FINAL REPORT

Brazil - Case Study

Project: Energy Planning

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The author of present document is Sergio Valdir Bajay.

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Executive Summary

The policy of using federally- and state-owned companies as the main operators in the Brazilian energy supply industry succeeded up to the mid-1980s, with low prices and adequate supply to fuel Brazil's economic development. However, the policy had also led to a number of missteps, including:

(i) the artificially low tariffs for electricity, mirroring most public service tariffs set by the federal government, in often vain efforts to control high inflation rates;

(ii) the political misuse of electricity supply and gas distribution utilities, involving incompetent and often corrupt management and the initiation of construction of several plants, particularly electric power stations, primarily to reap political benefits to some politicians, but without the necessary funding to finish them on schedule; and

(iii) the unmet desire of the federal government to have substantial and fast increases in domestic production of oil and gas.

Changes were undoubtedly needed in the Brazilian electric power sector during the middle nineties. Some of the partial deregulation measures had positive results. A substantial insertion of sizeable private agents in the whole production chain (generation, transmission and distribution) can be mentioned, together with efficiency gains, which brought much more benefits to the producers than to the consumers. As well, there have been a growing number of free consumers, medium to large size users that reaped large benefits from cheap surplus power in the free market from 2003 to 2006.

The privatization-for-cash approach to reform, however, generated early income for the government but did not resolve key problems in making the power business a profitable and reliable enterprise. The new institutional model did not consider forward planning for the expansion of generation, a fatal error that precipitated the subsequent shortage in 2001.

Despite the end of its legal monopoly, Petrobras, the Brazilian state-owned oil company, still produces, imports and transports most of the natural gas consumed in the country. The company is also a partner in the majority of gas distribution utilities in Brazil. Even if electricity deregulation can yield a competitive generation market with many price-taking sellers, its success in delivering low and stable prices is unlikely in the presence of dysfunctional input markets, as is the case with Petrobras continuing to dominate the natural gas and gas pipeline markets.

Long-term generation marginal costs have been increasing in Brazil because new hydro power plants are located far from the main load centres, resulting in high costs for transmission and environmental mitigation. The overall effect is that Brazil has been seeing rising tariff levels.

As pointed out by the power sector agents and analysts during the discussions that preceded the enactment of the new institutional model for the Brazilian electric power sector, the main challenges that it will face are: (a) the difficulty to forecast electricity demand 5 years in advance and to provide a portfolio of bilateral supply contracts to meet 100% of such forecast; (b) the risk of the Ministry of Mines and Energy (MME) unrealistically capping the price of the "new energy" auctions to hold down tariffs; (c) the eventual inability of MME to formulate clear and stable energy policies and realistic forward plans; (d) the need to facilitate the negotiations with the government bodies responsible for environmental and water resources regulations in the country; (e) lack of definition about the roles to be played by the state-owned companies in the sector; and (f) assurance of autonomy and financial resources for a stable regulatory framework.

The new institutional model for the power sector brought major changes to energy planning in the country. There are, now, integrated medium and long-term plans for the whole energy industry. The former provide the background information for MME to organize auctions for new power plants, transmission lines and oil and gas exploration fields; they are updated every year. The latter are purely indicative; the Energy Reserach Company (EPE) and MME intend to update them every two or three years.

Despite the progress of recent years, energy planning in Brazil still has some shortcomings and also suffers from problems both "upstream" and "downstream" of the planning process.

Upstream of the planning process, there is a lack of clear, long-term policies, from MME or the National Council for Energy Planning (CNPE), for several important issues and, consequently, EPE/MME's plans should resort to many assumptions without a strong political support, diminishing the credibility of the forecasts.

Downstream of the planning process, the results of the "new energy" auctions carried out so far do not match what have been forecast in EPE/MME's plans. One of the reasons for this strong divergence between plans and reality is the lack of enough candidate hydro plant projects, due to environmental licensing problems. Another reason comes from the procedure used by EPE to calculate the cost-benefit index employed to classify the candidate thermal power projects during the "new energy" auctions; this procedure favors plants that are highly flexible to operate but have high variable unit costs and cause much pollution.

The government plans for the oil and gas industries go on following the track of Petrobras' plans for these industries, and not the other way round.

There is not yet guarantee of convergence between the demand and the supply-side studies and between the energy sector plans and plans for other sectors of the economy. Progress in these directions will only be achieved with the use of partial and general equilibrium models, as is happening in several countries for already some years.

The Brazilian experience and the other study cases carried out in this project reveal that a hybrid institutional model is emerging in the energy markets evaluated, where private enterprises and state-owned companies compete with each other in an increasing way, but also have joint undertakings, particularly in the oil and natural gas industries and, also, in large hydro power projects.

Most of the planning experience of the Latin-American countries evaluated in this project is concentrated in the electric power sector, particularly in the operation planning of their hydrothermal power systems. Integrated planning of the whole energy system is still in an early stage.

Long-term energy planning, when exists, has been considered much less important than medium-term planning and few or no interactions happen between them. The lack of clearly defined long-term energy policies, with targets to be achieved, is the main constraint to further developments of long-term energy planning in Latin-American countries.

Regulation of the energy markets is slowly getting consolidated in the continent, but the institutions charged with these tasks still have little autonomy from the government and, in general, they do not know how to use effectively, in their regulatory tasks, the results contained in the energy plans.

1. Introduction

Each stage in the development of the Brazilian energy industry (Bajay, 2009) and the institutional environment surrounding it produced benefits; at some time, however, serious problems occurred, which forced the birth of the next stage. These benefits and problems are discussed in this report, together with the challenges facing the current institutional framework of this industry.

An important section of the report for this project presents the evolution of energy planning in Brazil and current shortcomings.

In the following section, comparisons are made about the experiences of Brazil, Colombia, Chile and the Canadian provinces of Toronto and Alberta in what concerns the institutional frameworks of their energy industry, their energy policies, planning procedures and regulatory practices.

At the end of the report, some general conclusions are put forward about the recent evolution of energy planning in Latin America.

2. Benefits and drawbacks in the Brazilian energy industry when it was dominated by state-owned companies

The policy of using federally- and state-owned companies as the main operators in the Brazilian energy supply industry succeeded up to the mid-1980s, with low prices and adequate supply to fuel Brazil's economic development. However, the policy had also led to a number of missteps, including (Bajay, 2006):

(iv) the artificially low tariffs for electricity, mirroring most public service tariffs set by the federal government, in often vain efforts to control high inflation rates;

(v) the political misuse of electricity supply and gas distribution utilities, involving incompetent and often corrupt management and the initiation of construction of several plants, particularly electric power stations, primarily to reap political benefits to some politicians, but without the necessary funding to finish them on schedule; and

(vi) the unmet desire of the federal government to have substantial and fast increases in domestic production of oil and gas (Bajay, 2004).

