641.290** |

Table 5.1 - New Investments 2021 - Source: PDE 2012-2021 adjusted

## 5.2) Development - Stage 2

The research identified 100 projects to be auctioned. It would be hard to draw up an equivalent number of models or Excel spreadsheets since it was desired a simple and fast tool, so the development was divided in four blocks in just one sheet: Conventional Generation, Alternative Generation, Transmission Lines and Substations, each block consisting of information about:

- Physical Characteristics - The greatest detail of the project, eg: name, type, power, transmission line distance, processing capacity, load factor;
- Economic Characteristics - Planned investment, average unit cost, medium unit tariff, annual revenue – RAP, medium unitary RAP, investment curve, commercial operation curve, % equity, % debt, disbursement debt curve, % tax to be deducted from gross revenue, % EBITDA margin of a reference company with the same asset, % of transmission charges in relation to gross revenue, % royalty on gross revenue, expenditure breakdown PMSO in %, P and MSO; % depreciation and income tax.

The economic information block were added to an accounts memory for cases in which the project was simulated considering loans, so the costs of such loans could be considered for setting the rate of return for each corporate structure.

Looking up to represent the future asset life and through a mini income statement and cash flow, their respective impacts on the company, corporately or in partnership. The option to play an auction and how to participate are variables that the operator selects on the simulator.

Figure 5.1 shows the structure of the investment module.

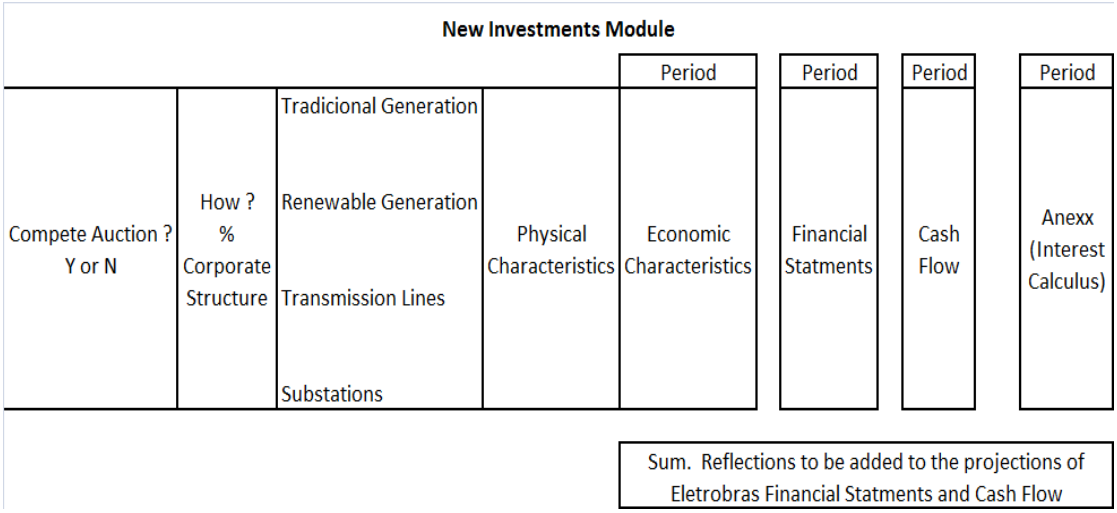


Figure 5.1 – Investment Simulator Structure

## 5.3) Development - Stage 3

From the implemented structure and data entry completed, the sequence of accounts is done as following:

**Investment** = % disbursement curve of project x Projected Investment;

**Debt** = % uptake curve of project financing x Total Debt Expected;

**Gross Revenue G** (Additional revenue per year) = Load Factor (%) x Input Operating Curve (MW) x 8.760 hours / year x expected average tariff (R$ / MWh); In this formula, the recipe can still be corrected in the first year of operation by the month of commissioning of the first machine when appropriate;

**Gross Revenue T** (Additional Revenue per year) = Physical Size of investment (km or MVA) x unit average tariff (R$ / km or R$ / MVA) or RAP set at the input as a premise when the notice of the auction was already published;

