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A COMPARATIVE ANALYSIS OF THE BRAZILIAN AND THE U.S. ELECTRIC SECTOR: FROM CHANGES TO CHALLENGES

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EXECUTIVE SUMMARY

The electric sector is a very complex network system, both from technical and regulatory standpoints. A strong and independent regulatory arrangement needs to be in place to balance the necessity of protection for consumers and assurance to investors that their capital will not be indiscriminately expropriated. Even in a climate of deregulation, it is necessary to establish some rules and monitor how stakeholders are behaving, looking for signs of misconduct or anomalies that could lead to potential market abuse. But naturally, this requires accountability in both design and application.

This paper compares and contrasts the two largest power systems in the Americas: Brazil and the United States of America.

U.S. and Brazil have followed different models. Despite remarkable differences, they are both sizable and have embarked on a trajectory of deregulation and competition, in particular in generation and marketing.

However, many challenges remain, on the regulatory and operational domain.

Brazil has to consolidate its regulatory system and institutions, which are still in a state of flux resulting from how they came into being. In the U.S. however, institutions have been in place for a longer period of time, but the U.S. struggles with excessive fragmentation of roles and responsibilities between federal and state agencies, which make changes more difficult and the decision making process more cumbersome.

The two countries have restructured their systems looking for more competition and in both cases participation of multiple players and private capital occurs extensively. In scenarios

such as these, a regulatory agency is a key to enabling the provision of modern rules, enforce these rules, detect and act upon abuses, and balance the interest of multiple stakeholders.

Given the strong role that would be assigned to the regulators and the need for independence, doubts remain about who is going to monitor and assess the regulatory process or indeed the regulator? There is not a simple answer to this question.

In this context, organizations such as Brazilian Court of Audit (TCU) in Brazil and Government Accountability Office (GAO) in the U.S. play a major role overseeing the government action, its public polices and their results.

The institutional arrangement and the role of each institution, although in a continuous process of learning, are fundamental to bringing stability to the system and to giving a sense of what the risks are allowing a reliable system to flourish. It is a never-ending process to balance multiple interests in such a complex and fundamental industry. In this regard the challenges for both countries are proportional to the size of the electric sectors, and these are enormous.

The emergence of smart grids, in part driven by an evolution in metering and two-way communication technologies, will create new challenges for the regulator and similarly for the institutional arrangements at large. Brazil is now experiencing a special challenge discussing the final term of concession contracts that will be a difficult test for regulators and a demonstration of the strength of the institutions.

Briefly, the comparisons highlighted the following observations: i) important differences and similarities in the configuration of electric sectors in Brazil and in the U.S.; ii) the Brazilian electricity history and how it provided the country with some important lessons about economics and the sustainability of the electric sector; iii) the importance of

regulatory authorities and transparency provided by Supreme Audit Institutions; iv) the importance of competition in infrastructural sectors; (v) the challenges and opportunities moving forward. And the benefit of wisdom gained by maturity in the sector by its constituents and regulators.

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1. INTRODUCTION

The electric sector is a very complex network system. In order to understand the context of how things function in this sector it is first necessary to take a bird's-eye-view on the size, level of interconnectivity, configuration, and driving force that shaped the industry.

In this scenario, an independent and strong regulatory system in place has an important role for the proper functioning of the industry: to balance the consumers' protection from the power monopoly and investors from capital expropriation. Even in a climate of deregulation, it is necessary to establish some rules and monitor how things are working, to look for signs of misconduct or anomalies that could lead to potential market problems. But naturally, this requires accountability in both design and application.

The vast U.S. experience related to regulated industries (and its process of deregulation), especially in the electric sector has led to a dynamic but stable regulatory framework. The purpose of this paper is to perform a comparative review between Brazil and the U.S.'s regulatory evolution, their regulatory authorities' chief missions, the external controls provided by the Brazilian Court of Audit (TCU) and the Government Accountability Office (GAO), and today's challenges. Despite the differences between these two countries and their electricity entities, this comparative study provides an overview of the common changes experienced by both countries and provides some suggestions to improve Brazil's situation.

This paper compares and contrasts the different regimes of the Brazilian and U.S. systems. Particularly, Section 2 shows the context of today's electric system. Restructuring models adopted along the recent years are discussed in Section 3. The competencies of regulatory authorities are examined in Section 4. Section 5 sheds some

light on the external oversight provided by the Supreme Audit Institutions (SAI). Today's challenges and issues under discussion are presented in Section 6. And finally, a summary and concluding remark are presented in Section 7.

2. BACKGROUND

2.1. ELECTRIC SECTOR IN BRAZIL

Brazil has a population of more than 190 million. Its electric system provides energy to more than 95% of the population and is structured into four segments: generation, transmission, distribution and commercialization of electricity.

Energy production relies heavily on hydro generation, representing more than 80% of the total power output. In 2010, according to the Brazilian Energy Balance (EPE, 2011, p. 17), the installed capacity exceeded 113 GW (including 7 GW from the Itaipu Power Plant[1]). Hydropower generating represents approximately 71% of the total portfolio of all built electricity plants. Besides hydroelectric and fossil fuels plants, the Brazilian sources of electricity generation include nuclear, biomass, wind power and solar plants

Brazil is a developing economy that is growing fast and expects a significant increase in electricity demand in the coming decades. The government foresees an average consumption growth rate of 5% per year over the next ten years. The fulfilment of this market demand depends both on continued investments in large hydropower plants and on diversification of sources for electricity production.

[1]Itaipu, with its 14 GW of installed capacity, is the second largest hydropower plant in the world with regard to installed capacity (Three Gorges Dam, in China, is 20 GW); but in terms of energy actually produced, it continues to be the largest. Itaipu's energy is shared between Brazil and Paraguay. Each country owns one-half of the plant, however Brazil buys all the energy that Paraguay does not use (most of Paraguay's half).

According to the National Operator of the Brazilian Electric System (ONS, www.ons.org.br), almost 97% of the nation's energy consumption is transported through the so-called National Interconnected System (NIS) with its almost 100,000 km of transmission lines. It covers 55% of the Brazilian territory. The supply for the other 45% of the country is provided by isolated systems, mainly in the Amazon region. With Amazon basin hydropower plant projects underway, expansion of the NIS is expected. In a few years, the isolated systems will be limited to only the very most isolated areas in which it will not be economically feasible to interconnect to the main grid.

Interconnection among regions, which has been occurring gradually since 1970, has allowed optimization of watersheds, making it possible to take advantage of hydrological diversities, thus increasing energy security. Moreover, the integrated use of generation and transmission resources of the NIS makes possible the reduction of operational costs, the reduction of fossil fuel consumption and the increase in reliability. At present, service to the end user is delivered by distribution networks in 64 concession areas. The licenses for transmission, distribution and generation services for hydropower plants greater than 30 MW are granted competitively, through public auctions to private or government own companies.

According to ANEEL (www.aneel.gov.br), the Brazilian electricity regulatory authority, in Brazil, the annual revenue of the electric sector was $58 billion in 2009.

2.2. Electric Sector in the United States

The U.S. electricity industry was developed initially by independent providers, with loosely connected structure of individual monopoly utility companies including power plants, transmission and distribution lines serving only local areas. Today there is a lot of

interconnection between these providers, forming strong regional systems. However, contrary to Brazil, there is not a single interconnected system operated by one single operator.

The American electric sector consists of more than 1,000 GW of generating capacity connected to more than 550,000 km of transmission lines (U.S. Department of Energy, 2004, p. 5).

According to the U.S. Energy Information Administration (http://www.eia.gov/energyexplained/index.cfm?page=electricity_in_the_united_states), in 2010, almost 90% of the electricity in the U.S. was produced by thermal plants, with fuel sources comprised of: coal (45%), natural gas (24%) and nuclear (20%). Differing from Brazil, only 6% of all electricity produced in the U.S. comes from hydropower projects. Remaining sources (6%) are biomass, wind, geothermal and solar power. U.S. consumer demand for electricity is expected to rise 36% in the period between 2006-2015, requiring significant investment in new power plants and transmission lines (GAO, 2005, p. 1).