Discussions about institutional changes to correct the problems dragged through several governments and lasted nearly a decade, up to the time when a deep financial crisis in the electricity supply industry required urgent action.

3. Benefits and problems brought by the Brazilian electric power sector deregulation

Changes were undoubtedly needed in the Brazilian electric power sector during the middle nineties (Bajay, 2006). Some of the partial deregulation measures had positive results. A substantial insertion of sizeable private agents in the whole production chain (generation, transmission and distribution) can be mentioned, together with efficiency gains, which brought much more benefits to the producers than to the consumers (Mota, 2003). As well, there have been a growing number of free consumers, medium to large size users that reaped large benefits from cheap surplus power in the free market from 2003 to 2006.

3.1 The Government priority was state debt reduction

When deregulation started, the Brazilian government's main priority was new revenue from the privatization of the utilities, to be used to reduce debt and promote economic growth. There was little attention to market development and overall efficiency gains in the industry (Brown, 2002). The majority of state governments that privatized their own utilities followed suit. The adopted model was a tight power pool like the Pennsylvania-Jersey-Maryland (PJM) inter-connection, with centralized dispatch of the main power stations and transmission lines, free negotiation of long-term bilateral contracts and a small spot market. This model did not consider forward planning of generation expansion, a fatal error that precipitated the subsequent shortage in 2001 (Bajay, 2006).

Under the privatization program, which took place before a regulatory structure was established by law and organized (Baer and McDonald, 1998), government-owned generation and distribution companies were sold to private investors to raise US$21 billion mainly to service public debt, of which US$17.5 billion came from the sale of state utilities and only US$3.5 billion from the sale of federal companies (Barbosa and Francato, 2004). Preoccupied with raising revenue, the government decided to adopt the revenue maximization criterion to select the winning bids in the auctions to grant concessions for the construction of new hydro power plants.

3.2 The perception of risk was high among private investors and eligible free consumers

The reform envisaged that private investors would assume key roles as owners and operators of the power system, under the control of an independent regulator. The role of the Ministry of Mines and Energy (MME) would be limited only to empowering the regulator and providing strategic policy guidance (Barbosa and Francato, 2004). The state-owned generation utilities were not allowed to be major partners in new generation undertakings.

The privatization-for-cash approach to reform generated early income for the Government but did not resolve key problems in making the power business a profitable and reliable enterprise (Oliveira, 2003).

Under the rules then prevailing, generators were exposed to market, thus facing both sale and price risks. If demand was too low, generators risked not to find buyers, even at low prices. Worse yet, hydropower reservoir storages are usually full during wet years, so that generators can not sell their outputs at profitable prices. During shortages, generators were often forced to supplement their output to meet delivery obligation by buying in the spot market at very high market prices. In either case, spot market price signals did not induce generation expansion by investors (Barbosa and Francato, 2004).

There was and still is a lot of uncertainty concerning the granting of environmental licenses and the magnitude of the environmental impact mitigation costs of hydro plants. The same applies to natural gas prices for combined cycle thermal power plants, since these prices are regularly updated according to the Brazilian currency (Real), exchange rate and to a basket of oil prices (imports from Bolivia). To forecast electricity demand and the corresponding cash flow for the utilities is a challenging task in Brazil, plagued by the often large swings in the growth of the local economy and, to a lesser extent, in the tariffs as well.

Given such uncertainties, several Brazilian distribution utilities turned to affiliates to contract long-term generation, particularly from combined-cycle gas-fired plants, to meet forecast load growth (Bajay, 2006), as done elsewhere (Orans et al., 2004). But if generation investment can only be supported through affiliate transactions, deregulation has failed to foster independent power production by competitive generators.

Frustrating the expectations of the federal government, few eligible "captive" electricity consumers[1] opted to become "free" consumers in the first years of deregulation of the power industry in the country because of the cross-subsidies under past regulations for energy-intensive large consumers. Recognizing this distortion, but concerned about likely losses in export revenues and short-term job losses if large tariff increases are imposed on the energy-intensive industrial branches, the previous federal administration decided to spread these increases along 4 years, at 25% per year (Decree No. 4562, December 31, 2002). The current administration has decided to extend the transition period to 5 years, with just a 10% increase in 2003, provided that the interested energy-intensive industrial consumer invests in generation expansion (Decree No. 4667, April 4, 2003) (Bajay, 2004).

Despite the rate subsidies, retail competition market grew substantially from 2002 to 2007, because of the cheap surplus power available in existing hydro power stations during that period. Commercial and industrial consumers experienced 10-30% savings over the utility default rates along those years.

3.3 Increasing tariff levels

Long-term generation marginal costs have been increasing in Brazil because new hydro power plants are located far from the main load centres, resulting in high costs for transmission and environmental mitigation. The overall effect is that Brazil has been seeing rising tariff levels.

The rising tariff levels was partly due to the federal government's belief that the private investors, under the new rules of the Brazilian electrical power supply industry, would prefer to build efficient, combined cycle gas turbines (CCGT). In 1999, the government launched the Gas-Fired Thermal Power Plants Priority Plan (PPT) to mitigate CCGT investment uncertainties, particularly those related to the future evolution of gas prices. However, CCGT expansion did not materialize; and most of gas-fired stations which were actually built counted on a strong participation of Petrobras (e.g., fuel supply and power purchase). The sharp devaluation of the Brazilian currency from 1999 to 2003 and high oil prices, however, made CCGT uneconomic until recently.

3.4 Lack of competition in the natural gas supply industry

Despite the end of its legal monopoly, Petrobras still produces, imports and transports most of the natural gas consumed in the country. The company is also a partner in the majority of gas distribution utilities in Brazil and the sole owner of the State of Espirito Santo's utility. Even if electricity deregulation can yield a competitive generation market with many price-taking sellers, its success in delivering low and stable prices is unlikely in the presence of dysfunctional input markets, as is the case with Petrobras continuing to dominate the natural gas and gas pipeline markets (Bajay, 2006).

3.5 Lack of concerted action between the Ministry of Mines and Energy and the sector's regulatory agency

The previous federal administration over-estimated the ability of ANEEL, the new regulatory agency for the power sector. Policy making and planning activities were considered to

[1] Initially, there were consumers with demands of 10 MW and higher connected at 69 kV and above. The size threshold was reduced to 3 MW in July 2000 and remains so to date.

be of secondary importance and left to the Ministry of Mines and Energy (MME). As a result, non-concerted actions occurred. A case in fact is the auction of whatever hydro power plant projects that ANEEL determined to be economically feasible, without fully considering their environmental impact. At the same time, the MME was betting on the Gas-Fired Thermal Power Plants Priority Plan, which did not lead to substantial generation investment. Sadly, the end result was the electricity shortage of 2001.