**Net Operating Revenue - ROL** = Gross Revenue x (%) tax to be deducted;

**EBITDA =** ROL x (%) Ebitda margin; It is important to observe that it is an account made backwards analyzing financial statement and this approach was used because it would be too complex to detail the cost of so many different projects;

**Costs:**

**Transmission Charges** (only for generation) = Gross Revenue x (%) transmission charges;

**Royalties** (only for generation) = Gross Revenue x (%) royalties;

**PMSO** = (1 -% Ebitda Margin) - T Charges - Royalties;

**P** = PMSO x (%) of wages of the total cost;

**MSO** = PMSO - P;

**Depreciation** = Total Investment x (%) Depreciation;

**Operating Profit** = EBITDA - depreciation;

**Net Income before taxes** = Profits - Interest, in this block, it is considered that the amount of interest is zero to corporate ventures because the objective is to calculate the Project IRR and not return to the company;

**Net income** = Net Income before taxes - IR;

**Cash Flow for Project IRR** = Net Income + Depreciation - Investment;

**Extra calculation (competing in the enterprise in Partnership):**

**Interest during the Grace Period** = Outstanding Balance Rate x (%) Interest rate;

**Interest shifted by Grace** = Outstanding Balance with Grace x (%) Interest rate; Paid in January after the loan;

**Principal** = Loan amount / term (months);

**Principal with Grace**; Represents the beginning of the loan payment with grace;

**Outstanding Balance** = Debt - Principal;

**Outstanding balance shifted by Grace** = Debt - Principal with Grace;

**Net Income before taxes** = Operation profit - Interest;

**IR** (Tax) = Net Income before taxes x (%) IR;

**Net Income** = Net income before taxes - IR; this is the value to reflect the equity of the business in partnership and it is taken to the financial statement in other module of the simulator;

**Adjusted Net Income** = Net Income - Principal (principal or moved by grace); this is the amount for the company after the loan payment;

**Dividends** = Adjusted Net Income x (%) Payout; this is the value that reflects the payment of dividends when the project is done in partnership and the result is taken to the Cash Flow module of the Simulator;

**Cash Flow (SPE IRR)**= Net Income + Depreciation - Investment; The company rate of return that developed the project in partnership; It should be noted that the SPE cost of capital WACC was already considered in the Ebitda margin;

## 6) Scenarios for Eletrobras

After the simulation tool developed and currently under specific adjustments, several of possibilities can be simulated through the generation of scenarios, three that were tested for this paper.

It is emphasize that to reach the results, it was considered the total number of projects to be presenting at the macro level of possibilities for Eletrobras and not the particular auction.

In scenario 1, the baseline, there is not exactly a simulation but an overview of the company for the next decade according to the contracted investments in recent years still under construction, including the hydroelectric plants Belo Monte, Teles Pires, Santo Antonio and the Madeira Power Plants transmission system.

In scenarios 2 and 3, the results of simulations are presented for the following assumptions: i) the company tries to expand in the current conditions and ii) the company tries to maintain its market share at the end of the ten-year planning period.

In all scenarios, some assumptions were considered by the lack of accurate information and to comparability of the results.

### 6.1) Scenario 1 – Break Investments from 2013

According to the decrease in revenue caused by the renewal of concessions added an annually 13 billion Reais budget for investments, the capacity of Eletrobras entering into new ventures may be impaired, indicating a stagnation scenario in the short term and then it was wondered what should be the impact if the company break new investments from 2013.

To answer this question it was required extensive research in ANEEL data bank of auctions and internal reports of Eletrobras to cross information that result in a reasonable estimative for the evolution of the company's market share. Some assumptions were:

- The main reference reports that reflect the company's position and progress of projects in December 2012;
- A proportional physical aggregation considered in situations that the subsidiary of Eletrobras participate in SPEs
- The evolution of installed capacity (MW) of the country based on data from the PDE-2012-2021;

- The evolution of the transmission system (km) of the country according to information from the PDE-2012-2021 and PET-2013-2017.

