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DIFFICULTIES IN EXPANDING HYDROPOWER GENERATION IN BRAZIL

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ABSTRACT

Brazil has enormous tradition in hydropower generation. However because of many difficulties in the grant processes, it has become harder and harder to construct news hydropower plants. Because of this, the thermopower generation has increase very much. Considering that the Brazilian hydropower potential is not fully explored, it is not rational that we have to increase the electrical energy supply by using other source than hydraulic, a source that usually is more expensive and more polluting than hydroelectricity. This paper will present the characteristics of the Brazilian electric matrix and some difficulties to implement hydropower plants. By the end, it will propose measures to assure the hydropower participation in the sector expansion.

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1. INTRODUCTION

Brazil is a country covered by a huge amount of rivers, which makes more than 75% of our electric energy framework, about 100,000 MW, be constituted by hydro power plants. This characteristic allows Brazil to be in an advantageous position comparing to other countries. The hydropower energy is a renewable energy, cleaner and cheaper than others; and this feature is very important if we considered the worldwide environmental concerns regarding the global warming and carbon emissions.

The hydropower plant construction has been since 1970s, and mostly during the military government, an important support for the national economic development. However, even though Brazil still has a great hydropower potential to be explored, the hydropower generation expansion has been very restricted.

In the latest two A-5 Energy Auctions, those which sold energy to be delivered after 5 years, from 5,400 MW of energy traded, only 850 MW were from hydropower plants. The rest of the energy traded was produced by thermopower plants based on fossil fuels, highly polluting and expensive.

Some factors may explain the less participation of hydropower plants in the future generation projects to be implemented in the medium term. First, it is the fact that the major hydropower projects in the Brazilian Southeast, South and Northeast had already been carry out, remaining basically a few medium and small projects. The new projects are located in the Northern region of Brazil, with emphasis on the Xingu, Tocantins, Tapajos and Madeira river basins. Nevertheless, because these river basins are far from where the energy is more consumed, the energy transportation cost is higher than usual.

One thing that makes this problem worse is the difficulty that the hydropower plants have to obtain the environmental license and the fact that this kind of project faces a great resistance from the environmental institutions. The licensing process is even harder taking into account the lawsuits brought by the Prosecutors' Office and environmental entities. Therefore, frequently the environmental license process goes to the Law Court.

On account of the lawsuits brought against the hydropower projects, the implementation schedule of the projects have been compromised, making difficult to forecast when the plants will be concluded, and even more difficult to estimate the total cost of the enterprise. This situation increases the entrepreneurs' risks and definitely results in over price. For instance, in the latest energy auction (A-5), the presence of only a hydroelectric plant was explained by the large number of projects without prior environmental license.

The difficulties in getting an environmental licensing for a hydropower plant compelled the entrepreneurs to design new hydropower plants with reservoirs much smaller than they used to be; for this reason, the new plants have been operated without regulating the river discharge. Opposing to what has been done in the last decades, when the hydropower plants used to be design with huge reservoirs to accumulate water for many years; this new conception makes our electrical system vulnerable during the drought season, requiring to be complemented by thermopower plants in order to guarantee the energy demands.

Nevertheless, it is not only the environmental licensing that interferes in hydropower plant construction. The huge changes and the uncertainty in the regulatory framework associated to the transition to a new sector model drove off the private investment. Besides that, the low energy price foreseen for the next years, resulting from the energy oversupply after the rationing in 2001, also contributed to chase away new investments.

Considering that the implementation of a hydropower plant is a long-term project, uncertainties reflect right on the development of these projects and if there is any unexpected stop, the project can take a very long time to be restarted. As a result of that, there is a lack of new projects to be developed in the sector portfolio, which decreases the quantity of enterprises that can be offered in the energy auctions.

Another difficulty that the hydropower projects have to face is competition with the small hydropower plants (PCH in Portuguese). These small plants usually have less opposition to their implementation, because of their reduced dimensions and consequently reduced impacts; and they also have a more simplified granting process. However, even those small hydropower plants are facing problems to be implemented.

In Santa Catarina, a state in southern Brazil, the Federal Prosecutors' Office is trying to stop the environmental licensing process for the PCHs; and in Parana, another Brazilian state, the suspension of environmental licensing process has already been happening since 2004.