4. Challenges for the new model

As pointed out by the power sector agents and analysts during the discussions that preceded the enactment of the new institutional model for the Brazilian electric power sector, the main challenges that it will face are: (a) the difficulty to forecast electricity demand 5 years in advance and to provide a portfolio of bilateral supply contracts to meet 100% of such forecast; (b) the risk of MME unrealistically capping the price of the "new energy" auctions to hold down tariffs; (c) the eventual inability of MME to formulate clear and stable energy policies and realistic forward plans; (d) the need to facilitate the negotiations with the government bodies responsible for environmental and water resources regulations in the country; (e) lack of definition about the roles to be played by the state-owned companies in the sector; and (f) assurance of autonomy and financial resources for a stable regulatory framework. Each of these points is discussed below, together with some recent problems, which were discussed in a workshop promoted by the Federal University of Rio de Janeiro, last March, in the 5th anniversary of the new model.

4.1 Problems to fully meet the forecast demand with medium to long-term contracts

The new model specifies that each distribution utility should use medium- and long-term power purchase contracts to fully meet the forecast demand of for the next 5 years. As such, the distribution utilities have the responsibility for making the forecasts. The model also defines the types of auctions used to fulfil the previous requirement (Bajay, 2006).

Over-contracting can be settled in a short-term market. Trading losses, if under 3%, will be passed through to the tariffs. The distribution utilities absorb losses that exceed 3% and retain all trading gains.

The distribution utilities argue that forecasting electricity demand 5 years in advance is a challenging task in Brazil that often has large swings in the economy. They also found the 3% loss ceiling too low. The generators, in the other hand, are concerned with credit risks posted by some distribution utilities that are the counter-party of the bilateral power contracts.

Five years of experience with the new model, however, showed that both market agents – distribution companies and generators – over-rated their concerns. In the other hand, however, there are evidences that the generators are not selling all their potential output in long-term contracts and that the electricity demand forecasts are being manipulated, to some extent, by the distribution utilities, to take advantages of price expectations in both the "new energy" auctions and the "adjustment auctions". Also, "self-dealing" is occurring in the "adjustment auctions", i.e., distribution utilities are buying energy from suppliers belonging to their controllers, at prices above the average in these auctions. These behaviours prove that some speculation in the spot market is inevitable when you have any degree of competition in the market place; the Brazilian model for the power sector should acknowledge this fact sooner or later.

4.2 Eventual manipulation, by MME, of the ceiling prices of the "new energy" auctions

According to the new model, MME establishes ceiling prices for both "old energy" and "new energy" auctions. As the Ministry is concerned with holding tariffs down, the generators fear that these ceiling prices could unrealistically be kept down, particularly in the "new energy"

auctions, where high price ceilings are required to induce new generation.

In the auctions carried our so far, low ceiling prices in some of them actually kept away some generators and some plant types, without, however, frightening all the interested sellers out of them.

MME can organize auctions for specific types of power stations, or auctions open to all technologies. The auctions can envisage purchases of energy, of capacity, or both. If, in one hand, all auctions so far attracted some kind of interested seller, in the other hand, they attracted much more thermal power generators burning highly polluting fuels as fuel oil or coal, and selling their power through capacity contracts, than envisaged in the government plans. This problem reveals a certain inability of the Ministry in designing the auctions types and rules, and, also, their timing, as is explained later in connection with the difficulties EPE is finding to get the environmental licences for the new hydro power plant projects sent to the auctions.

4.3 Eventual inability of MME to properly play the central role it has in the model

The new institutional model assigns a central role for MME to formulate clear and stable energy policies and, helped by the Energy Research Company (EPE), to produce realistic forward plans.

EPE is a new state-owned company, created in 2004, to produce energy plans, under request of MME. Even though EPE's funding seems adequate and its staff is experienced, there are concerns about the ability of the new company to perform this task well, at least in the short-run, because no government body or state-owned company in Brazil had any significant experience with integrated expansion planning for the whole energy sector in the country. EPE's eventual success will depend on its ability to produce not only optimized but also realistic expansion plans, which require, besides a well qualified staff and a good data base, frequent and high level interactions with the market agents. Such interactions have been scarce so far.

Separately, MME has always been depending on Eletrobras and Petrobras to formulate energy policies and carry out planning exercises for the electric power and the oil and gas industries. Neither the previous nor the current federal administration (so far) succeeded in overcoming MME's recurrent structural problems of inadequate funding, lack of skilled staff, and poor management.

Although the quality of the first medium and long-term forward plans produced by EPE and approved by MME has been acceptable, the results of some of the auctions carried out so far for new power stations did not stick to them.

4.4 Decentralization of policy making and planning in the energy supply industry

Brazil has an advanced body of legislation concerning the environment. Enforcement of this legislation, however, has had failures, mainly due to short budgets of the regulatory bodies at both federal and state government levels (Bajay, 2004).

Environmental policies and regulation activities are decentralized in Brazil, involving not only federal and state government bodies, but also municipal ones.

The same kind of decentralization was established by Law No. 9433, of August 1, 1997, for water resources. This law created a new agent, the Hydrographic Basin Committee (Barbosa and Braga, 2003), comprising representatives of municipalities who are responsible for elaborating a Hydrographic Basin Plan and setting the priorities of water usage in the basin. Needless to say, this committee is very important to the interests and activities of the energy supply industry.

So far there has been little coordination between environmental and water resource policies, in one side, and energy policies, in the other. This worries the power sector agents, since the practical effects of this lack of concerted government actions are difficulties in and high costs of obtaining environmental licenses and water rights for hydro power. Moreover, the centralization of energy policy making and planning in the federal government goes against the decentralized

counterparts in the environmental and water resources fields, making agreements and joint actions more difficult to carry out.

It is impossible to develop a single objective or solution that satisfies all interests, all players, and all political and social viewpoints, in a country of great diversity such as Brazil. Perhaps neither centrally directed, command-to-control, nor purely private sector approaches provide the organizational model needed to plan and manage large-scale mainly hydroelectric power systems. Nevertheless, good trade-off solutions will certainly require a comprehensive management framework, with roles for representatives of electricity supply utilities, environmental and water resources agencies, water managers, community leaders and citizens in long-term coordinated efforts to identify, negotiate, and implement the actions that are needed ((Barbosa and Braga, 2003).

One of EPE's attributions is getting the environmental licences for the new power station projects sent to the auctions. Giving this responsibility for EPE was a big step forward, since this forces two institutions linked to the government– EPE and the licensing agency, but in opposite sides in what concerns environmental issues, to negotiate. Nevertheless, as already mentioned in section 4.2, EPE is finding a lot of difficulties to get these licences in due time for new hydro power plants, what causes the distortions between EPE's plans and some auction results referred to before.

4.5 Lack of clearly defined roles to be played by the state-owned companies in the power sector

State-owned companies serve several purposes. They participate both in natural or legal monopolies, and as partners of investor-owned companies; also, they carry out special projects of strategic or social value for the government. Moreover, they may compete with investor-owned companies and, eventually, with other state-owned companies. In the latter case, depending on their importance in oligopolies and provided they do not enjoy unfair advantages, the government can employ them as price-makers, preventing market power abuse by private competitors. This actually happened in the auctions of two hydro power station projects in the Madeira river, in December 2007 and May 2008, thanks to the participation of state-owned generation utilities as partners of the main private competitors in these auctions.