The table 6.1 presents the evolution of the installed capacity s and the respective Eletrobras market share in the generation segment.

| | Installed Capacity (MW) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Generation** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Corporate | 41.150 | 41.797 | 42.814 | 42.814 | 42.814 | 42.814 | 44.219 | 44.219 | 44.219 | 44.219 |
| Partnership | 1.183 | 2.946 | 3.766 | 5.081 | 6.759 | 8.591 | 10.424 | 10.729 | 10.729 | 10.729 |
| **Total** | **42.333** | **44.742** | **46.580** | **47.895** | **49.573** | **51.405** | **54.643** | **54.948** | **54.948** | **54.948** |
| **Total Brazil** | **121.100** | **130.625** | **138.469** | **143.904** | **151.372** | **156.970** | **162.907** | **167.928** | **173.645** | **182.408** |
| **Market Share** | **35,0%** | **34,3%** | **33,6%** | **33,3%** | **32,7%** | **32,7%** | **33,5%** | **32,7%** | **31,6%** | **30,1%** |

Table 6.1 - Market Share Evolution - Contracted Generation Projects

It can be observed a 5% decrease in market share which is positively surprising due to the company run a decade without new investment. The government included Eletrobras in the development of all infrastructure projects in the country (Belo Monte, Teles Pires and others) and it justifies this low decrease.

According to table 6.1, there is a 7.5% increase in corporate projects while partnerships grow impressive 807% in the period. This expansion in partnerships has been proved effective in risks reducing to construct projects and attracting more investors, which optimizes the cost of expansion and helps to ensure low tariffs, which is one of the pillars of the sector.

The table 6.2 presents the evolution of transmission lines from SIN (those with voltage above 230 kV), developed corporately or in partnerships, and the respectively Eletrobras market share.

| | Transmission Lines - Voltage Level >230 kV (km) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Transmission** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Corporate | 52.516 | 53.150 | 54.365 | 55.076 | 55.076 | 55.076 | 55.076 | 55.076 | 55.076 | 55.076 |
| Partnership | 2.602 | 4.821 | 7.485 | 8.072 | 8.217 | 8.217 | 8.217 | 8.217 | 8.217 | 8.217 |
| **Total** | **55.118** | **57.971** | **61.849** | **63.148** | **63.293** | **63.293** | **63.293** | **63.293** | **63.293** | **63.293** |
| **Total Brazil** | **105.929** | **109.634** | **119.859** | **127.324** | **135.333** | **138.121** | **141.297** | **144.438** | **145.063** | **148.969** |
| **Market Share** | **52,0%** | **52,9%** | **51,6%** | **49,6%** | **46,8%** | **45,8%** | **44,8%** | **43,8%** | **43,6%** | **42,5%** |

Table 6.2 - Eletrobras Market Share - Contracted Transmission Projects

As demonstrated, the transmission market losses reaches at 10% in the period and it would be worst if it was considered data from 2009 and 2010 when this reduction totalized 15%. It supports the success of the liberalization of the electricity market and the introduction of competition.

As in the generation sector, there is a small corporate growth in transmission (5%) while expanding contracted partnerships is 216%, which also justify the desire for risk reduction and to use the private companies expertize to develop business.

The financial statements of this scenario, such as expected revenue and contracted debts will be omitted in this study because it was considered confidential. The reader can obtain a general sense of values referring to the news and results of recent auctions on the website of EPE, ANEEL and Bovespa.

### 6.2) Scenario 2 - The expansion continues as currently

After visualizing the contracted expansion, the first scenario developed were that Eletrobras, as a state company, even in financial crisis, will continue to be responsible for leading the expansion of the electricity sector in the country, since this is one of the tasks of government.

In this simulation, it was thought that the company will continue to operate as it does today, it means, it were adopted the following assumptions:

- The federal government will continue requiring Eletrobras through its subsidiaries in infrastructure projects. For the simulator, it means that these projects will be done in partnership which Eletrobras will have 49% of these future SPEs;
- The subsidiaries will maintain the same success rate achieved in previous auctions of generation and transmission. Historically it means that in disputed generation projects, not structural, Eletrobras will keep the success rate in 25% (16% corporately and 9% in partnerships) with variable percentages up to 49%. For transmission, the success rate is 29% (20% partnerships and 9% corporately);
- The Eletrobras participation will remain constant in 3% of private projects of alternative energy sources, not auctioned.

It was considered that project information is updated as the auction approach, and thus, average values had to be used initially.