These aspects, besides others, have been constant barriers for the implementation of hydropower projects and what can push away new investors. If the investors consider that there aren't favorable conditions to invest in the hydropower market, they can invest in thermopower plants instead, or in windpower plants or even change to another infrastructure segment.

Taking into account that the electrical system safety and a reasonable tariff are the basic principles to be followed when planning the expansion of the electrical system; and considering that the Brazilian hydropower potential is not fully explored, it is not rational that we have to increase the electrical energy supply by using other source than hydraulic, a source that usually is more expensive and more polluting.

It is in this environment full of uncertainties that ANEEL and other public institutions are involved in. They have to stagger the need to diversify the sources of energy and the perspectives in long and short term related to each electric energy source with the pressing necessity to guarantee the growing energy demand.

The compliance of the strategic goals depends on the strength and adequacy of the regulatory policy and regulatory agent. In this context, ANEEL has a extremely relevant role because the Agency is responsible to define the best hydraulic potential sites, to approve the hydropower projects, to organize the energy auctions, to manage the grant's contracts and to supervise the hydropower construction and operation.

Bearing in mind the huge challenges that the electric sector has facing in order to assure an increase in the electric energy supply in a sustainable way and according to the economic growth expectation, it is important to understand how the electric sector works and it synergy with other sectors. It is also essential to identify which actions or system modifications can help to develop a precise, efficient and transparent regulatory environment. A regulatory environment that raises the investment in the generation sector and enables a decrease the hostility related to the hydropower plants.

2. BRAZILIAN ELECTRIC MATRIX

2.1 Electric Energy Participation in the Brazilian Energy Matrix

Renewable sources of energy represent a significant part of the Brazilian energy matrix, which puts Brazil in a privileged condition comparing to other countries in the world. Preliminary data from the Brazilian Energetic Balance (2008) shows that in 2007, 46.4% of the energy supply was produced from renewable sources (EPE, 2008), more than the 45.1% in 2006 (MME;EPE, 2007). The graphic shows the evolution of the renewable and non-renewable sources along the time.

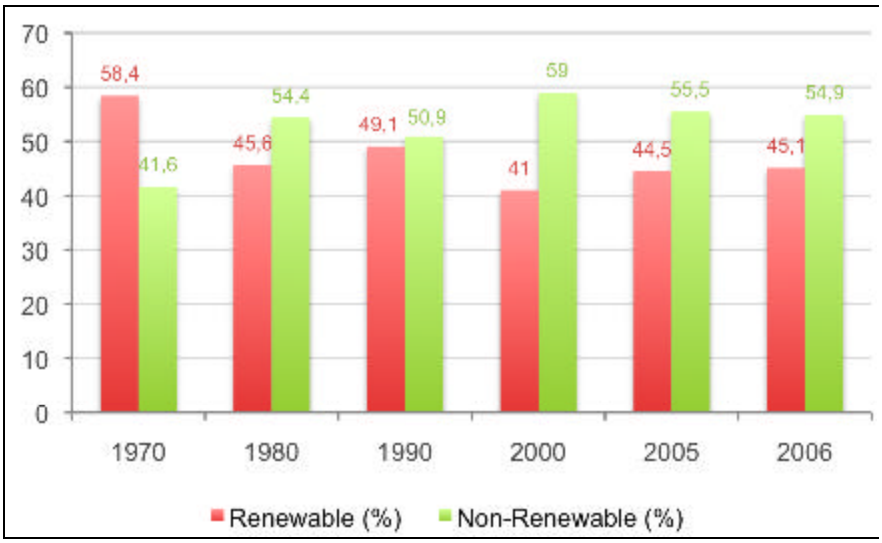


Figure 1 – Renewable and Non-Renewable Sources Evolution
Source: MME, EPE (2007)

We can realize the Brazilian outstanding position when we analyze the national situation in the world scenario, where the energy consumption from the renewable sources is about 13% (MME; EPE, 2007). Compared to USA, Brazilian situation is even more positive. In the USA, the renewable sources provide only 3% of the energy consumed (MME, 2007). The following figures illustrate this condition.