Despite some success stories, state-owned and investor-owned companies sharing competitive markets is always controversial, requiring clear-cut rules which define the objectives of the former and the boundary conditions under which they should operate. Of particular concern is the existence of a "Chinese wall" between their strategic/social and competitive activities.

The current federal administration ceased the privatizations carried out by the previous administration, however did not define clearly the roles to be played by the state-owned electricity utilities such as Furnas, Chesf, Eletronorte and Eletrosul, and also by the powerful Petrobras. The latter, as done by many other oil and gas companies throughout the world, is entering the electricity generation business.

Petrobras has total control or is a partner in 15 gas-fired thermal power stations in the country (http://www.petrobras.gov.br, consulted in 03/02/2009). According to the latest version of the company's strategic plan, US$11.8 billion should be spent from 2009 to 2013 in the gas and electricity businesses.

Private generators argue that without clear guidelines from the government, state-owned generators may bid their energy in the auctions well bellow marginal prices. This already happened with some generators in the auctions of December 2004 and April 2005 (Bajay, 2006).

4.6 Autonomy of the power sector regulator

A stable regulatory framework is essential for the success of the new institutional model for the Brazilian power sector. This requires that the autonomy of ANEEL should be assured, and also the financial resources necessary for a good performance of the agency. Unfortunately, this is

unlikely to occur.

The current federal administration overvalues the policy making and planning activities of MME, relegating regulation to a secondary position, an exactly opposite stand of the previous administration, whose supporters are now in the opposition. The government also sent to Congress, in 2004, a controversial project of law defining general rules for the external control, by the associated Ministries of State, of all federal regulatory agencies. This project raised a very strong opposition and is still dragging in Congress.

Another important point frequently discussed in Congress and the press is the recurrent practice of the Ministry of Planning to withhold part of the revenue of such agencies (collected through specific levies defined in laws). This happens in order to help the achievement of targets fixed by the government for public account surpluses.

The different views between government and opposition regarding the autonomy of the regulatory agencies represent a major source of uncertainty for the market players now. It also means that major changes may still come to the sector's institutional model if the political parties, which are now in the government, loose the next presidential election.

4.7 The current stagnation of the "free market"

The number of medium to large consumers of electricity in the Brazilian "free market" increased from 34, in 2004, to 651, in December 2008, after reaching a peak of 694 free consumers in October 2007. The free market was responsible for 23.2% of the electricity traded in the Brazilian Interconnected System (SIN) in December 2008 (Machado, 2009).

The free market swelled so fast in just a few years because of the cheap surplus power available from 2004 to 2006. This cheap power, however, is now over, and the free market agents are pessimistic about new sources of cheap power for them in the future, at least in the short or medium-term. The reasons for this pessimism, that stagnated the growth of the free market in Brazil (Silva, 2009), are: (i) the increasing difficulties to obtain environmental licences for large hydro power plants, which can generate cheap electricity; (ii) the current high costs of the other generation alternatives; and (iii) the recent successes of the federal government to use some features of auction design and partnerships involving state-owned companies to arrive at low electricity prices in the regulated market, at the expense of the free market.

Besides setting the ceilings for the "new energy" auction prices, the government also has another powerful tool in designing these auctions: the share of the auctioned power stations' output that should be sold in the regulated market; the rest can go to the free market. In the auctions of the Santo Antonio and Jirau hydro power plants, both in the Madeira River, carried out in Decembre 2007 and May 2008, the low prices of R$ 85.01/MWh and R$ 74.81/MWh, respectively, were achieved for the regulated market because two state-owned companies were partners of the two largest private building companies in the country competing fiercely for the construction of these plants and, also, because the government reserved 70% of these plants output for the regulated market; the remaining 30% was sold in the free market at prices in the range R$ 130–140/MWh. Obviously, free consumers "cross-subsidizing" regulated ones is not sustainable in the future.

The current institutional model of the Brazilian power sector does not allow consumers of the free market to trade eventual surplus power in their contracts outside the spot market, where prices are determined by marginal costs determined by the Electricity Trading Chamber (CCEE), with the help of the computer programme Newave. The Brazilian Association of Electricity Traders (Abraceel) and the Brazilian Association of Large Industrial Consumers (Abrace) have been campaigning for years the free trading of such surpluses and, also, the setting up of demand-side bidding mechanisms in the free market; they also demand free access to the auctions of the regulated market (Pedrosa, 2009; Lima, 2009).

4.8 High prices of electricity in Brazil

A power supply system made up by a majority of medium and large hydro power stations provided cheap electricity in Brazil for decades. This picture, however, has been changing in the current decade.

Growing marginal costs are one of the reasons, particularly for generation. The majority of new power stations brought on line recently, or that win the "new energy" auctions are thermal power plants, with generation costs higher than those of hydro plants (Neiva, 2009). Even the costs of the latter have been growing, because the new hydro plants are located farther from the main load centres than beforehand, requiring long transmission lines, and because the costs of supposedly[2] mitigating environmental impacts have been soaring[3].

Generators (Menel, 2009; Calou, 2009) and large consumers have been proposing to the federal government, in the last years, the creation of a strategic reserve of hydro power potentials.

The taxes and levies of several kinds charged by both federal government and state governments to electricity consumers in the country have also been growing in the current decade. According to the Brazilian Association of Electricity Distribution Utilities (Abradee), taxes and levies represent today 41% of the average residential tariff. Just taxes constituted 35% of the average industrial tariff in 2004 (Neiva, 2009). These percentages are among the largest in the world. These growing taxes and levies are destroying the international competitiveness of several electricity-intensive industrial branches (Lima, 2009), which are important in the Brazilian industry and contribute substantially for the country exports.

Electricity tariffs, which in Brazil are set for the concession areas of distribution utilities, have increased more in large regions with low load density; distribution networks with long radial lines and high losses; areas with local, small or medium-scale and high-cost thermal generation; and places with high levels of electricity thefts (Salomão Filho, 2009)[4]. This fact have motivated claims of return to tariff equalization, as occurred in the seventies and eighties, or, at least, some degree of cross-subsidies among concession areas (Ramos, 2009; Salomão Filho, 2009). Redefinition of such areas, putting together low cost and high cost concessions (Santana, 2009), would be another possible solution to this problem, with certainly many legal issues to tackle.

The new model of the Brazilian power sector gave two big steps forward to attenuate the growth of electricity prices in the country: the mandatory use of auctions in the regulated market and the separation between "new", more expensive, and "old", cheaper, energy, with separate auctions for each of them. Another opportunity arises in the horizon with the end of the concession period of several large hydro power stations in 2015; a government task force is studying several alternatives to renew these concessions, or to auction them, providing, hopefully, the benefit of cheap generation sources to the electricity consumers.