There are seven Regional Transmission Organizations (RTOs). They are independent entities that manage regional networks of electric transmission lines, covering part or all of 35 states and the District of Columbia and serving over half of the U.S. demand.

The Brazilian system is different. Because of the prevalence of hydropower plants the environment is conducive to a single centralized operator dispatching the system to minimize cost and optimize the overall generation and transmission capacity. The U.S. electricity system, with its preponderance of thermal plants, local and regional generation could offer different conditions for several operators, like RTOs and other kinds of operators.

According to GAO (2008), in the U.S., consumer expenditures for electricity amounted to $343 billion in 2007: this means almost 6 times more than in Brazil.

3. Electricity Industry Restructuring Models: the Paradigm Changes

3.1. Brazil: from the State Monopoly to a Conducive Environment for Investments

The Brazilian electric sector has undergone important changes to its structure and institutions in the last 15 years. Restructuring has not been an easy path. In 2001 Brazil experienced a major power crisis, partially due to an incomplete reform which did not provide a smooth migration from the state monopoly (the sole provider of services and the sole investor) to a market model with participation of multiple public and private stakeholders. According to Tolmasquim (2011, p. 5), in past decades, the state-owned enterprises had already done almost all the heavy investment in generation and transmission. At that time, the companies owned by the states had been responsible for planning and building new infrastructure.

With the international financial crisis in the 1970s and changes in tax policy that supported the electric sector, the ability to obtain funds to improve or to expand the electricity supply was practically nil. In fact, there was a decline in investments, power generation did not increase in the period of the 1980s, and tariffs were misused as a tool of monetary policy and inflation control. The power supply in the long run was undermined by these happenings. As a result of these factors, in the first half of the 1990s, distribution companies suspended payments for purchased power, increasing financial defaults in the sector.

At about the same time, inspired by an international debate regarding the state's role in the economic activities, Brazil began a wave of privatization in most of its industrial and network sectors. Basically these steps were taken seeking reduction of the state's role and participation in the provision of public services and in economic activities. As reminded by Martins *et al.* (2005, p. 33), "*by reducing its participation in the direct delivery of public services, the State's performance becomes more focused on the transfer of public services exploitation rights over to the private initiative by means of privatizations or the granting of new concessions, permits and authorizations*". It was supposed to be apropitious age for increasing efficiency too but this did not always happen. As an example, electrical losses in some distribution companies actually maintained for a while even after the privatization as a result of inefficiency[2]. In this period, as a result, the privatization effort itself has come into question and has been evaluated for its contribution to society.

In 1998 and in parallel with the wave of privatizations of the power sector, significant reform in the electric sector was carried out with the objective of creating a competitive electricity market[3]. It was designed to lead to a complete "deverticalization"[4] (unbundling) and subsequent privatization of state-owned enterprises that would have to separate natural monopoly segments (transmission and distribution of energy) from those where competition could be feasible (energy generation and marketing). At that time, the Brazilian state assumed that the free market would be able to offer the necessary supply of electricity. However, the following years were marked by periods of dangerous deficits in investments in which the growth of installed capacity lagged in relation to the increase in

[2]Reported in the item 67 of "Nota Técnica Aneel n. 26/2006" – regulation applied to losses in the tariffs of electric energy – and highlighted in an audit of TCU (Acórdão 2.211/2008-Plenário – available in www.tcu.gov.br. All the TCU decision is documented in a report that is judged by their ministers and result in an "Acórdão").
[3] Law 9.648/1998.
[4]Deverticalization represents a break in the vertical structure of an industrial chain.

the demand. The storage capacity of the hydro reservoirs was stretched to dangerous levels. The negative effects only appeared years later, when Brazil experienced a power crisis in 2001. The regulatory model put in place in 1998 did not provide sufficient incentives to encourage private investment in power generation in the volume necessary to meet growing demand. Moreover, in retrospect, the estimates for "firm hydro energy" certificates[5]were overestimated (Brazil, 2001). The supply of electricity, which resulted from contracts based on these overestimated certificates, proffered a false sense of a reliable system.

The combination of these factors was a gross miscalculation. Infrastructure reforms during the 1990s were necessary but the Brazilian state neglected basic requirements for improving investments and for itself providing guidelines to the market. At that time, growth of generation capacity was no longer the responsibility of state-owned generation companies following a centralized plan but rather was done as a reflection of market forces. Indeed this did not function very well either. Actions were not orchestrated as well they were supposed to be and in 2001, as already mentioned, this resulted in a national supply crisis.

In a report about this crisis, the Commission for Analysis of the Brazilian Hydrothermal System of Electric Power (Brazil, 2001), which aimed to analyse the matter, concluded that generation companies did not have an understanding of how or when they should invest. But particularly with regard to the state-owned companies, although these companies had conditions to make investments, the commission reported that the government's economic agenda did not allow them to carry out the necessary investments because these investments were deemed as government spending on public accounts –

[5] This document estimates how much energy a hydropower plant can produce and it is the limit of the energy that a hydropower plant can negotiate in long-term contracts.

thereby increasing the public deficit. And, at the same time, the private companies did not have the necessary guarantees to balance their perception of potential risks of making these investments. In other words, reform was implemented halfway, resulting in under-investments in power generation. The commission (Brazil, 2001) also reported that the severe hydrology (extended drought) experienced at that time was a stimulating factor in amplifying problems that would occur sooner or later. They reported that the system, plagued by structural problems, could have managed for a while without a crisis only in the presence of good hydrology.

It was clear that the legal framework in Brazil was incomplete or truncated, with no inter-institutional coordination and no incentives for private investment. So, the lack of investments and the consequent supply crisis observed in 2001 demanded a new legal framework for the sector (even before the 1998's model completed implementation).

The historical policy of subsidized tariffs had a similar debilitating effect on the electrical system. The tariff trajectory basically followed this path: initially tariffs were based on "cost-plus" where the utility's cost of production and distribution was augmented with a simple rate of return on assets; after that, in the 1970s an equal tariff for all the country was created, where companies with surplus transferred resources for ones with deficits. The first kind of policy was very limited in terms of efficiency stimulation. The second type not was only limited but it had the effect of discouraging any kind of efficiency. Moreover, in the era of high or hyper-inflation (during the decade of 1980 and the early 1990s), electricity tariffs were used as a macroeconomic tool (errant policy for inflation reduction). All these actions resulted in a massive tariff shortfall, which ended up being paid by the taxpayer: the Brazilian Treasury made payments for guaranteed profitability, discharging the accumulated deficit of $26 billion, in 2003.

Since the Concessions General Act[6], enacted in 1995, there has been a general rule for public services tariffs no longer based on the cost of production but rather on prices of service with a tariff revision mechanism. But even this type of tariff policy does not function well when there is something not working in the system like during the period prior to the reforms of 2004 began to make effect. The Brazilian electricity tariff history had two more bad examples of missed objectives. First, with the modifications of the electricity specific framework and in the imminence of the crisis of 2001, the government established a maximum cap for the price of energy based on a standard cost of production thinking that the distribution companies could have the best price for supply and they could offer the best tariff for the consumers. The problem with this was that despite the fact that the government established the cap level, every company charged the full price allowed, even if this meant self-dealing internally to raise their perceived cost and thus their profit in a near monopolistic manner. So it became necessary to stimulate competition again. Second, as a consequence of the 2001 crisis, as identified in an audit by TCU[7], the consumer paid almost $10 billion because the tariffs review process associated with the Emergency Program for Electricity Demand Reduction (PERCEE)[8]. Here, there were some problems: as said before, the overestimated certificates of the guaranteed energy of hydropower plants and the policy of management looking for only one side of the problem (as extensively discussed by Hazlitt, 1946) – the control over demand while forgetting the commitment of the supply in the system; tariffs lagged so there was a need to recover them;

[6] Law 8.987/1995.

[7] Acórdão 1.543/2009-Plenário.

[8] The Emergency Program for Electricity Demand Reduction (PERCEE) was created with the objective to rebalance supply and demand during the 2001 crisis. It allowed the market to reduce demand during this period by 20%, however the generation companies were suppose to be paid for the energy that they had actually commercialized for the distributors that were in the National Interconnected System (NIS).

and the generation and distribution companies lobbied to have their losses due to power rationing recovered – which led to a disguised bailout.