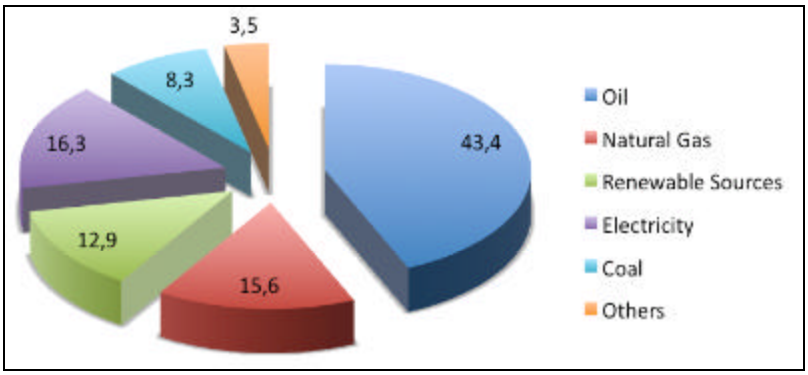


Figure 2 – World Energy Consumption Structure in 2005
Source: MME, EPE (2008)

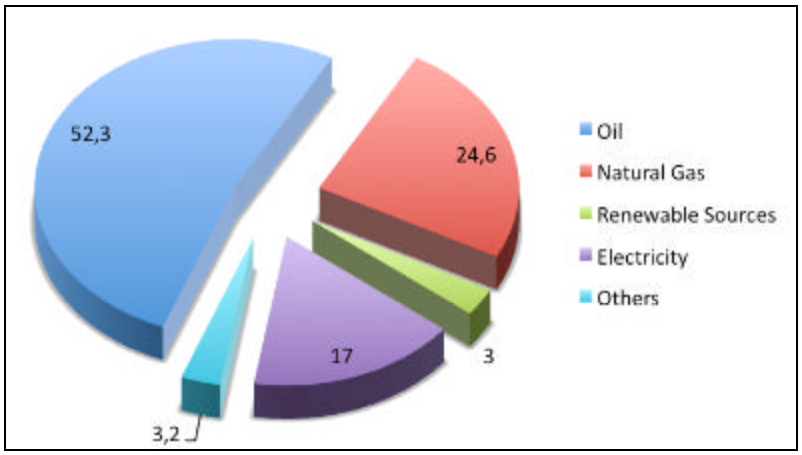


Figure 3 – USA Energy Consumption Structure in 2004
Source: MME (2007)

The Brazilian susceptibility for the renewable sources was stimulated by the oil price since the 70's. Aiming to substitute the imported petroleum, which represented about 80% of the domestic consumption (Cunha da Costa e Prates, 2005), Brazil started to identify its energetic potentiality, and to achieve this goal Brazil has to count on its natural attributes, water resources and biomass. The higher oil price also stimulates Brazil to invest in technological innovation in oil exploration in open sea (Cunha da Costa e Prates, 2005).

Nowadays, in the Brazilian energetic matrix the electric generation corresponds to 14.7% of the total amount of energy supply, answering 17.6% of the domestic consumption (EPE, 2008). Comparing to 2006 and 2007, we can see a 5.6% increase in the energy supply; however, we can't verify a significant percentage change in the energy matrix (EPE, 2008). Figure 4 and Table 1 presents the composition, in

percentage, of the energy supply in Brazil (EPE, 2008), while Table 2 indicates the evolution of each source in 2006 and 2007.

Table 1 – Energy sources participation in supply

	2007 (%)	2006 (%)
Non-Renewable	**53.6**	**55.1**
Oil and Derivatives	36.7	37.8
Natural Gas	9.3	9.6
Mineral Coal and Derivatives	6.2	6.0
Uranium and Derivatives	1.4	1.6
Renewable	**46.4**	**44.9**
Sugar cane Products	16.0	14.5
Hydraulics and Electricity	14.7	14.8
Firewood and Vegetal Coal	12.5	12.7
Other Renewable	3.1	2.9

Source: EPE (2008)