4.9 Captive consumers: More opportunities for electricity-price-responsiveness

Large and medium size electricity consumers of the Brazilian free market are highly responsive to the prices of this product, as usually happens in any of such markets in the world. The same does not happen with the electricity consumers of the regulated market in the country, the so-called "captive" consumers.

Time-of-day electricity tariffs exist in Brazil, just for medium and large electricity consumers, since the eighties, but some of the data about marginal costs that support the structure of this kind of tariff have not been updated (Santana, 2009) and there are few options available for

[2] Often local politicians (governors, deputies, mayors, etc.) require the building of schools, hospitals, roads, etc., that have nothing to do with the environmental impacts of new hydro power stations but will bring political prestige for them, to grant their support to the projects, during the public hearings of the environmental licensing procedures.

[3] The federal government issued a decree in 2009 setting ceilings for such costs.

[4] According to Abradee (Guimarães, 2009), the scatter of residential tariffs was only 9% in 1994; it increased to 12% in 1997 and to 73% in 2008.

consumer choice. A lot of progress could be made in this direction, learning, for instance, with the successful experience of Electricité de France, in France.

Demand-side electricity auctions involving “captive” consumers have been regulated and practiced in some American states since the nineties and represent another opportunity to provide more electricity-price-responsiveness to such consumers.

5. Evolution of energy planning in Brazil and current shortcomings

Energy planning started to be practiced on a systematic and regular basis, comprising both demand and supply analysis, in the Brazilian power sector largest state-owned companies, as Furnas, CESP and CEMIG, in Eletrobras and in Petrobras during the early seventies. The planning of Eletrobras and the other power sector companies addressed just issues concerning the expansion of that sector, while the planning of Petrobras did the same with the oil and gas industry. There were no interactions between the two and they were mandatory.

The plans produced by Eletrobras and Petrobras provided the basis and eventual targets for MME's energy policies, which, often, were also formulated by these companies, for some political adjustments and approval by the Ministry, and implemented by them.

There were medium (10 years ahead) and long-term (20-25 years ahead) plans for the power sector. Petrobras' plans, given their corporate purpose and the company's monopoly in the oil and gas industry that lasted until 1995, envisaged shorter planning horizons – usually 5 years ahead.

The expansion planning of the coal and nuclear industries was occasional and completely dependent on the changing roles given to these energy sources by the succeeding power sector plans.

The planning of new fuel-alcohol distilleries lacked continuity and reliability and was carried out by a government institution with limited competence and little credibility with the private owners of these plants.

During the second half of the nineties, few medium-term plans and none long-term one were produced for the Brazilian power sector and the former were purely indicative; they provided little guidance to the sector's expansion, as proved by the electricity shortage of 2001/2002. Petrobras's planning did nor change significantly during this period.

The first efforts to produce an integrated energy planning on a regular basis occurred in 2001/2002 in the Ministry of Mines and Energy, with two long-term projections of the whole Brazilian energy sector (Bajay, 2009). These exercises neither used sophisticated planning tools nor provided brilliant foresights for the decision-makers at that time, but started a new form of energy planning in the country, which lasts up to now.

The new institutional model for the power sector brought major changes to energy planning in the country. There are, now, integrated medium and long-term plans for the whole energy industry. The former provide the background information for MME to organize auctions for new power plants, transmission lines and oil and gas exploration fields; they are updated every year. The latter are purely indicative and have the same long-term prospective purpose of the energy outlooks published by the International Energy Agency and the American Department of Energy; MME and EPE intend to update them every two or three years.

Despite the progress of recent years, energy planning in Brazil still has some shortcomings and also suffers from problems both "upstream" and "downstream" of the planning process.

The government plans for the oil and gas industries go on following the track of Petrobras' plans for these industries, and not the other way round (Bajay, 2009).

There is not yet guarantee of convergence between the demand and the supply-side studies and between the energy sector plans and plans for other sectors of the economy. Progress in these directions will only be achieved with the use of partial and general equilibrium models, as is happening in several countries for already some years (Bajay, 2003).

Representatives of many agents in the Brazilian electric power sector have been complaining that the use of the model Newave, by EPE, is not representing all the constraints imposed by the National Operator of the System (ONS) in its long-term operation planning, i.e., there is not the necessary coordination between operation planning and expansion planning in the Brazilian power system (Chipp, 2009). Some of them also complain that the security-of-supply standards currently adopted by ONS for power station dispatching are excessive, requiring the frequent and long-lasting operation of costly thermal power stations, as occurred in 2008; they propose that these standards should be reviewed under a cost-benefit approach (Pedrosa, 2009).

Upstream of the planning process, there is a lack of clear, long-term policies, from MME or CNPE, for several important issues and, consequently, EPE's plans should resort to many assumptions without a strong political support, diminishing the credibility of the forecasts (Bajay, 2009).

Downstream of the planning process, the results of the "new energy" auctions carried out so far do not match what have been forecast in EPE's plans. Altogether, the share of thermal power in the total auctioned up to December 2008 was 63%, against only 37% for hydro power (Machado, 2009), a result very far from the hydro dominance among the new power plants envisaged in EPE's plans[5]. The new thermal power stations will increase the share of thermal power in the production of electricity in Brazil from 13% in 2008 to 26% in 2013 (Silva, 2009).

One of the reasons for this strong divergence between plans and reality is the lack of enough candidate hydro plant projects, due to the environmental licensing problems referred to before.

Another reason comes from the procedure used by EPE to calculate the cost-benefit index employed to classify the candidate projects during the "new energy" auctions. This procedure simulates the operation of the whole interconnected power system just during the first years of operation of the candidate plants and employs different decks of input data for each of the main parameters involved in the calculation of the cost-benefit index. A bias towards flexible power plants, that will operate, for instance, just 10 or 20% of the time, results from such procedure, postponing investment in power stations with larger capacity factors (less flexibility), required for techno-economic reasons, as is the case of nuclear power stations, or take-or-pay contracts, as happens with power stations burning Brazilian coal. A problem exists because all types of thermal power stations will be dispatched more often by ONS in the future, due to the decreasing share of hydro power generation and water storage capacity[6], and the current cost-benefit index calculation procedure does not capture the increasing burden of the operation cost of flexible power plants in the future and the corresponding increase in the competitiveness of base-load thermal power stations. The use of the same input data deck to calculate all the parameters of the cost-benefit index and the simulation of power plant dispatching over longer time horizons could reduce substantially the size of this problem.

EPE also did not expect that highly polluting thermal power sources, like fuel oil (28% of the contracted energy in the "new energy" auctions), coal (9%) and diesel oil (3%), would have such a large share in the basket of the recently contracted new power supplies. In order to avert the repetition of such a picture in the next auctions, EPE is proposing for MME the setting of a ceiling of R$ 200/MWh for the unit variable costs of the plants[7]; this measure, if adopted, should put out of the competition most of the players relying in such fuels.