For scenarios 2 and 3, it were adopted the following general assumptions.

- **Generation:**

1) There was no information about the value of a specific investment in a new plant. The average cost: R$ 3.5 million per MW for conventional power plants and R$ 4.0 million per MW for alternatives sources (small hydro, wind, etc.);
2) The UHE São Luiz do Tapajos (6.133 MW) were considered structuring project.
3) There was no information about the load factor for a specific new plant. It was adopted 65% for conventional power plants and 50% for alternative sources;
4) The average tariff will for new projects: 102 R$ / MWh for conventional plants and 135 R$ / MWh for alternative sources;
5) The EBITDA margin: 65% for conventional projects and 68% for projects of alternatives;
6) The capital structure of new projects: 40% equity and 60% debt;
7) In partnership, the loans have payment term of 10 years, with four years of grace period after the start of operation. The interest rate is 8% per year. Additionally, it was considered that the SPE will not pay interest during the grace period;
8) Finance conditions were not addressed in a corporate form; this item is treated in another module of the simulator. This information and the calculations were important in partnerships expansion to obtain the SPEs rate of return and to reflect the dividends payment;
9) The depreciation rate: 2.4% for conventional projects and 2.6% for projects of alternative sources. The calculation uses the straight line method;
10) The legal reserve of profits of SPEs: 5%, it means that 95% of the profits can be used to pay dividends.

- **Transmission:**

1) There is no information about the value of a specific investment and RAP. It was used the average according to voltage level, obtained based on the latest auctions as table 6.3:

| Voltage Level | 800 kV | 750 kV | 600 kV | 525 kV | 500 kV | 440 kV | 345 kV | 230 kV | |
|---|---|---|---|---|---|---|---|---|---|
| Average Cost | 1,4 | 1,25 | 1,25 | 0,82 | 0,8 | 0,6 | 0,6 | 0,45 | R$ millions/km |
| Average Income | 0,15 | 0,13 | 0,13 | 0,14 | 0,13 | 0,12 | 0,12 | 0,09 | R$ millions/km |

Table 6.3 - Average cost and RAP for new transmission lines

2) The Belo Monte transmission system was considered structuring project;
3) The EBITDA margin: 70% for partnerships and 67% for corporate projects;

4) The capital structure of new projects: 40% equity and 60% debt;
5) In partnership, the loans have payment term of eight years, with two years of grace period after the start of operation. The interest rate is 7% per year. Additionally, it was considered that the SPE will not pay interest during the grace period.
6) The depreciation rate: 3.0% for the transmission lines and 3.5% for the substations. The calculation uses the straight line method;
7) The legal reserve of profits of SPEs: 5%, it means that 95% of profits can be used to pay dividends.

According to these assumptions, it was reached the following values:

| Installed Capacity (MW) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Generation** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Corporate | | - | - | - | - | - | 176 | 194 | 318 | 630 |
| Partnership | 41.150 | 41.797 | 42.814 | 42.814 | 42.814 | 42.814 | 44.395 | 44.413 | 44.537 | 44.849 |
| **Total** | **42.333** | **44.742** | **46.580** | **47.895** | **49.583** | **51.423** | **54.936** | **55.371** | **55.694** | **56.318** |
| **Total Brazil** | **121.100** | **130.625** | **138.469** | **143.904** | **151.372** | **156.970** | **162.907** | **167.928** | **173.645** | **182.408** |
| **Market Share** | **35,0%** | **34,3%** | **33,6%** | **33,3%** | **32,8%** | **32,8%** | **33,7%** | **33,0%** | **32,1%** | **30,9%** |

Table 6.4 - Eletrobras Market Share in generation (MW) - Maintained current scenario

| Transmission Lines - Voltage Level >=230 kV (km) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Transmission** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Corporate | 52.516 | 53.150 | 54.365 | 55.082 | 55.610 | 55.793 | 56.011 | 56.214 | 56.279 | 56.323 |
| Partnership | 2.602 | 4.821 | 7.485 | 8.086 | 9.405 | 9.811 | 10.296 | 11.157 | 11.302 | 11.914 |
| **Total** | **55.118** | **57.971** | **61.849** | **63.168** | **65.015** | **65.603** | **66.307** | **67.372** | **67.581** | **68.237** |
| **Total Brazil** | **105.929** | **109.634** | **119.859** | **127.324** | **135.333** | **138.121** | **141.297** | **144.438** | **145.063** | **148.969** |
| **Market Share** | **52,0%** | **52,9%** | **51,6%** | **49,6%** | **48,0%** | **47,5%** | **46,9%** | **46,6%** | **46,6%** | **45,8%** |