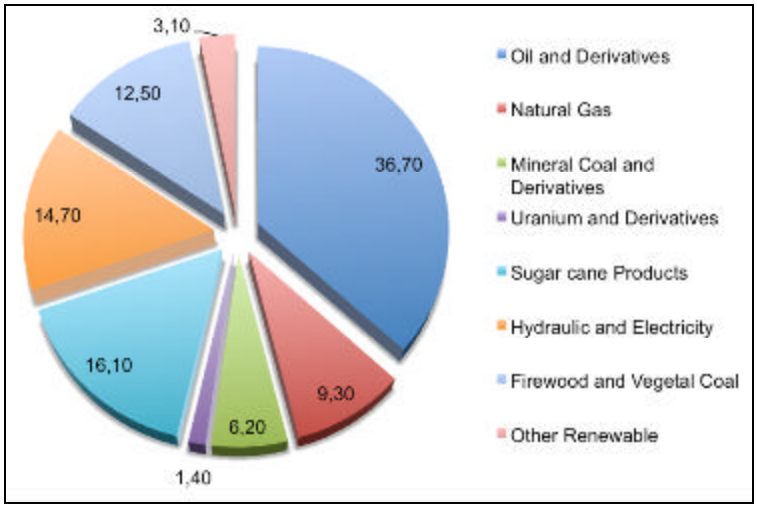


Figure 4 – Brazilian Energy Supply Composition
Source: EPE (2008)

Table 2 – Energy Sources evolution in 2006 e 2007

	2007 (toe)	2006 (toe)	Variation (%)
Total	**239,4**	**225,9**	**5,9**
Non-Renewable	**128.3**	**124.4**	**3.1**
Oil and Derivatives	87.9	85.5	2.8
Natural Gas	22.3	21.6	3.0
Mineral Coal and Derivatives	14.8	13.6	8.6
Uranium and Derivatives	3.3	3.7	-9.9
Renewable	**111.0**	**101.5**	**9.4**
Sugar cane Products	38.4	32.8	17.1
Hydraulic and Electricity	35.3	33.4	5.6
Firewood and Vegetal Coal	29.9	28.6	4.6
Other Renewable	7.5	6.7	11.8

toe - tonne of oil equivalent

Source: EPE (2008)

2.2 Brazilian Electric Matrix Characteristics

The hydraulic energy participation in the Brazilian electric matrix is predominant. The hydropower plants start to be implemented in the 50's. However, only in the 70's the development of the hydropower generation sped up, mostly with constructions of huge plants such as Itaipu and Tucurui (Cunha da Costa e Prates, 2005). Nowadays, about 85% of the electric potential installed comes from hydropower generation (EPE, 2008).

Table 3 – Each Source Evolution between 2007 and 2008

Source	2007 (%)	2006 (%)
Non-Renewable	**10.2**	**11.3**
Natural Gas	3.3	4.0
Oil and Derivatives	2.8	2.7
Nuclear	2.5	3.0
Mineral Coal and Derivatives	1.6	1.6
Renewable	**89.8**	**88.7**
Hydraulic	85.6	84.7
Biomass	4.1	4.0
Wind	0.1	<0.1

Hydraulic includes importation
Biomass includes firewood, sugar cane bagasse and others
Source: EPE (2008)

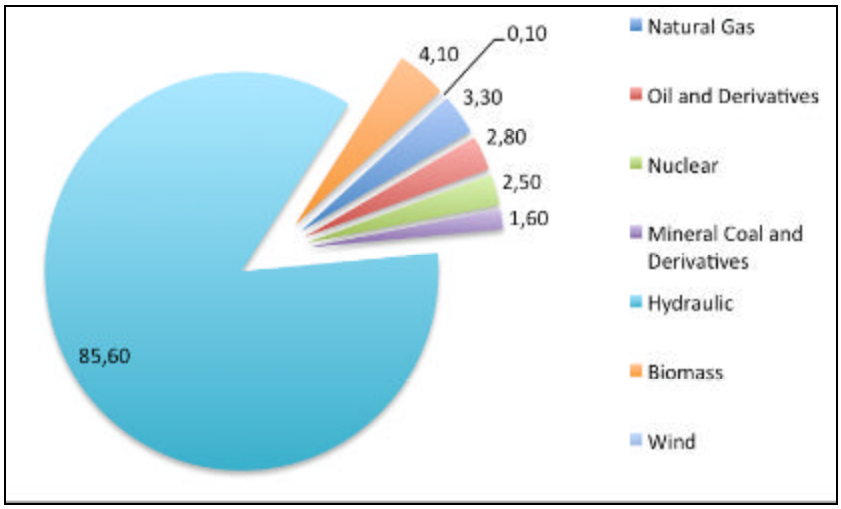
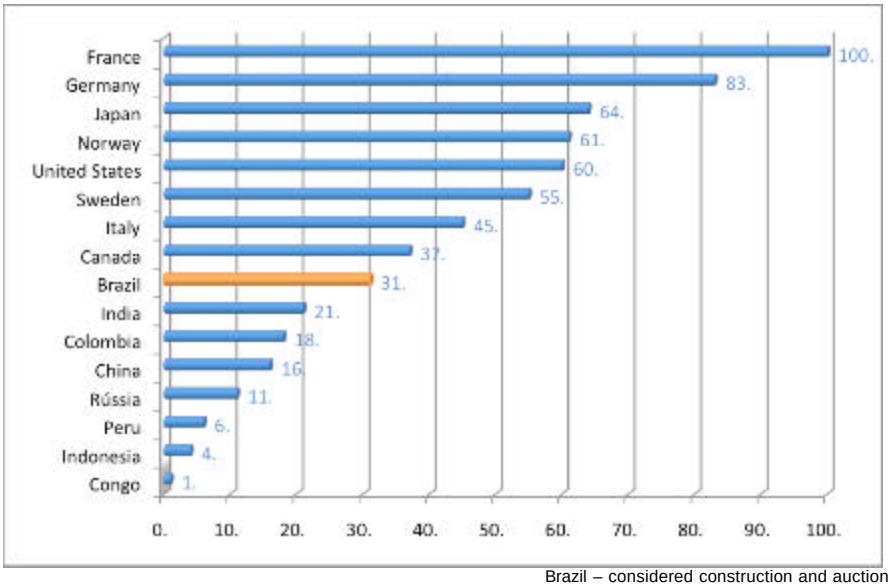