To remedy, at least partially, the bad environmental outcome of the last "new energy" auctions, EPE is proposing for MME and Petrobras the conversion from fuel oil to natural gas in as much as possible of the auction winning power stations consuming such fuel, depending on the availability of natural gas.

[5] Only about 30% of the huge hydro power potential of Brazil (258,000 MW) has been exploited so far (Neiva, 2009).

[6] The ratio between the maximum energy that can be stored in the hydro power station reservoirs and electricity demand was 6 in 2002, 5.4 in 2009 and is expected to decrease to 4.7 in 2013 (Chipp, 2009).

[7] Most of the thermal power projects consuming diesel oil or fuel oil that win the last auctions, as well as some of those consuming coal or liquefied natural gas, have unit variable costs higher than R$ 200/MWh. Their generation capacity and not energy output were contracted (the so-called "availability" contracts). ONS dispatch them according to the system needs. Their average capacity factor ranges from a few per cent to no more than 20%. In a dry year, however, with low inflows to the hydro power plant reservoirs, they can be dispatched with much higher capacity factors, producing big increases in the electricity tariffs.

6. Comparisons with the Chilean, Colombian and Canadian experiences

For this project, Walden *et al.* (2008) reported electricity market restructuring and competition in the Canadian provinces of Alberta and Ontario and their impacts on regional energy planning. In terms of competitive energy markets, Ontario was the second Canadian province to undertake significant restructuring efforts in the electricity industry following Alberta.

In Latin America, three study cases were contemplated in the project as references for energy planning: Brazil, Colombia and Chile. Carmenza Álvarez (2009) reported the Colombian case and Claudio Espinoza (2009) the Chilean one.

The similarities and differences found in these studies can be better understood bearing in mind some important features of these countries.

Government activities are highly decentralized in Canada, while this does not happen in Brazil, Colombia and Chile. The provincial governments in Canada have much more power than the state or department governments in the three South-American countries. As a consequence, large differences on energy policies, planning and market regulation are found among the Canadian provinces, as can be realized reading the report of Walden *et al.*, in what concerns the comparisons between the provinces of Alberta and Ontario.

Ontario is a net importer of fossil fuels with oil and natural gas coming mainly from Alberta and coal from the United States. Alberta on the other hand is a net exporter of fossil fuels. Ontario relies on nuclear, hydro and coal for much of its electricity, while Alberta has a generation system that is heavily reliant on coal and, to a lesser extent, natural gas. Out of the total electricity generated by utilities in Ontario in 2005, 34.6% came from hydro power plants; the share of hydroelectricity in Alberta in the same year was only 2.2%. The evolution of regulatory laws and institutions has, therefore, differed in the two provinces (Walden *et al.*, 2008).

Brazil's oil industry is self-sufficient and recent new discoveries of deep water offshore oil and gas reserves should make the country self-sufficient in natural gas and a exporter of oil and oil products in the next decade. The Brazilian hydrothermal power system is dominated by hydroelectricity, as shown before in this paper. Colombia is rich in fossil fuels, particularly coal, which is exported at a large scale; the share of hydroelectricity in the total generation of power is also large in that country. In the other hand, Chile imports most of the fossil fuels it consumes. The Chilean hydrothermal power system is mostly made up by thermal power stations and relies heavily on natural gas imported from Argentina; cuts on Argentina's exports of gas since 2004 induced the partial substitution of this input for the power stations by fuel oil and coal (Bajay, 2009; Álvarez, 2009; Espinoza, 2009).

Analysis of these study cases reveals that the larger the share of hydroelectricity in power generation, greater is the importance given to both operation and expansion planning of the corresponding electric systems, including, more recently, policies setting preferences or targets concerning fuel choices for thermal power, or technologies employing renewable energy sources.

Canada has a large experience and tradition with the regulation of utilities, at both national and provincial levels, particularly were private utilities dominate, as is the case of Alberta. Chile is the Latin-American country were regulation of private power utilities developed the most, since the reform process, involving privatizations of all state-owned utilities of the power sector, started still in the late seventies and took many years, so as to settle most of the contentious issues involved in the process. In both the Canadian provinces of Alberta and Chile deregulation can be considered successful. Regulation in the energy industry is usually not so well developed in countries were the presence of state-owned companies was dominant in the past and, to some extent, is still widespread today, as are de cases of Brazil and Colombia; in these places, the regulatory agencies also do not have much autonomy. It can be observed that, where regulation has been more successful and deregulation progressed fast, energy planning is considered less important and has a more limited scope.

When the wholesale electricity markets in Toronto and in Brazil were opened up in the late nineties, the potential market power of state-owned companies and some ill-designed features of the

new markets (Bajay, 2009; Walded *et al.*, 2008) cast shadows on potential private investors' confidence in the new "rules of the game". Also, the power reserve margins were low and demand growth high during the deregulation process in both places. Very high prices resulted inevitably in the wholesale market and the governments intervened freezing the retail rates for small and medium size consumers in Canada and capping the clearing prices in the Brazilian wholesale market. In the latter case, a deep electricity shortage also happened from April 2001 to the beginning of 2002, as reported by Bajay (2009). These deregulation failures did not throw these market structures back to the past, but lead to new, hybrid, institutional arrangements, characterized by the coexistence of regulated and free markets, private and state-owned companies, and regulated access to the transmission and distribution grids. The energy planning process in these places was revived in new grounds, with mostly indicative but also some mandatory components.

According to Walded *et al.* (2008), the Government of Ontario is involved in the energy planning process, through the Ministry of Energy, more so today than it was prior to electricity restructuring. The Ministry has authority to issue directives to the Ontario Power Authority (OPA), which is charged with producing an integrated plan for Ontario's electricity system over the next 20 years. OPA also has a conservation bureau to develop conservation and demand management programs for consumers. A competitive bidding process is run by OPA to secure new private sector generation.

The upgraded role of the Ministry of Mines and Energy (MME) in the new institutional model of the Brazilian electric power sector, particularly for policy making and energy planning, and the creation of the Energy Research Company (EPE), to provide technical assistance to the Ministry on energy planning issues, are reported by Bajay (2009). The long-term national energy plan, produced by EPE to MME, is purely indicative, as are, for instance, the regular energy outlooks issued by the International Energy Agency and by the US Department of Energy. The ten-year-ahead plan, also produced by EPE to MME, however, has some mandatory components, comprising the new transmission lines to be added to the existing network and eventual power stations considered by the National Council of Energy Policy as strategic for power development in the country. The latter plan also indicates the sequence of new large hydro plants expected to go to competitive bidding, after receiving a preliminary environmental license, and the thermal and renewable energy (other than large hydro) power blocks which should also go through a bidding process. As discussed in the previous section of this report, the outcome of these auctions can be quite different, in terms of energy sources or generation technologies, from what has been envisaged in the plan.