The experience of the electric sector provided the country with some important economic and sustainability lessons. For example: how price setting policies and, more than that, how macroeconomics objectives hurt the system; how important it is for the government to study projects in order to design guidelines; and how the market responds to freedom in the absence of regulation.

The Brazilian framework was reformulated in 2004[9] with the aim of removing the causes of past crises and increasing the supply of electricity by overcoming barriers to investment in the expansion of the sector. In addition to bringing new perspectives to the sector, the new model's main objectives were to ensure low tariffs for consumers, provide continuity and quality in service delivery, guarantee a fair return to investors in order to encourage them to expand the service, and provide universal access of energy services. In implementing this model, contract sanctity was preserved. It was also necessary to reduce transaction costs during the implementation period. To achieve these goals, rules were created (and continue to be enforce), such as: i) distribution companies must purchase energy in regulated auctions; ii) expansion of power generation is necessary and must be encouraged in order to prevent the risk of shortages and to increase the supply of electricity; iii) hydroelectric plants are granted by auctions but, to reduce risks of delays in construction, these new ventures must be supported by the existence of a prior environmental license[10].

[9] Law 10.848/2004.

[10] In Brazil, the environmental license process includes three phases: a preliminary license (granted in the preliminary planning phase of the project or activity approving its location and design, environmental sustainability certification and establishing the basic requirements and conditions to be met in the next stages

This new model provides two distinct sets of conditions, one regulated and other free market. In the free market, generation companies sell their energy to free consumers[11], through free bilateral negotiation (without any intervention of the government) using contracts of long or short-term (the spot market). In the regulated situation[12] (with its captive consumers in the retail market), the electricity is sold to distribution companies through specific auctions using long-term contracts.

Effectively, in Brazil, during the electric sector auctions, there has been strong competition "for the market". This competition primarily takes place only at the beginning of a concession for transmission or generation. Both of these concessions are granted to companies as a result of a competitive price, via auctions. For the auction, the government sets upper limits for the tariff or price. The company who bids the lowest tariff or price wins. With the introduction of the2004 model, the auction winner does not pay any up front fee for the concession[13]. Instead the auction is based entirely on lowest tariff offered. In the retail market, the distribution companies' situations have also had a change in framework. This change allowed companies to move from a regulated and guaranteed rates of return to regulated rates based on certain standards of efficiency as defined by "best

of its implementation); an installation license (authorizing the installation of the project or activity in accordance with the specifications of the approved plans, programs and projects, including the environmental control measures and other conditions); and an operating license (authorizing the operation of the projector activity, after the verification of compliance with the licenses listed above, with the environmental control measures and conditions specified for the project's operation).

[11]According to Law 9.648/1998, consumers that buy more than 3 MW are allowed to be a "free consumer", which is a consumer that can choose his supplier and enter into short term markets.

[12] The regulated environment is organized into a pool of consumers, matching electricity demand and supply capacity through long-term contracts. The method used by the government is the "single-buyer" model, where the government organizes the purchase of all the energy demanded by the distributors. "However, although establishing a common mechanism for the purchase of energy, the model allows market risk to be shared among participants instead of being borne exclusively by the government, which acts rather like an auctioneer than a buyer" (OECD, 2005, p. 3).

[13] In the 1998 model, the company who offered the highest grant price won the auctions. For the government it was an interesting rule because it increased its sources of revenue; for the consumer, it was a terrible rule, because the consumer was supposed to pay for the grant fee inside the tariff.

practices". Their profits are now linked to price of service, and are associated with a tariff revision mechanism whereby, if they are more efficient than the regulator's defined benchmark, they can capture some of that value for a period of time.

However, privatization reforms stopped before the framework was complete and the deverticalization did not happen fully. Despite that, approaching a decade later, this new legal model has so far been a success. The SWOT Analysis shown in Appendix 1 highlights the characteristics of the recent changes in the Brazilian's framework, especially those in 1998 and 2004. Regardless of successes achieved so far, day-to-day actions remain a challenge between the provision of a continual and universal power service, and there is an ever-present tension associated between quality and reasonable tariffs.

Since last year, the main discussion in the sector has been the final term of granting contracts, the achievement of setting up new auctions to grant these concessions or their renewals for continued operation. Those are a key issue that will demand careful government decisions to maintain success in this existing model.

3.2. THE U.S. MODEL: FROM REGULATION TO DEREGULATION

In the past local utility monopoly model, the federal government and the states regulated the wholesale and retail electricity prices. The basic framework for electric utility regulation was established in 1935, which required federal regulation of these companies. According to GAO (2005, p. 5), this was enacted to eliminate unfair practices that could be done by large holding companies (electricity and natural gas owned companies in several states). The main purpose of statutory oversight and regulation over output prices was focused on direct interventions designed to protect customers in final-output markets.

During the last 30 years of 20th century, with a movement that began in the intellectual environment of universities, the U.S. had experienced a phase of deregulation in several industries[14] that gained momentum in 1990s. Whereas, in the past, "*the objective of government oversight over network industries had been to restrain the use of market power to charge high prices for their outputs, under a new paradigm, regulatory control of final-output prices has moved into the background. The main task of regulatory institutions for network industries today is to promote the development of competition in these industries*" (Hellwig, 2008, p. 5).

Particularly since 1992, the U.S. federal government has been working with the electricity industry and supporting its restructuring. The reforms were looking for increase in competition in the wholesale market as a matter of bringing more benefits to consumers, including lower electricity prices and access to a wider array of retail services. The decision reached was to deregulate the wholesale market. In particular, as described by GAO (2005, p. 2), the federal government changed several things, especially: i) electricity is now priced by the market — in the past, prices were set by regulators; ii) addition of new entities selling electricity; iii) consumers have options (a very important change, because there are now programs that allow consumers to participate in markets); and iv) there is now a schedule to ensure the electricity consumer is protected by the oversight of the industry. The major thrust of the restructuring is that it provides changes from a highly regulated environment to one that places greater reliance on competition for its controls and drivers.

[14] Basically, the deregulation is "the elimination of some or all regulations from a previously regulated industry or sector of an industry" (EIA, 2011).

As recalled by Markiewicz *et al.* (2004, p. 7), *"it has long been argued that traditional cost-of-service regulation does relatively well in limiting rents but less well in providing incentives for cost-minimizing production"*. This is the experience everywhere, including the U.S. and Brazil. Both countries have restructured their systems looking for more competition. In Brazil, it was implemented in the segment of electricity production and to a lesser extent in the retail market. In U.S., the competition in some states has been implemented even in the retail market. After some years, it is now possible to look back and see there were in fact some gains but also there were some opportunities for improvement.

Regarding the retail market, 16 states (including District of Columbia) have actually opened their retail markets to competition and 7 seven more states had opened it for a while but have subsequently suspended the deregulation, partly in response to the California and Enron crisis (EIA, 2011).

Analysing the restructuring, in 2008, GAO (2005, p. 2) opined that *"federal restructuring efforts, combined with efforts undertaken by states, have created a patchwork of wholesale and retail electricity markets; broadened electricity supplies; disconnected wholesale markets from retail markets, where most demand occurs; and shifted how the electricity industry is overseen. Taken together, these developments have produced some positive outcomes, such as progress in introducing competition in wholesale electricity markets, as well as some negative outcomes, such as periods of higher prices"*.

In contrast, in Brazil, the captive consumer, which represents a large majority of customers, is not allowed to choose alternative suppliers and the incumbent utility has

full monopoly on marketing. However, the free consumer[15] has this option and has in most cases exercised it. Currently, about 30% of the market in Brazil, represented by large customers, no longer pays regulated tariffs. This is good for the customer, as he/she is able to benefit from lower prices in the short-term market. However, doubts have been raised as to what extent this customer is not "free-riding" on the system. The free consumer does not commit nor contract any rate of consumption contributing to the long term planning and execution of generation expansion, as its load is not considered in the planning forecast of the distribution utilities. The building of hydropower plants demands intense capital and hence consumption commitments. For the feasibility of hydropower plants, it is necessary to provide some guarantees, like those of long-term contracts or power purchase agreements (PPAs). When talking about the deregulation of the retail market, there is another issue needing to be understood about the Brazilian electric sector: in a system based on hydropower in addition to the viability of hydropower projects, it is necessary to remember that the electricity price today depends on the prospect of the future hydrology. So the economic questions get a little more complex.