Table 6.5 - Eletrobras Market Share in Transmission (km) - Maintained current scenario

As the tables 6.4 and 6.5 presents, if current performance remains in future auctions, Eletrobras will get a loss of 4% in generation market share and 7% in the transmission sector at the end of decade. Furthermore, this scenario would generate the following additional impacts on the company cash flow:

- New investments (corporate and proportional in partnerships): R$ 10 billion in the period, according to the table 6.6.

| New Investiments - Scenario 2 (R$ millions) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Generation** | **-** | **82** | **207** | **475** | **736** | **1.346** | **1.421** | **1.349** | **1.472** |
| Corporate | - | 64 | 149 | 310 | 476 | 964 | 1.042 | 978 | 1.114 |
| Partnership | - | 18 | 58 | 165 | 260 | 383 | 379 | 370 | 358 |
| **Transmission** | **27** | **219** | **458** | **552** | **464** | **541** | **512** | **253** | **60** |
| Corporate | 14 | 116 | 227 | 236 | 144 | 131 | 69 | 20 | 9 |
| Partnership | 13 | 103 | 231 | 316 | 320 | 410 | 444 | 233 | 51 |
| **Total** | **27** | **302** | **664** | **1.027** | **1.200** | **1.887** | **1.934** | **1.602** | **1.532** |

Table 6.6 - New investments to maintain the current market share

- New revenues: R$ 1.5 billion in the first period as shown in table 6.7.

| New Income - Scenario 2 (R$ millions) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Generation** | **-** | **-** | **-** | **-** | **2** | **72** | **111** | **172** | **358** |
| Gross Income | - | - | - | - | - | 71 | 102 | 167 | 327 |
| Dividends | - | - | - | - | 2 | 1 | 10 | 5 | 31 |
| **Transmissão** | **-** | **-** | **0,2** | **35** | **77** | **97** | **129** | **132** | **170** |
| Gross Income | - | - | 0,2 | 35 | 75 | 95 | 120 | 127 | 139 |
| Dividends | - | - | - | - | 2 | 1 | 10 | 5 | 31 |
| **Total** | **-** | **-** | **0,2** | **35** | **79** | **169** | **241** | **304** | **528** |

Table 6.7 - New revenue aggregated with the maintenance of the current market share

It should be emphasized that the currently concessions in the Brazilian electric sector has 30 years period and the average period of construction of transmission lines and power plants used in the simulation was 3 and 5 years respectively which explains the high requirements resource and low income in the first decade. Additionally it is important to highlight that enterprises have all concession period simulated and summing all the expected cash flows and putting in present value, the projects achieves rates of return consistent with those desired by Eletrobras.

## 6.3) Scenario 3 - Company tries to maintain the current market share

Similar to scenario 2, it was thought a possibility of expansion for Eletrobras, not just keeping the current position, but acting more aggressively, with the company trying to keep its market share.

There are infinite possibilities to achieve this goal, but in order to be more accurate it was done a simulation that reduced the expenses in investments keeping the rules for expansion that the company adopts nowadays.