Figure 5 – Participation of each source in Brazilian electric matrix
Source: EPE (2008)

Despite the fact the hydropower energy is a significant part of the Brazilian electric matrix, less than 30% of the estimated capacity, about 260 TW, was explored (MME, 2008), which represents a huge potential to be developed. As we can see in Figure 6, developed countries are those that use most their hydropower potential.



Brazil – considered construction and auction

Figure 6 – Hydropower Potential technically exploited (%)

Source: MME (2008)

As we can see in Figure 7, the hydropower expansion has changing from the areas concentrated near the main consumers, in the coastline, between the states of Sao Paulo, Rio de Janeiro and Minas Gerais to the middle of the country, characterizing a bigger dispersion and centered between Sao Paulo, Minas Gerais, Mato Grosso do Sul and Goias. This expansion was able thanks to the improvement in the energy transmission technologies in huge blocks and for long distances (ANEEL, 2005).

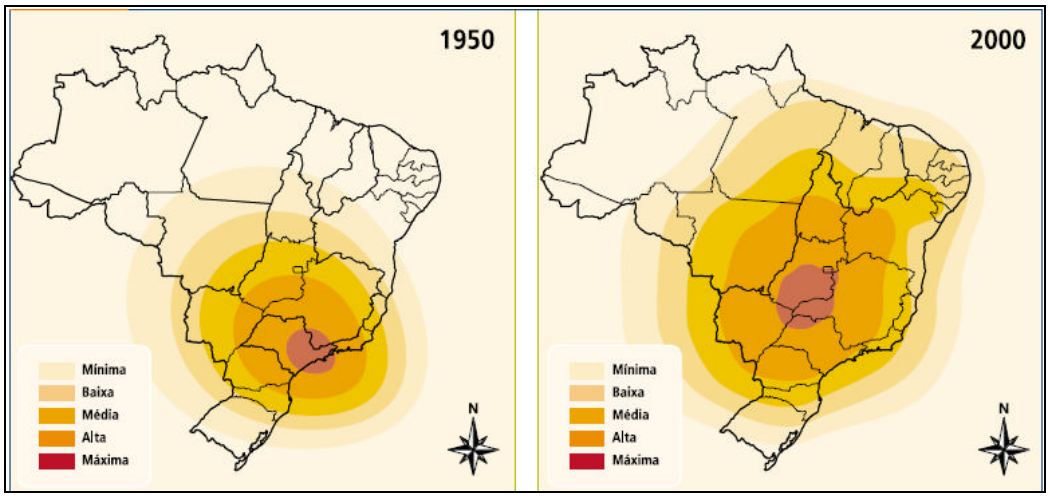


Figure 7 – Evolution of the Brazilian hydropower potential

Source: ANEEL (2005)

Obviously, the proximity to the main consumers facilitates the energy transmission and implementation of new hydropower plants. In the Center-Southern region,

the accelerated economic development and the land characterized by plateaus led the region to explore more intensely the hydropower potential. However, the growing of the country toward the interior region and the use of the best hydropower potentials in the South-Southwest region drove is demanding the development of hydropower plants in remote and less developed areas. Figure 8 presents the already explored potential in each Brazilian region.