GAO (2005, p. 2) in its report identified four key challenges to the effective operation of the restructured electricity industry: *"i) making wholesale markets work better together so that restructuring can deliver the benefits to consumers that were expected; ii) providing clear and consistent signals to private investors when new plants are needed so that there are adequate supplies to meet regional needs; iii) connecting wholesale markets to retail markets through consumer demand programs to keep prices lower and less volatile;*

[15]For example, TCU (see Acórdão 1.196/2010-Plenário) related that in 2005 free consumers were responsible for 25% of the energy consumption and then they paid 52% less for the energy.

and iv) resolving divided regulatory authority to ensure that these markets are adequately overseen".

In less mature markets, such as Brazil, it is has been acknowledged, in particular after the 2001 crisis, that it is important to give consistent signals to private investors for them to build new power plants.

The disconnection between the wholesale market and the retail market also creates all sorts of problems, such was observed in California during the 2000/2001[16]. Despite other problems, during the crisis it became clear that there was no link between the wholesale and the retail market: the wholesale prices were increasing and the electricity demand was increasing as well, so there was an inadequate demand-side response (FERC, 2001, p. 4). This fact not only aggravated the crisis but also increased the manipulation of prices by private companies and profiteers.

The issue of connection between the wholesale and the retail market reminds one that in Brazil there is not a complete connection between the operation of generation plants and the tariffs. As warned by TCU[17], there is a discrepancy in time between the tariffs paid by the Brazilian consumer and the tariffs required as a result of contingencies (such as supplemental thermal generation in times of drought) that he would pay, because the tariff's application is not immediately impacted by the changes in the system of generation. The spot prices do not reflect the cost of emergency generation in each zone and the additional costs to run those plants are "socialized" via the System Service Charge (ESS). This also discourages energy efficiency and demand response. The regulation

[16]Between May 2000 and August 2001, there was a deep and prolonged crisis of electricity supply in the State of California, with frequent blackouts and untold economic damage. In fact, the California market worked as a laboratory for deregulation. This was gratefully acknowledged by Kelly (1999, p. 4,) thanking California "for its bold experiments that so richly benefit the rest" of the country.
[17]Acórdão 1.196/2010-Plenário.

defined the exact moment to pass on new costs into the tariffs or time for its review. For example, despite that there is relative stability in the Brazilian captive consumer tariffs (hydropower plants provide for contracts of long-term duration), there is volatility in the thermal power plants, because it is not possible to know a year in advance what amount of energy they are going to produce (or how much it will cost). The Brazilian model does not provide the consumer the necessary mechanisms express his price-elasticity. Currently, there are some initiatives underway by ANEEL to allow the consumer to express his behaviour in response to higher tariffs[18]. The issue of time between consumption and tariff application and the related consumer ability for elasticity in demand continue to be one of the challenges for Brazil and are associated with the "smart grid" (discussed in the challenges described in section 6).

4. REGULATORY AUTHORITIES

4.1. THE CONTEXT OF ANEEL'S FOUNDATION AND ITS MISSION

The restructuring of the infrastructure sectors in Brazil, and the simultaneous decrease in state ownership of network industries, has demanded an active regulatory role by independent agencies. This is not to say that these agencies were not necessary before the restructuring but taking into account some guarantees, like universal service, adequate quality, amongst others, without precise regulations and enforcement these probably would have been neglected or poorly managed. Moreover, the existence of solid regulatory agencies provide: the necessary protection for consumers from monopoly power;

[18]With a signal of price when it will be necessary to operate a lot of fossil fuel thermo power plants, and the demand-response program that would be created with the substitution of electro-mechanic meters by electronic ones.

guarantees of political independence for the rules to be issued by these institutions and enforcement of contracts for investors (besides protecting them from capital expropriation); and the adequate implementation of government guidelines. In this new context, regulation should basically have the mission to encourage and ensure the investments needed to promote the welfare of consumers and users and increase economic efficiency.

As reported by Pires and Piccinini (1999, p. 223), "*the increased complexity of the industry, with input from the private sector, meant that agencies required total independence from all stakeholders (like government or other industry players). It is important for the regulator to ensure the defence of the welfare of society and to mediate disputes among investors, consumers and government. The independence of agencies implies autonomy, stable boards, staff expertise and transparency and a clear definition of its functions and powers guaranteed by an existing regulatory framework*". The triangle of interests that ANEEL manages was illustrated by Pedrosa (2005, p. 3) and shown in Appendix 2. Besides the natural complexity of the regulatory activity, ANEEL, like any other regulator, suffers from asymmetric information[19]. In this scenario, it is essential that accountability and oversight of the regulators activities are provided by Supreme Audit Institutions.

Since the Brazilian electric sector's restructuring, there have been various entities created to support the model, with redefinition of the roles and responsibilities of

[19] The asymmetry can be associated with "moral hazard" or "adverse selection". The adverse selection is caused by the fact that the regulator does not have the same level of information about the firm set of exogenous factors that affect the efficiency of the firm (technological parameters, behaviour demand, etc). The moral hazard is caused by the fact that only the firm knows the outcome of certain movements inherently endogenous (costs, the result of administrative measures, etc) which creates the possibility of manipulation efforts by firms, aiming, for example, to obtain advantages in the review process of contracts or the definition of favourable regulatory rules.

both public and private[20] institutions. On the public side, institutional involvement in the electric sector includes the Ministry of Mines and Energy (MME)[21] and the Brazilian Electricity Regulatory Agency (ANEEL). They are both responsible for the design guidelines of public policies and for defining regulatory issues respectively. More than defining rules, the main activities of the regulators includes overseeing the system and mediating conflicts.

It is interesting to note that the Brazilian privatization reforms had begun in the 1990s but the electricity regulatory authority was only created in 1996. With that late start, ANEEL's capabilities suffered from the onset and needed some changes during the process of its early beginnings. And, it was as a consequence of the maturation process that the current legal model was subsequently established.

At the present, there is only one federal regulatory authority in the Brazilian electric sector. In all the 27 states, there are regulatory authorities for infrastructure but their only role in the system is the oversight of distribution companies by delegation of ANEEL's authority. Nevertheless, for sometimes there was confusion about the role of the federal regulator's activities and the states' supervisory ministries. For instance, when it was created, ANEEL was suppose to have the function of granting licenses for concessions; today it is clear that the granting of licences is a MME competence although MME has subsequently delegated it back to ANEEL since 2004. Broadly speaking, the Agency is in

[20] It's possible to highlight the role of the Chamber of Electric Energy Commercialization (CCEE), responsible for maintenance of the structure to allow the commercialization of energy at National Interconnected System (NIS), and of the National Operator of the Brazilian Electric System (ONS), which has as a function the control of generation and transmission at NIS.

[21] In the planning activities, MME is supported by the Energy Research Company (EPE). Also, the National Energy Policy Council (CNPE) was created - a strategic player in the definition process of policy for the electric sector (proposing these policies to Brazil's President) - and the Monitoring Commission for the Electricity Sector (CMSE), with has the mission to continuously monitor and assess the security of electricity supply across the country.

charge of organizing bids for transmission and generation expansion, defining tariffs and their revision processes, monitoring compliance to contracts, and providing oversight of quality and regularity of electricity services. On the other hand, the supervisor ministry is responsible for policy-making and standards supervision.

As said by Rodrigues (2005, p. 6), "*the regulatory body was conceived, nonetheless with ample independence, as a mechanism of protection against the opportunism of political interests and against abuse of economic power*". ANEEL's mission is "*to provide favourable conditions for the electric power market to develop with balance between the agents [and] for the benefit of society*" (www.aneel.gov.br) and it has as basic functions "*to normalize the policies and the guidelines established by the Federal Government for the electric sector, inspect service rendering to society and diminish eventual conflicts that may arise among different sector players*" (ANEEL, 2008).