The general assumptions of the simulation were the same as scenario 2. The results are presented in the following tables 6.8 and 6.9:

| Installed Capacity (MW) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Generation** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Corporate | 41.150 | 41.797 | 42.814 | 42.814 | 42.814 | 42.814 | 44.659 | 44.704 | 45.013 | 45.793 |
| Partnership | 1.183 | 2.946 | 3.766 | 5.081 | 6.925 | 9.050 | 11.709 | 13.058 | 14.949 | 17.963 |
| **Total** | 42.333 | 44.742 | 46.580 | 47.895 | 49.739 | 51.864 | 56.368 | 57.763 | 59.962 | 63.756 |
| **Total Brazil** | 121.100 | 130.625 | 138.469 | 143.904 | 151.372 | 156.970 | 162.907 | 167.928 | 173.645 | 182.408 |
| **Market Share** | **35,0%** | **34,3%** | **33,6%** | **33,3%** | **32,9%** | **33,0%** | **34,6%** | **34,4%** | **34,5%** | **35,0%** |

Table 6.8 - Eletrobras Market Share in Generation (MW) - Aggressive Scenario

| Transmission Lines - Voltage Level >=230 kV (km) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Transmission** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Corporate | 52.516 | 53.150 | 54.365 | 55.110 | 57.985 | 58.979 | 60.168 | 62.279 | 62.633 | 64.133 |
| Partnership | 2.602 | 4.821 | 7.485 | 8.098 | 10.414 | 11.165 | 12.063 | 12.898 | 13.165 | 13.345 |
| **Total** | 55.118 | 57.971 | 61.849 | 63.207 | 68.400 | 70.144 | 72.231 | 75.177 | 75.798 | 77.478 |
| **Total Brazil** | **105.929** | **109.634** | **119.859** | **127.324** | **135.333** | **138.121** | **141.297** | **144.438** | **145.063** | **148.969** |
| **Market Share** | **52,0%** | **52,9%** | **51,6%** | **49,6%** | **50,5%** | **50,8%** | **51,1%** | **52,0%** | **52,3%** | **52,0%** |

Table 6.9 - Eletrobras Market Share in Transmission (km) - Aggressive Scenario

In this scenario, it is observed that to maintain the current market share in 2021, Eletrobras must have to triple the success rate in generation auctions, and also propose partnerships in half of all new businesses from alternative sources developed in Brazil. It should be noted, however, that there would be other ways to expand, such as the purchase of companies or participate in the 7,000 MW of new thermal plants planned in PDE, but while the focus is clean energy, this kind of business was excluded from this study.

As for the transmission segment, the task seems even more difficult. There are 18,500 km of lines planned to be auctioned, and thus to maintain the current market share, Eletrobras needs at least 14,500 km of those new lines, it means that the company would have to participate in almost all consortia who win auctions, and it should increase your success rate in corporate enterprises by four times. The table 6.10 shows the cost of this effort:

- New investments (corporate and partnership): R$ 37 billion in the period:

| New Investiments - Scenario 2 (R$ millions) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Generation** | **-** | **305** | **872** | **2.006** | **3.213** | **5.319** | **5.849** | **5.900** | **5.714** |
| Corporate | - | 160 | 373 | 775 | 1.191 | 2.409 | 2.606 | 2.446 | 2.784 |
| Partnership | - | 145 | 500 | 1.231 | 2.023 | 2.910 | 3.243 | 3.454 | 2.930 |
| **Transmission** | **91** | **729** | **1.498** | **1.676** | **1.207** | **1.234** | **999** | **496** | **163** |
| Corporate | 59 | 477 | 932 | 970 | 590 | 537 | 282 | 82 | 37 |
| Partnership | 32 | 253 | 566 | 706 | 617 | 697 | 717 | 414 | 126 |
| **Total** | **91** | **1.034** | **2.370** | **3.683** | **4.421** | **6.553** | **6.848** | **6.397** | **5.877** |

Table 6.10 - New investments maintained market share

- New Revenue: R$ 4.6 billion in the first period as shown in table 6.11:

| New Income - Scenario 2 (R$ millions) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Generation** | **-** | **-** | **-** | **-** | **27** | **241** | **367** | **491** | **1.034** |
| Gross Income | - | - | - | - | - | 177 | 254 | 417 | 817 |
| Dividends | - | - | - | - | 27 | 64 | 113 | 74 | 217 |
| **Transmissão** | **-** | **-** | **0,7** | **146** | **314** | **413** | **502** | **530** | **576** |
| Gross Income | - | - | 1 | 145 | 307 | 393 | 492 | 521 | 571 |
| Dividends | - | - | - | 1 | 8 | 20 | 10 | 9 | 6 |
| **Total** | **-** | **-** | **0,7** | **146** | **342** | **654** | **869** | **1.021** | **1.611** |

Table 6.11 - New revenue aggregated maintained market share

As in scenario 2, the maintenance of Eletrobras market share proves to be extremely difficult and requiring a large amount of resources in the short term which seems incompatible with the current finance position of the company.