More relevant than the proximity to the consumers is the aptitude of the water body to the support a hydropower plant. Differently from other projects, where the best site is defined based on the distance to the market and suppliers (Woiler and Mathias, 1996), in the hydropower projects, the best location is related to the characteristics of the water bodies, specially discharge and declivity.

Nowadays, Brazilian huge challenge is to increase the hydropower generation in the Amazon region, where only 9% of the total potential was used (Abrage, 2008). The construction of hydropower plants in the Amazon region, in a moment when the world is discussion about the deforestation, raises a lot of criticisms and opposition, as any other project that intends to explore the Amazon.

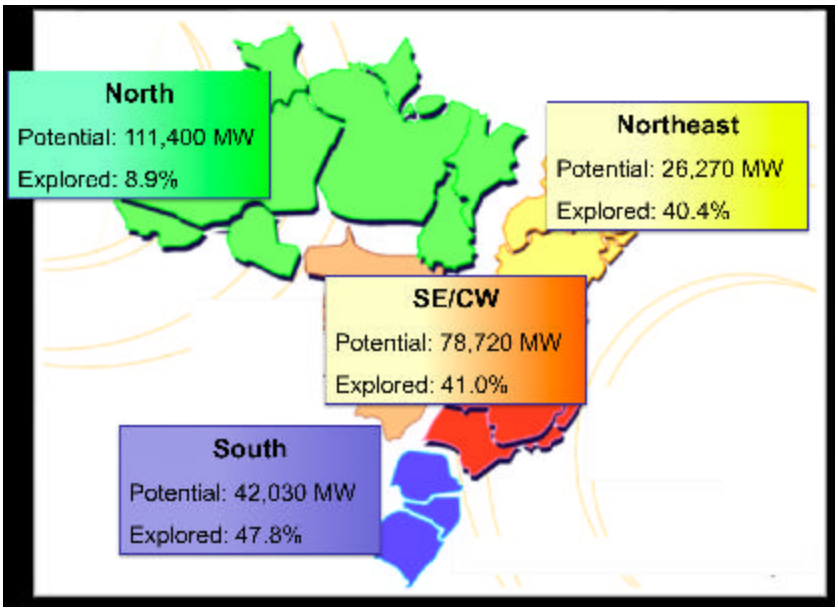


Figure 8 – Hydropower Potential by Region
Source: MME (2007)

Although we know that the hydropower plants interfere with the environment and require involuntary population rearrangement, there are many ways to conciliate the energy generation with the social and environmental dimension.

2.3 Brazilian Electric Matrix Expansion

When dealing with the Brazilian hydropower system is necessary to consider that it was planned to attend the energy consumption even in long drought periods. If the system is in balance, only exceptional droughts can cause supply problems. If it is not, the whole system becomes very dependent of the hydrology (Kelman, 2001).

Considering this aspect, we can notice that during the 90's Brazil increases the energy supply in about 1.500 MW per year (ANEEL, 2008), amount less than necessary. The small increase in the generation capacity associated to other factors resulted in an energy crisis in 2001 that was known as "electric sector blackout".

The Electric Energy Hydrothermic System Commission – created trough the Decree from May 22nd, 2001 to evaluate the energy production politics and to identify the structural and conjuncture causes of imbalance in energy demand and supply – identified the main cause of the energy crisis in 2001 (Kelman, 2001):

- **Unbalance between energy demand and supply:** energy not added to the system due to delay in hydropower construction and lack of new hydropower projects was an essential factor to supply crisis, since there was not reduction in demand.
- **Unfavorable Hydrology:** accelerated the crisis. The crisis due the unbalance system was aggravated because of the unfavorable hydrological situation.
- **Over dimensioned contracted energy:** wrong market signal that not stimulated new sectors investment.
- **Government Inefficiency:** the government failures in notice the problem gravity and it was inefficient in coordinate and control the problem.

- **Inefficiency in correct the market failures and to conduct actions in order to prevent the energy rationing:** There was not complementarily between the public policy tools, sector planning and regulation.

I account of that episode, we have learnt that the energy supply needs to follow the rise of the energy consumption generated by the economic growth. New plants need to be planned, constructed and operated in order to guarantee the demand. The Federal government must follow the energy expansion and provide the necessary conditions to the energy plants and transmission system to develop according to the country needs.