The electricity shortage of 1991 – 1992, caused by the climate phenomenon El Niño, spurred on a market reform in the Colombian electric power industry, which separated the generation, transmission, distribution and trading activities of the industry and introduced competition in the first and last of these activities. A wholesale market was created and large consumers were allowed to choose their electricity supplier. Regulated access to the transmission and distribution grids was assured to all interested parties. Hydro power was responsible, in 2007, for 78% of the total generation of electricity in the country. As in Brazil, this dominance of hydroelectricity assured that both expansion planning and operation planning remained in the Colombian hydrothermal power system after the reform.

The same company operates the Colombian hydrothermal power system and manages the wholesale market, while in Brazil two non-profit organizations are responsible for these two tasks.

In both countries, there are long-term bilateral contracts and short-term power transactions. Different from Colombia, where the wholesale market is based on prices, the wholesale market in Brazil, after the last reform, is based on costs, calculated by an optimization computer program, and is employed just to settle small differences between the real consumption and the energy acquired in bilateral contracts, which are mandatory to meet 100% of the distribution companies and free consumer's electricity demands.

Long-term bilateral contracts and a spot market, as well as free and regulated consumers, also exist in the Chilean electric power sector. The distribution companies in that country should

carry out international auctions to meet the energy demand of their consumers for at least three years ahead; the government sets price caps to these auctions (Espinoza, 2009).

The successful deregulation of the electricity market in Alberta did not leave room for generation expansion planning in the province. However, the 2007 Transmission Regulation imposed specific planning responsibilities on the local Independent System Operator (ISO), which should prepare a 20-year transmission system outlook to be updated every four years and a 10-year transmission system plan to be updated every two years. These plans should address domestic load, exports, imports, appropriate reserves and generation capacity, timing and location of future generation additions, identifying timely and efficient transmission facility additions. The 10-year plan is also to include an implementation schedule for each transmission facility project identified as needed within five years (Walded *et al.*, 2008).

In Chile, the expansion plan for the electric power generation system is indicative, but it serves to calculate nodal prices for the transmission grid. In the other hand, the expansion plan for the transmission grid is mandatory: extensions of current installations are compulsory for their owners and the construction of new grids should go through international auctions.

Oil, gas and coal markets have been unregulated at the wholesale level for many years in Canada. There are regulatory structures to deal with environmental and related aspects of developing such resources, since they do not have associated markets.

Energy policy in Alberta has evolved around the province's vast reserves of coal, natural gas and crude oil. Alberta accounts for most of Canada's oil and gas output, much of which is exported to the United States. With very little hydro potential, Alberta has relied on its abundant coal resources to provide most of its electricity. Due to limited hydrocarbon resources in Ontario, the province has had to focus more on developing hydro and nuclear power. Walded *et al.* (2008) do not report government planning activities for oil, natural gas and coal either in Alberta or in Ontario.

Although there are no longer legal monopolies in the oil and gas industries of Brazil, Colombia and Chile, state owned companies – Petrobras, Ecopetrol and ENAP, respectively – dominate in the corresponding markets. Government plans for these industries essentially just reflect these companies' strategies and targets.

In Brazil the access to oil and natural gas transportation pipelines has been negotiated and there is not yet third party access to distribution pipelines, while in Colombia there is third party access to both transportation and distribution pipelines. Espinoza's report (2009) provides no information about third party access to oil and natural gas pipelines in Chile.

The exploitation of coal both in Colombia and Brazil is carried out by private companies. These companies, however, are large international conglomerates, with facilities directed mostly to exports, in the case of the good quality Colombian coal, while the coal producers in Brazil are local companies and their poor quality yield goes to the internal market, particularly for coal-fired power stations.

In terms of renewable energy sources other than large hydro power stations, fuel ethanol is produced at large scales in Brazil[8], Colombia and in the Canadian province of Toronto. In all these places anhydrous ethanol is blended with gasoline; in Brazil hydrated ethanol is consumed in dedicated cars and increasingly, after 2003, in flex fuel vehicles, whose engines can consume alcohol, gasoline, or any blend of these two fuels. Biodiesel is also produced in Brazil and Colombia, where it is blended with diesel oil.

The share of thermal power produced in plants fuelled by biomass, particularly, sugar cane bagasse, in the total generation of electricity has been growing fast in Brazil in the last years.

Brazil and Colombia have high potentials to generate electricity in small hydro power stations, but just small parts of these potentials have been exploited so far. The participation of wind power in electricity generation in these countries is also very short of the corresponding potentials.

Canada, following the example of the neighbor country USA, has been promoting energy efficiency programs intensively since the seventies. There are important and effective programs at

[8] World's second largest producer and largest exporter.

both central government and provincial government levels; the province of Ontario, in particular, is notorious in this respect. Although the Latin- American countries compared here – Brazil, Colombia and Chile – have energy policies, laws and programs aiming to foster energy conservation also for decades, their effectiveness and scope are much smaller than in Canada.

The cuts on natural gas exports from Argentina to Chile since 2004 have promoted in the latter country not only the substitution of fuel oil and coal for natural gas, but also the renewed interest in exploring the remaining hydro power potential and a more significant exploitation of other renewable resources, as wind power, and the setting-up of new energy efficiency programs.

Neither Brazil, nor Colombia, or Chile have long term policies and goals for energy efficiency strategies and programs and for renewable energy sources other than the support for building new large hydro power. Thus, the role of these "resources" have been secondary in the energy planning of all these countries and essentially concerning some short or medium-term targets.

Both Brazil and Colombia have Ministries of Mines and Energy and institutions linked to them responsible for preparing expansion plans for the energy sector of these countries; they also have agencies or commissions charged with the duty of regulating the power sector and the oil and gas industry. Different from what happens in Brazil, Colombian's regulatory agency for the oil and gas markets also plans the upstream activities of these industries. Chile's National Energy Commission is a rare institution in the world, since, although it is not a ministry, it is, nevertheless, responsible for energy policies and, also, for energy planning and for economic regulation of the electricity market.

The activities of the Brazilian and Colombian Ministries of Mines and Energy and those of their planning institutions have not been integrated as they should be, creating gaps between the ministries' policies, usually short or medium-term ones, and the plans' assumptions and targets. In Brazil some cooperation between the planning institution and the regulatory agencies started to be built up in recent years, while in Colombia this is not yet the case (Álvarez, 2009).

The National Energy Commission, in Chile, calculates the nodal prices for the transmission grid, that are the main economic reference for the private generators' businesses; recent changes in the legislation will introduce auctions in the year 2010, which will still use the nodal prices as references. The Commission also calculates the third party access tariffs for the transmission grid and the price caps for the international auctions that the distribution utilities should promote to meet the power demands of their consumers. For the oil industry, the Commission calculates the parity prices for the imports of oil products, as determined by the law that created the Stabilization Fund for Fuels, and reviews the investment plans of the state-owned companies which operate in this industry (Espinoza, 2009).