On the revenue side, there would be no large entries in the company's cash flow as shown in table 6.11. It is important to highlight that the situation could be even more complicated because the currently delays are largely in projects developed in the country, by environmental embargoes, which slows the entry of revenue and undermines the rate of return. These simulations have not been provided any delay from the time the projects are auctioned.

## 7) Conclusions

Nowadays, Eletrobras can be observed as a split company. On the one hand, the state-owned company, bureaucratic, slow, crowded with its many social responsibilities and representing the strong arm of government to develop parts of the country where the private sector still does not venture. On the other hand, there is the largest energy company in Latin America, a leader in technology and relying excellence technical

workers. There is a public company stocked on major markets in the world and it has their financial data analyzed and rolled daily.

The capitalism has reached in the Brazilian electric sector and the biggest proof of that is the incredible increase in competition which has been reducing the company market share year after year, and probably, it will continue to happen as shown in the simulated cases.

It is definitely not easy to be a government company and a market company at the same time. It should be though how is it possible make profits for shareholders with so many social demands, and if does it really matter the market share, and the price to maintain this market share.

Analyzing these questions, it is concluded that Eletrobras needs to impose itself and seek competitiveness solutions to stay alive. The expansion of the Brazilian electric sector will continue accelerated in the next decade and it is necessary to be strong to take the renewable energy leadership in 2020.

The main conclusion of this work, however it is not in the analysis of scenarios or to set premises in a simulation tool itself, but the importance of the concept behind the development of this tool, it means, the conscience of the necessity to make short, medium and long term planning within the company.

## 8) References

Agência Nacional de Energia Elétrica – ANEEL – www.aneel.gov.br

Empresa de Pesquisa Energética – EPE – www.epe.gov.br

Operador Nacional do Sistema Elétrico – ONS – www.ons.com.br

Camara de Comercialização de Energia Elétrica – CCEE – www.ccee.com.br

Bolsa de Valores de São Paulo – BOVESPA – www.bmfbovespa.com.br

Centrais Elétricas Brasileiras – ELETROBRAS – www.eletrobras.com

Agência de Notícias Canal Energia – www.canalenergia.com.br

2012 ONS Annual Report - ONS

2012 Eletrobrás Annual Report – Eletrobrás

Plano Decenal de Expansão de Energia 2021 – EPE

Programa de Expansão da Transmissão 2013-2017 – EPE

BATISTA, Romário de Oliveira**. Debate sobre uma segunda prorrogação de concessões no setor elétrico (sem licitação): verdades, meias-verdades e pontos para reflexão.** Brasília: UNB, jan 2009.

BONINI, Mario Roque. Setor Elétrico Brasileiro: **O problema do prazo das concessões.** São Paulo: Fundap, Nota Técnica 1 / nov 2009.

CASTRO, Nivalde J. de; BRANDÃO, Roberto. **O maior desafio do setor elétrico para o novo governo: vencimento das concessões.** Rio de Janeiro: GESEL/UFRJ, nov. 2010.

CUNHA, Pedro Paulo da; **The Problem of Concession Agreementes in the Brazilian Eletric Sector.** Minerva Program 2009.

CHAGAS, Marcus Eduardo; **Setor Elétrico Brasileiro: O Modelo após a reforma de 2004;** Florianópolis: UFSC, mar 2008.

SILVEIRA, Maria Alzira Noli; DAVID, Pedro Américo Mortz-Sohn; ARAÚJO, Edna Maria de Almeida: **Estrutura do Planejamento e Expansão da Geração e da Transmissão no Brasil;** Rio de Janeiro, 2012.

CAVALCANTI, Teófilo de Holanda; **O Modelo Institucional do Setor Elétrico Brasileiro e a Comercialização de Energia – Uma Visão Global;** Rio de Janeiro, 2009.

NERY, Eduardo; **Mercados e Regulação de Energia Elétrica;** Rio de Janeiro, 2012.