Pushed by the energy price raise brought by the 2001 rationing, between 2000 and 2004 the Brazilian energy matrix grows about 5.8% per year (ANEEL, 2008). That represents 4,600 MW per year. However, since 2005, in part because of the changes in the sector legislation, the growing dropped to 3.1%. Figure 9 shows the evolution in the electric energy capacity between 1990 and 2008.

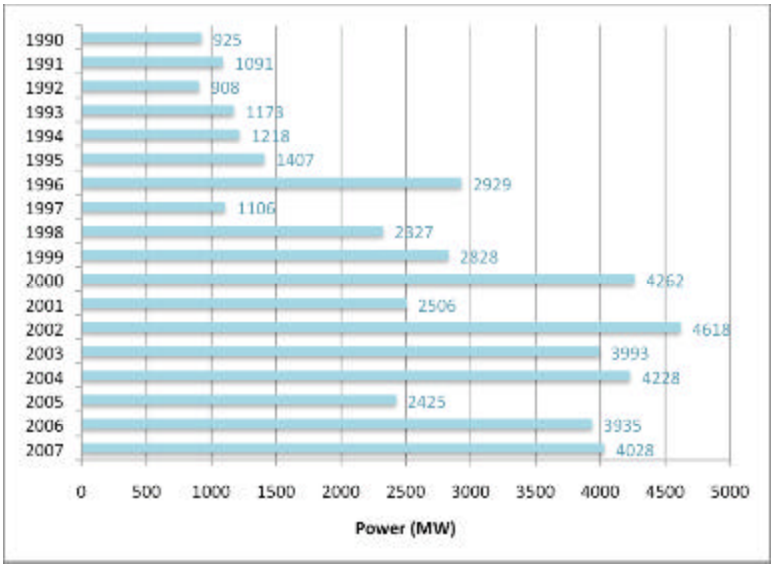


Figure 9 – Annual generation Increase (MW).
Source: ANEEL (2008)

Although the hydropower generation prevails in the electric energy capacity, we can notice an increase in the thermopower generation. From the amount

increased from 2000 to 2007, more than 40% is from thermopower, while in the Brazilian energy matrix the thermopower is less that 20% (ANEEL, 2008).

The following Table presents the potential aggregated to the system from each source of electric generation since 2000.

Table 4 – Starting Operation between 2000-2008

Year	UHE	UTE	PCH	EOL	SUM
2000	1.773	2.466	23	-	4.262
2001	1.396	1.041	69	-	2.506
2002	2.662	1.921	56	-	4.639
2003	2.216	1.515	268	-	3.999
2004	1.140	3.020	68	7	4.235
2005	1.733	566	126	-	2.425
2006	2.367	1.132	228	208	3.935
2007	2.915	850	253	10	4.028
2008	180	1.244	643	91	2.158
Total	16.382	13.755	1.734	316	32.187

Source: *SFG/ANEEL - Relatório de Acompanhamento da Expansão da Oferta de Geração Hidrelétrica* (February, 2009)

We can conclude from the above data that the hydraulic expansion is increasing in a rhythm beneath the expected, mainly if we consider that the Brazilian electric matrix is characterized by renewable and clean energy, mostly from the great hydropower plants. Therefore, we can also conclude that the thermopower is becoming more important in the Brazilian electric system.

When assessing the projections for 2009 and 2012, we recognize that the situation is even more worrying. As we can see in Table 5, considering the 16.000 MW of energy to be implemented until 2012, only 7.000 MW comes from hydropower, which represents 44% from the total amount.

Table 5 – Starting Operation between 2009-2012

Year	UHE	UTE	PCH	EOL	SUM
2009	826	3846	1164	456	6.293
2010	2213	2185	541	-	4.939
2011	1646	819	176	-	2.641
2012	644	1711	30	-	2.385
Total	5.330	8.561	1.911	456	16.258

Source: *SFG/ANEEL (*2009)

Theoretically the thermopower generation complements the hydropower generation, reinforcing the system safety, avoiding energy deficit during the droughts or operating to attend demand peaks. Nevertheless, although it is desirable to have this kind of complementarity in the electric matrix, this complementarity must be implemented inside the sectorial planning and not as a result of difficulties to make the hydropower projects feasible.