According to Decree 2.335/1997 (it regulates the Law 9.427/1996, which created ANEEL), the Agency's guidelines are to: prevent potential conflicts between the agents and their consumers; regulate and supervise the operation of the electric sector, and avoiding anti-competitive practices that make difficult the free access to electrical systems; create conditions for reasonable tariffs, with emphasis on the quality of electric services; create a conducive environment for investment in the sector; adopt effective measures to ensure the supply of electricity looking for the social development and reducing regional inequalities; educate and inform agents and other stakeholders on policies, guidelines and rules of the electric sector; delegate activities to state entities; and ensure transparency and effectiveness for the society. In recent years, the Agency's action has been looking for the coherence of industry regulations, the preservation of low tariffs, the optimization of

methodology for the sector's regulation, the transparency of decision-making, and the strengthening of tools for dialogue with society at large (ANEEL, 2010, p. 3).

Before the ANEEL's creation, the National Department of Water and Electricity (DNAEE) regulated the electric sector. This entity, linked directly to the structure of the executive, had no power to regulate conflicts between agents. As previously reported, at that time tariffs were established with a pricing policy of utility's cost of production plus a rate of return. But more than that, they were used as a tool for inflation control. Today, the framework is looking to build a competitive market establishing auctions to supply energy to distribution companies, which in turn will deliver energy to the "captive consumers". The framework is further looking for the efficiency in the regulated segment of distribution (where now is not possible to have competition) and to establish incentive-regulation mechanisms[22]. ANEEL is responsible for all these activities.

4.2. THE U.S. REGULATORY ENVIRONMENT AND FERC'S COMPETENCES

In the U.S., the regulatory authority over the electricity industry is divided between the Federal Energy Regulatory Commission (FERC), the states and other market monitors.

FERC is *"an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to build liquefied natural gas (LNG) terminals and interstate natural gas pipelines as well as licensing hydropower*

[22]In Brazil, the aim of incentive-regulations is the increase of efficiency and quality in electricity service but with low prices. For instance, the remuneration model for distribution companies is based on the rule that tariffs allow the payment of all the costs but the regulator creates mechanisms to improve the efficiency (if the company is more efficient than the standard established by the regulator, it is awarded to retain some of the gains; if not, it is self-punished with its inefficiency).

projects" (www.ferc.gov). By comparison, in Brazil, activities related to exploitation and distribution of natural gas and oil are regulated by National Agency of Oil, Gas and Biofuel (ANP), although when there is a link with electricity generation ANEEL's regulation takes precedence.

Before the establishment of FERC in 1977, electricity industry regulation was first undertaken by the Federal Power Commission. It oversaw the rates, terms, and conditions of wholesale and transmission of energy in interstate commerce. For many years now, FERC has regulated, among other things, sales of electricity for resale and the transmission of electricity over high-voltage power lines in interstate commerce. The tariffs regulation was based on the utilities' costs of production plus a fair rate of return on the utilities' investment. After restructuring in 1992, the framework allowed the creation of a free wholesale market.

The states' regulatory authorities oversee the retail sales of electricity, electricity generation, construction of transmission lines within their states' boundaries, and intrastate transmission and distribution. The states regulate retail markets by participating with utilities in forecasting growth in demand, planning and building new power plants, reviewing and approving utility costs (www.ferc.gov). Generally, the states set retail rates based on the utility's cost of production plus a rate of return. But there are some states with deregulated retail markets (as previously reported, today this applies to 16 states).

The Commission's core responsibility is to protect the consumer from exploitation by non-competitive electric power companies. Its mission is to *"assist consumers in obtaining reliable, efficient and sustainable energy services at a reasonable cost through appropriate regulatory and market means"*. The success of this mission involves the pursuit of two primary goals: *"ensure that rates, terms and conditions are just,*

reasonable and not unduly discriminatory or preferential; and promote the development of safe, reliable and efficient energy infrastructure that serves the public interest". The Commission has always used the following two general approaches to meet its responsibility: "*regulation - was the primary approach for most of the last century and remains the primary approach for wholesale transmission service; and competition - has been the primary approach in recent years for wholesale generation service"* (http://www.ferc.gov/industries/electric/indus-act/competition.asp).

Despite ANEEL's only acting in the electric sector, as opposed to FERC, the Brazilian Agency has wider jurisdiction. In parallel responsibilities, it regulates all the Brazilian generation, transmission, distribution and commercialization of electricity, including, amongst other things, organizing auctions for the grants, organizing auctions for commercializing energy in the National Interconnected System (NIS), technical regulation, economical regulation (transmission and distribution), regulation of quality, and oversight of the entire sector (when possible, ANEEL delegates the distribution's oversight to the states' regulatory authorities).

The Commission's goal has always been to find the best possible mix of regulation and competition to protect consumers from the monopoly power. Analysing electricity restructuring, GAO (2005, p. 11) reported FERC activities include monitoring the markets looking for tips of misconduct, conducting investigations and audits, and reviewing large amount of data for anomalies that could lead to potential market problems. It summarized that *"FERC has improved the transparency of wholesale markets, a key requirement of competitive markets, by increasing the availability and accuracy of price and other market information"*. Similarly, in the context of the Brazilian electric sector, it is possible to say that ANEEL has been working hard to provide conditions for the

development of the electricity market. ANEEL has been cautioned about opening the retail part of the business to a free market. The reality of the Brazilian electricity system is significantly different from U.S.': it is necessary to pay attention to large investments necessary to build hydropower plants and their process of operation with a very short run marginal cost. After all, in general, the cash flow of a power generation company depends on a mixture of fixed income provided by long-term contracts (like power purchase agreements) and variable income associated with the energy sold in the spot market. The long-term contracts provide guarantees for these very large investments.

5. EXTERNAL OVERSIGHT: SUPREME AUDIT INSTITUTIONS

5.1. THE ROLE OF THE BRAZILIAN COURT OF AUDIT (TCU)

The accountability of the Brazilian government, its structure and who manages public resources is provided by the external control of the Brazilian Court of Audit (TCU), who's main objective is to oversee *"the public administration to contribute to its improvement for the benefit of society"* (www.tcu.gov.br).

In fact, the Brazilian Constitution provides the external control power (in respect to accounting, finance, budgeting, operations and its property) of the Federal Government to Congress. TCU is an arm of Congress and has the authority to audit, to examine and to use the power of the court to perform its external control upon direct and indirect administration. TCU activities are both demanded by the Congress and initiated of its own volition.

Since the 1988 Constitution, TCU has been doing "operational audits" (performance audits), which examine whether government programs meet their objectives

and has been looking for opportunities to improve government action. In the past, TCU has done only compliance audits with the objective of examining the legality and legitimacy of management actions. The purpose of these was to determine how federal resources, under its jurisdiction, regarding the accounting, finance, budgeting and asset rules, where spent.

Over the years, the Court has contributed to the reduction of risks associated with the regulatory model, corrected misconduct and recommended the adoption of improvements through monitoring and supervision of regulators' actions. In terms of ANEEL's role, the oversight of TCU allows more empowerment for the Agency. Looking to ensure the correct operation of entities within the "triangle of interest" that ANEEL manages (illustrated by Pedrosa, 2005, p. 3 and shown at Appendix 2). This includes the government and its public policies, the consumers and its interest in low tariffs, and investors and their need to be fairly paid. TCU oversees the ecosystem of this triangle of interest to ensure fairness in these relationships.