The current Chilean government is considering the creation of a Ministry of Mines and Energy, since the National Energy Commission's efforts are consumed mostly in medium-term planning activities and economic regulation of the local electricity market, leaving little room for policy making and long-term planning. The Commission also needs to use the mandatory power of some ministries to implement eventual policies.

Both Brazil and Colombia produce a long-term national energy plan and medium-term expansion plans for their power systems and natural gas transportation networks. In Colombia, only the electricity transmission system expansion plan is mandatory; the rest are just indicative. Brazilian's expansion plans have some other mandatory features, as referred to before in this section. In both countries, the expansion plans are considered much more important than the national plans and often inconsistencies are found between them. Chile has a ten-year-ahead national energy plan which is indicative, but serves to calculate nodal prices for the transmission grid, and a mandatory expansion plan for the transmission grid.

The models employed in Brazil, Colombia and Chile to carry out the operation and expansion planning of their hydrothermal power systems take into account the stochastic nature of the water inflows to the hydro power station's reservoirs; the models for operation planning are more elaborate than those for expansion planning. None of the national energy plans of these

countries make use yet of partial or global equilibrium models in their preparation; such use of these models is common today in Europe and the USA.

7. Conclusions

The Brazilian experience and the other study cases carried out in this project reveal that a hybrid institutional model is emerging in the energy markets evaluated, where private enterprises and state-owned companies compete with each other in an increasing way, but also have joint undertakings, particularly in the oil and natural gas industries and, also, in large hydro power projects.

The role of state-owned companies is still very important in the oil and natural gas industries in Latin America and their corporate planning is the basis of the corresponding government planning for these industries.

Apart from hydro power generation in large plants and fuel ethanol production and consumption in Brazil and, to some extent, in Colombia, the share of other renewable energy resources in the energy supply of the countries analysed in this project is still very limited.

Despite the fact that all these countries have some experience with energy conservations programs, the role of the so-called “demand-side planning and management” is quite limited in all of them, compared to the heavy weight given to the energy supply options available.

Actually, most of the planning experience of these countries is concentrated in the electric power sector, particularly in the operation planning of their hydrothermal power systems. Integrated planning of the whole energy system is still in an early stage.

Long-term energy planning, when exists, has been considered much less important than medium-term planning and few or no interactions happen between them. The lack of clearly defined long-term energy policies, with targets to be achieved, is the main constraint to further developments of long-term energy planning in Latin-American countries.

Regulation of the energy markets is slowly getting consolidated in the continent, but the institutions charged with these tasks still have little autonomy from the government and, in general, they do not know how to use effectively, in their regulatory tasks, the results contained in the energy plans.

References

Álvarez, C. C., Proyecto Planificación Energética – Estudio Caso Colombia, documento preparado para la Organización Lationoamericana de Energía (OLADE), Bogota, Colombia, Enero de 2009

Baer W. and McDonald C., A return to the past? Brazil's privatization of public utilities: the case of the electric power sector, *The Quarterly Review of Economics and Finance, 38*(3): 503-23, 1998

Bajay, S. V., Desafios metodológicos e organizacionais no planejamento da expansão do setor elétrico brasileiro e na elaboração das projeções da matriz energética brasileira. In: Congresso Latino-Americano de Geração e Transmissão de Eletricidade, 5. São Pedro, SP, Brasil, 2003. *Anais* (na forma de CD). Escola de Engenharia de Guaratinguetá / UNESP

Bajay, S. V., National Energy Policy: Brazil. In: Cleveland, C. J. (ed.), *Encyclopedia of Energy, v. 4*, Elsevier Inc., 2004, p. 111-25

Bajay, S. V., Integrating competition and planning: a mixed institutional model of the Brazilian electric power sector, *Energy, 31* (6-7): 865-76, 2006

Bajay, S. V., *Project Phase 1 – Report about Energy Planning in Brazil*, Contract no. CPSC/048/2008 for Consulting Services, Energy Planning Project between the Latin-American Organization for Energy (OLADE), the University of Calgary and the Canadian Agency for International Development, Núcleo Interdisciplinar de Planejamento Energético – NIPE, Universidade Estadual de Campinas, January 2009, 34p.

Barbosa P. S. F. and Braga B. P. F., Electric energy sector and water resource management in the new Brazilian private energy market, *Water International 28*(2): 246-53, 2003

Barbosa P. S. F. and Francato, A. L., Electricity contracting and risk management tools in the Brazilian energy market. Paper presented at the 6th European Conference of the International Association of Energy Economics, Zurich, Switzerland; 2-3 September 2004

Brown A. C., The privatization of Brazil's electricity industry: sector reform or reinstatement of the Government's balance sheet, Working Paper, John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts, 2002

Calou, S., Panorama setorial sobre a implantação do marco regulatório do novo modelo, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Chipp, H., Os desafios da garantia de abastecimento do setor elétrico, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Espinoza, C., Proyecto Planificación Energética, Fase I - Estudio de Caso: Chile, documento preparado para la Organización Lationoamericana de Energía (OLADE), Santiago, Chile, Enero de 2009

Guimarães, L. C., O novo modelo e a assimetria tarifária na distribuição, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março

de 2009

http://www.petrobras.gov.br, consulted in 03/02/2009

Lima, R., Realidade e perspectivas para o setor de energia elétrica, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Machado, A. C. F., Novas regras e a busca de estabilidade no mercado livre, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Menel, M., Visão dos autoprodutores de energia elétrica, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Mota, R. L., The restructuring and privatization of electricity distribution and supply business in Brazil: a social cost-benefit analysis, CMI Working Paper 16, Department of Applied Economics, University of Cambridge, UK, 2003

Neiva, F. A., Realidade e perspectivas para a geração de energia elétrica, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Oliveira, A., The political economy of the Brazilian power industry reform, Working paper #2, PESD, Stanford University, CA, USA, February 2003

Orans, R., Woo, C. K. and Clayton, W., Benchmarking the price reasonableness of a long-term electricity contract, *Energy Law Journal, 25*(2): 357-83, 2004

Pedrosa, P., Modelo setorial e perspectivas de evolução para o mercado livre de energia, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Ramos, D., Assimetria tarifária: Algumas reflexões em busca da solução, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Salomão Filho, Assimetria tarifária na distribuição de energia elétrica, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Santana, E., Ordenamento e desafios regulatórios, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Silva, E. L., Avanços alcançados na comercialização do mercado livre e possíveis aperfeiçoamentos, apresentação feita no Seminário – 5 anos do Novo Modelo do Setor Elétrico Brasileiro, Rio de Janeiro, RJ, março de 2009

Walden, T., Mei, M. and Prince, P., The implications of market restructuring and competition for sectoral energy planning, prepared for Organización Latinoamericana de Energia (OLADE), Canadian Energy Research Institute, May 2008