The actual oversight activity occurs in different stages[23]. The TCU's purpose is to prevent the occurrence of losses of public property, and to achieve the low tariffs and to improve the performance of the regulator. TCU does not replace or diminish the role of the regulator; instead, it checks and guarantees the regulator's function for the safety of the whole of society. TCU analyses the Agency and the government for acting in accordance with the laws and with due public concern. The Court does not assess the regulators'

[23] In general, the external control can be exercised by the Court prior, concurrent or subsequent to any government action. The last of these is the least effective if done after a lengthy delay from the action has been performed (for example: usually the grant has been awarded, the contract has been signed, the cost impact has already been incorporated into the public properties, the competition has already been eliminated, the action can no longer be transparent, amongst other issues). In another way, the prior control is extremely limited in application because the Court's actions are realized only after the manager took his decision. So, the concurrent oversight is the more effective control. In the concession monitoring, TCU performance is concomitant, concerning the process lawfulness and evenness, as well as the accuracy and consistency of economic and financial studies, cash flows and public notices.

options; it does not define what public policies are better or worse. These are not functions of TCU. The controller function of TCU monitors the results achieved by public policy from the end point of view (such as evaluating the results of government programs and actions), and from the point of view of the devices used (like the bidding process).

The external control done by TCU is not only good for Brazil but also consistent with international best practices on regulation. It follows the guidelines established by the International Organization of Supreme Audit Institutions (Intosai) and Latin American and Caribbean Organization of Supreme Audit Institutions (Olacef).

TCU assesses the performance of the regulatory agencies regarding institutional and management aspects. In terms of the regulated sectors, the TCU's oversight aims to verify regularity, efficiency, and transparency and improve the federal infrastructure sector management. As a result of this oversight, improvements are derived because regulatory agencies and other bodies that develop public policies and plan expansion and operation of the services do a better job. In the electric sector, TCU oversees performance and compliance by: monitoring concessions and contract compliance on power generation and transmission; assessing regulation regarding power distribution contracts, with particular attention to tariff reviews and adjustment mechanisms; by auditing governmental activities of planning, implementation, and by evaluation and regulation of public policies in areas that affect tariffs, quality, continuity and access to energy directly and indirectly amongst others.

In recent years, monitoring and decisions by the Court led to the amelioration of the bidding process, thus contributing to improved and strengthened methods employed by ANEEL. Some such gains in performance were seen in: refining and consolidating

methods to determine standards of company's cost of debt and cost of equity[24]; optimization of the amounts of forecast investment of hydropower plants[25] and transmission line projects (using the regulatory Agency's price bank)[26]; improvement of the environmental costs assessment associated with hydropower plant[27]; and more transparency in the definition of the allowable tariffs[28].

Recent audits highlighted that: there was no criterion of efficiency for subsidizing coal[29]; there were distortions in the methodology of tariff's readjustment[30]; there were some opportunities to improve the safety of the supply of energy[31]; and that it was important that ANEEL took adequate actions to stimulate the decrease of electric losses[32];and the necessary actions and information to facilitate the decision-makers about the final term of concession contracts starting from 2015 was not available[33].

Besides all the contributions for the achievement of the goals of public polices related to electricity service, its regularity, efficiency and effectiveness, the fundamental role of TCU's oversight is to ensure the transparency of the government and its agencies.

5.2. The Role of the U.S. Government Accountability Office (GAO)

The U.S. Government Accountability Office (GAO) is an independent agency in the legislative branch of the federal government. GAO works mainly at the request of congressional committees or subcommittees or is mandated by public laws or committee

[24]Acórdão 2.138/2007-Plenário.
[25]Acórdão 602/2008-Plenário.
[26]Acórdãos 1.032/2008 and 1.402/2011-Plenário.
[27]Acórdão 131/2010-Plenário.
[28]Acórdão 131/2010-Plenário.
[29]Acórdão 1.382/2011-Plenário.
[30]Acórdãos 2.210/2008 and 2.544/2008-Plenário.
[31]Acórdão 1.196/2010-Plenário.
[32]Acórdãos 2.211/2008 and 2.378/2010-Plenário.
[33]Acórdão 3012/2011-Plenário.

reports. GAO also undertakes research under the authority of the Comptroller General. GAO supports congressional oversight by: auditing agency operations to determine whether federal funds are being spent efficiently and effectively; investigating allegations of illegal and improper activities; reporting on how well government programs and policies are meeting their objectives; performing policy analyses - outlining options for congressional consideration; and issuing legal decisions and opinions, such as bid protest rulings and reports on agency rules (http://www.gao.gov/about/products/).

Compared with the TCU's experience, the GAO has been doing program evaluation longer. It has been doing this work since 1960.

GAO's mission is *"to support the Congress in meeting its constitutional responsibilities and to help improve the performance and ensure the accountability of the federal government for the benefit of the American people"*. It provides Congress *"with timely information that is objective, fact-based, nonpartisan, non ideological, fair, and balanced"* (www.gao.gov).

Similarly to TCU, GAO has an extensive portfolio of oversight reports about the electric sector. In this list, it is possible to note broad and very specific works. In the broad works, for example, the reader sees analyses about: electricity restructuring, the benefits of the regional transmission organizations [34] and lessons learned with the restructuring[35]; and energy markets, with the goal of evaluating FERC's oversight and enforcement capability[36]. On the GAO's specific works, there are reports about federal electricity subsidies[37], problems in California's restructured market[38] and its electricity's

[34]GAO-08-987 in www.gao.gov.
[35] GAO-03-271.
[36] GAO-03-845.
[37] GAO-08-102.

prices[39], and FERC's role in protecting consumers[40]. Particularly, there are some works about the smart grid[41].For example, it was observed that the necessity of updates in the electrical grid – the transmission and distribution systems – by integrating new technologies, additional IT in the operation of its systems/networks and enable real-time coordination of information from generation supply, demand, and distributed energy resources.

6. CHALLENGES AND ISSUES UNDER DISCUSSION

As reported before, in Brazil, day-to-day actions remain a challenge between the provision of a continual and universal service and an ever-present associated tension with quality and reasonable tariffs.

As electricity is a very important input in all industry supply chains, it is necessary to look for efficiency and reasonable price of energy aiming to increase Brazil's economic competitiveness.

In a system with the predominance of hydropower plants, there are always debates about environmental questions (demonstrated in the SWOT Analysis – Appendix 1). Although it is very healthy for ecologically sustainable electric system, sometimes these discussions affect the terms and conditions for generation plants. In the case of power plants, since 2004 for granting a concession for a hydropower plant it is necessary to have a prior environmental license however that is not the case for transmission lines. It is

[38] GAO-04-204 and GAO-02-828.
[39] GAO-01-857.
[40] GAO-03-726R.
[41] GAO-11-117 and GAO-09-944R.

important for the sector to discuss pros and cons of establishing rules obligating the prior issuance of an environmental licence before the process of granting a transmission line in order to reduce risks.

Despite there being a lot of challenges remaining in the electric sector (in its regulation, its oversight and its institutions' accountability), due to limitations of the scope of this analysis this section shows only the main current discussion underway by the electric sector in Brazil and the U.S. with the objective of finding some tips from their different realities.

In the case of Brazil, there are issues like the final term of concession contracts and its impacts over the electric system and the development of an environment conducive to a smart grid. With regards to the final term of concessions, there are not many parallels with U.S. system. But in the case of smart grid there is a lot of light to be shed on the matter comparing the U.S. to the Brazilian emerging experience.

6.1. Brazil: Final Term, the Achievement of New Auctions or Renewal of Concession Contracts

Since the 1988 Brazilian Constitution, it has been necessary to use auction processes to grant concessions that will be followed with a formal contract which must set the conditions for the service. But, only after 1995 were all the existing concessions contracts officially signed. Despite the fact that they were not granted competitively, the framework allowed a continuation of these contracts for twenty years because at that moment the government was more concerned about privatization attractiveness. As a result, all these contracts have been extended until at least 2015, based on provisions of existing law.

Today, the portion of the contracts in this situation involves approximately 20% of electricity generation, more than 70% of the transmission grid and 37 distribution companies from the current 64 existing around the country.

The present framework establishes the necessity of an auction to grant these concessions but there is an intense debate in Brazil about what the best way is to move forward: grant everything by an auction process or renew all the contracts.

The decision about these contracts must necessarily observe some boundary conditions provided by the legal framework, such as low tariffs, continuity, universal provision of public services, quality in service delivery, fair return for investors (to encourage them to expand the service), amongst others.

In case of reversal of concessions for the government, this must be preceded by prior compensation for any unamortized assets not already fully depreciated. There are several possibilities for compensation criteria to be adopted such as indexed historical cost, replacement of new value, and historical cost with correction.

In case of other extension, it is necessary to establish value for the assets, because this will be important data for establishing what tariffs will be allowed.

As highlighted by Nascimento (2011), in the process of defining the model to be adopted at the expiration of the concession contracts, there are various risks, including: legal uncertainty; lack of a clear criteria and an appropriate decision of the government to allow the decision-making of various actors, including the actual grantor; mistakes in data validation and information; and incorrect estimate of the economic and financial models. In practice, if not properly evaluated and executed, the option chosen will not minimize the associated risks and the following may occur: inhibition of investments, increased finance charges (with the reduction of the guarantees, mortgage rates for investment in existing

concessions can rise), discontinuity in the service, high tariffs, no guarantee of sustainability over the concessions term, reduced quality of service provision, increased costs for the industry, and impact on the competitiveness of the Brazilian economy, amongst others.

Aside from the risks, there are some opportunities such as: relocation of distribution concessions to areas providing greater efficiency and economies of scale (Kelman, 2009), reduction of electricity tariffs resulting from the appropriation of depreciated assets, increase in the competitiveness of the Brazilian economy, and signalling to all players the maturation of the involved institutions to make decisions with impartially and upon technical grounds. It is important to emphasize that these opportunities can improve all the system to the benefit of Brazil and its society. These opportunities are not exclusively to be decided for benefit of a "wailing pressure group", as warned by Hazlitt (1946).

Both the Ministry of Mines and Energy (MME) and the Brazilian Electricity Regulatory Agency (ANEEL), within their power limits, have arduous tasks to minimize the risks but more than that, they have opportunities that will arise in favour of better management in the provision of electricity in the country.

The external controller has the role of suggesting changes in methods and indicating failures, such as the recently identified lack of information for adequate decisions[42].

[42]Acórdão 3012/2011-Plenário.

6.2. A RELIABLE SMART GRID: A CHALLENGE FOR BOTH COUNTRIES

Smart grid is a change in the concept of an electric grid. It is much more than just electronic meters. It is *"an electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources to meet the varying electricity demands of end-users. Smart grids co-ordinate the needs and capabilities of all generators, grid operators, end-users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimizing costs and environmental impacts while maximizing system reliability, resilience and stability"* (IEA, 2011, p. 6). In fact the smart-grid includes the demand and the supply side. It also can allow a two-way path where the end-user can not only be a consumer but can also inject energy in the system.

Table 1 shows some characteristics of smart grids highlighted by the International Energy Agency.

Table 1. Some characteristics of smart grids (IEA, 2011, p. 7)

Characteristic	**Description**
Enables informed participation by customers	Consumers help balance supply and demand, and ensure reliability by modifying the way they use and purchase electricity. These modifications come as a result of consumers having choices that motivate different purchasing patterns and behavior. These choices involve new technologies, new information about their electricity use, and new forms of electricity pricing and incentives.
Accommodates all generation and storage options	A smart grid accommodates not only large, centralized power plants, but also the growing array of customer-sited distributed energy resources. Integration of these resources – including renewable, small-scale combined heat and power, and energy storage – will increase rapidly all along the value chain, from suppliers to marketers to customers.
Enables new products, services and markets	Correctly designed and operated markets efficiently create an opportunity for consumers to choose among competing services. Some of the independent grid variables that must be explicitly managed are energy, capacity, location, time, rate of change and quality. Markets can play a major role in the management of these variables. Regulators, owners/operators and consumers need the flexibility to modify the rules of business to suit operating and market conditions.
Provides the power quality for the range of needs	Not all commercial enterprises, and certainly not all residential customers, need the same quality of power. A smart grid supplies varying grades (and prices) of power. The cost of premium power-quality features can be included in the electrical service contract. Advanced control methods monitor essential components, enabling rapid

Characteristic	Description
	diagnosis and solutions to events that impact power quality, such as lightning, switching surges, line faults and harmonic sources.
Optimizes asset utilization and operating efficiency	A smart grid applies the latest technologies to optimize the use of its assets. For example, optimized capacity can be attainable with dynamic ratings, which allow assets to be used at greater loads by continuously sensing and rating their capacities. Maintenance efficiency can be optimized with condition-based maintenance, which signals the need for equipment maintenance at precisely the right time. System-control devices can be adjusted to reduce losses and eliminate congestion. Operating efficiency increases when selecting the least-cost energy-delivery system available through these types of system-control devices.
Provides resiliency to disturbances, attacks and natural disasters	Resiliency refers to the ability of a system to react to unexpected events by isolating problematic elements while the rest of the system is restored to normal operation. These self-healing actions result in reduced interruption of service to consumers and help service providers better manage the delivery infrastructure.

According to the U.S. Department of Energy (2004, p. 32), there are a wide variety of smart grids projects in progress in the U.S. Some of these projects are in a demonstration phase and are supported by the taxpayers[43] and other projects are working only as a test of strategy in the market. But the U.S. authorities understand that is necessary to design some guidelines for the development of a smart grid with at least a minimum degree of standards. Summarizing, the concerns about the smart grid include "*the development of interoperability standards for inter-system communication, system security, wide-area situational awareness, demand response, electric storage, and electric transportation should be prioritized and accelerated"* (FERC, 2009, p. 3). In the case of security, it is highlighted the necessity of a "*guidance that promotes or requires action to enhance the confidentiality, integrity, and availability of computer systems"* (GAO, 2011, p. 18), in the other words, cybersecurity.

In terms of reliability and cybersecurity, the North American Electric Reliability Corporation (NERC) is the electric reliability organization certified by the

[43]The American Recovery and Reinvestment Act, know as the Stimulus or The Recovery Act, is an economic stimulus package enacted in 2009 in response to the late-2000s recession. It allows financing up 50% of projects of smart grid.

Federal Energy Regulatory Commission to establish and enforce reliability standards for the bulk power system in U.S. under commission's oversight. NERC standards are subject to FERC oversight, review, and approval.

The U.S. initiatives pertaining to a smart grid have been underway for some years with progressive public policy, specially: the Energy Policy Act, enacted in 2005, and the Energy Independence and Security Act, enacted in 2009. The first one stimulated the use of smart meters and tariffs according to the level of demand. The second one defined the characteristics and objectives of a smart grid.

In the Brazilian case, although a smart grid would show all the characteristics listed in table 1, it is important to talk about the main advantages for the distribution companies and for the consumers. For the concessionaries, it represents reduction of operational costs and reduction of losses from the theft of energy. For the retail consumers, if associated with a demand response program, there is an opportunity to manage his energy demand with efficiency according to a signal of price. Demand management could be done directly by the consumer or the distribution company could be allowed to manage demand at the point of consumption for the small consumers using the smart grid[44].

Another possible application for smart grid initiatives are the integrate use of the electric nets to provide communication using the technology of broadband over power lines. In a country like Brazil where there are vast challenges to universal access to broadband, this is an option yet to be evaluated.

International experience (as summarized by Lamin, 2009) shows that the decision to commit to an electric smart grid build depends on the vision of the future. It

[44]For instance, in some areas in U.S., as in the state of Virginia, the distribution company can manage the demand of energy of a householders using smarts device to air conditioning cycling.

can be developed as a strategy of market of distribution companies or follow the path defined by regulators. It is sure begin with the change of old electro-mechanic (or other old model) meters for smart electronic meters, such as what happened in U.S. But even this change of devices needs to be coordinated to prevent premature obsolescence, ensure fair payment for the prudent investment, and guarantee fair tariffs for the consumer.

Today, some Brazilian distribution companies are using electronic meters in low tension applications. According to ANEEL (2009, p. 8), 7.5% of the Brazilian low tension meters are electronic. But most of them have the same functionality as the old electro-mechanic meters: they are used only to measure the total consumption of energy. This fact is associated with the decreasing price of electronic meters. Only a few pilot projects are employing more useful electronic meters. In Brazil, even the more sophisticated models of meters do not support a smart grid with all the characteristics shown in table 1 but they at least allow central measurement or remote communication (including cutting and rewiring the consumer). This is the case because distribution companies are concerned much more with diminishing their operational costs than with building an intelligent and efficient grid. It is important to take advantage of this moment for all the system, allowing and stimulating the concessionaries to be more efficient.

The analysis of issues related to a smart grid includes: what the needed minimum standards of the Brazilian meters are to bring more efficiency to the electric system; and, as it can provide benefits for both consumers and concessionaries, who is going to pay for these. If both the government and the regulatory authority wait for the market forces to direct the correct actions, the reality will be that the concessionaries will do their best seeking only to maximize their profits, without bringing advantages to the

consumer or improvements to the efficiency of the system. Thus, it is necessary for the authorities to provide some guidelines.

The cost part in a cost-benefits analysis is easy to calculate: it can be represented by the payment for the investment of the distribution companies to change more than 62 million of meters in low tension[45] (plus other necessary equipment and IT infrastructure) and the cost to throw away some of the old meters not yet fully depreciated. But the benefits part is a little more complicated. It is necessary to understand and quantify how much more efficient the system will be especially with: demand side management (with a possible change in the peak of consumption followed by a consequent reduction of dispatches of thermo power plants and a deferral in new investments in transmission lines and in distribution); reduced energy losses; reduced operational costs; increased revenue by offering new products and services; and new business models like pre payment of the energy (like the telephone service) amongst others.

Moreover, the implementation of a smart grid can provide the development of a more competitive market, because it can enable opening of the market for the consumer's choice (as in the model that today is reserved for the consumers in medium or high voltage categories who can choose suppliers in the "free market environment"). This option can stimulate the competitiveness of other kinds of "green energy" (like that generated from the garbage or photovoltaic systems from the household rooftop) enabling households or small producers to trade energy with the utility under a net-metering arrangement.

[45] The cost of a smart meter depends on the type of equipment, configuration and the infrastructure of communication used. The medium price of a two-way model is $250 each. Simplified, the cost of the change of all meters in Brazil will be more than $16 billion. Excluding other costs, it alone represents a large investment!

ANEEL recently approved new rules for the structure of tariffs that allow a demand-response program using tariffs ("white tariffs"[46]) which will be associated with changes in the meters. In the case of the meters, the rules are still under evaluation of ANEEL. The Agency is conducting a series of public hearings to discuss the guidelines for a minimum standard for the electronic meters. Although this process is not finished, there is a risk that the regulator will leave matters to the distribution companies to evaluate their strategy of market to change the meters. The building of a really smart grid is complex and broad and is substantially more than an issue of regulation or technology. It is a matter for a public policy debate which needs to be widely discussed by many stakeholders.

With the maturation of the Regulator's processes and decisions, TCU will need to audit the performance of the options chosen and measure their compatibility with current public policies and laws (or the lack of compatibility for that matter).

7. FINAL REMARKS

The objective of this paper was to perform a comparative review between Brazil and U.S. framework changes, their regulatory authorities' chief missions, their external controls provided by the Brazilian Court of Audit (TCU) and the Government Accountability Office (GAO), and today's challenges.

Despite the differences between these countries and their entities, this comparative study provided an overview of changes experienced (some common, some totally different) by both and gives some tips for improving Brazil's future.

[46]Resolução Normativa-Aneel n. 464/2011, approving the change in the tariffs' structure.

First, in the most elementary of comparisons, it is necessary to pay attention to the fact that the Brazilian electric system is based on hydropower plants. Investments in these plants are intensive of capital and demand some guarantees (like those provided by long-term contracts). Moreover, electricity prices today depend on the prospect of the future hydrology. The U.S. supply is largely associated with fossil fuel plants.

In Brazilian electric sector history, it was highlighted that it provided the country with some important economic and sustainability lessons. For example: how price set by policies and, more than that, how macroeconomics objectives hurt the system; how important it is for the government to study projects thoroughly for setting planning guidelines; and how the market responds to freedom in the absence of basic regulation.

In both the U.S. and Brazil, the role of regulatory authorities is indispensable for a safe and healthy system. The American experience of restructuring shows that, even in a free market environment, the regulator needs to oversee and to provide supervision to ensure that prices are fair and there are no unacceptable practices. This notion has been completely applied to the Brazilian reality. For that, transparency has been indispensable and the Brazilian Court of Audit (TCU) and the Government Accountability Office (GAO) have fundamental roles in improving the states and its independent agencies' actions in benefiting of their societies.

The challenges for Brazil with the final term of concession contracts and the smart grid initiatives are large but more than that, they are opportunities to move forward.

Maturity is necessary of all the institutions in conducting affairs in infrastructure sectors, especially in an essential service like the electricity. Competition is very healthy when possible. The maturity of institutions will contribute to an environment conducive to competition taking place.

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APPENDIX 1 – SWOT ANALYSIS

SWOT analysis: before and after the current Brazilian framework, enacted in 2004.

Before

Strengths	**Opportunities**
Electricity system centralized operation Past history of planning (in fact, it was a centralized government plan)	Time of transition of 1998's model External capital looking for opportunities of investments Improve the environmental license process (hydropower plants)
Weaknesses	**Threats**
Low reliability Growth of tariffs No universal access for energy No incentives for competition and for investments No guidelines established by the government (no long-term plan) Destruction of human capital during the process of privatization Conflicts of competence or regulatory vacuum The environment was not prepared for the competition without damaging the reliability of the electric system	Unfinished privatization process No incentives for creating of engineer professional critical mass Environmental issues

After

Strengths	**Opportunities**
Creation of a heath environment for competition during the grants Creation of the environment for a free market (allowed only to big consumers) Government plan the guidelines with the contribution of all the agents and companies Regulatory stability Clear role of institutions	Increase the Brazil's economy competitiveness Discuss the environmental license (prior license of transmission's line)
Weaknesses	**Threats**
Pressure of market to change the rules Increasing tariffs	Low knowledge of the engineers' corps Environmental issues

APPENDIX 2 – TRIANGLE OF FORCES

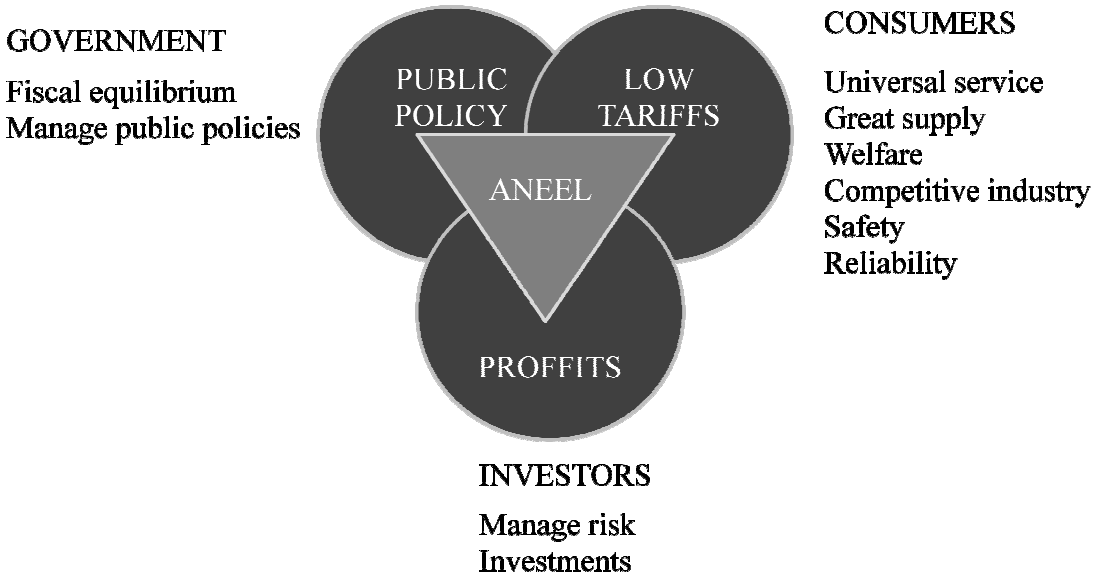

Figure 1. Balance between visions of government, consumers and investors (Pedrosa, 2005, p. 3, with adaptations)