If this situation continues in the nest years, it will be hard to attain the planned goals and to keep the Brazilian electric matrix clean and renewable. It will be necessary to implement more and more thermopower plants that produce a more expensive and polluting energy.

3. NACIONAL ELECTRIC SECTOR

3.1 The Electric Sector Model

The 2001 crisis – an energy deficit that required emergency measures for more than a year – was an important chock for the government, for the national economy and for the society. It was clear that about a year before the crisis that the energy scarcity was close to happen. The energy price in the spot market attained a high price never seen before, that brought new investments in hydropower plants. However, these investments weren't enough to avoid the deficit risk above the desirable.

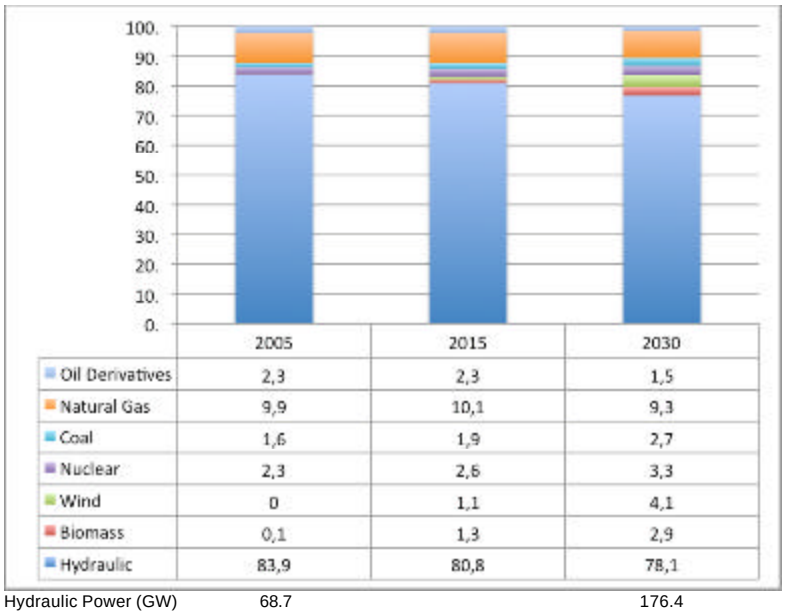
Under this scenario, the crisis was caused by inappropriate investment in generation and by insufficient variation in hydropower generation, besides the state reforms that failure to stimulate appropriate investments and the lack of gas. One of the most important lessons from the 2001 crisis was the need to correct the market failure.

Attracting the right investment, especially in generation, is the main challenge. The investment is generation is realized as relatively risky and besides that it is not easy to follow the demand growth. To assure the diversity in the energy sources is an associated challenge.

Based on the 2001 rationing experience, it was established a new model for the electric sector through the Law 10848/04. The present model is supported by two basic propositions: fair tariffs and guarantee of energy supply.

Therefore, it was defined the necessity to have a sector planning and this planning would be developed by the Ministry of Mines and Energy, advised by the Energetic Research Company – EPE. The planning is supposed to be indicative and it has the purpose to define tendency and points out the alternatives for the sector expansion for the next decades.

The sector planning consider the years until 2030, in this planning it is project that the hydropower energy will remains as the main source of generation, open a certain space for new sources, as the wind power, for instance. According to the medium and long-term plans (2015 and 2030), there is a perspective to diminish the oil use, dropping to 1.5% in this period. However, this cannot be seen in the recent information related to the system expansion.



	2005	2015	2030
Oil Derivatives	2,3	2,3	1,5
Natural Gas	9,9	10,1	9,3
Coal	1,6	1,9	2,7
Nuclear	2,3	2,6	3,3
Wind	0	1,1	4,1
Biomass	0,1	1,3	2,9
Hydraulic	83,9	80,8	78,1
Hydraulic Power (GW)	68.7		176.4

Figure 10 – Brazilian Electric Matrix Expansion Forecast
Source: MME (2008)

Another issue that came from the 2001 crisis refers to the need to have a specific entity in charge of following and assessing the energy supply reliability. To accomplish this role it was created the Electric Sector Monitoring Committee – CMSE.

Besides the institutional sphere, an important change regarding the previously model refers to the hydropower plants grants procedures. Nowadays , a hydropower plant is granted to the one that offers, in an energy auction, the lowest energy price to be produced in that hydropower.

The energy auctions are extremely important for the electric sector survival. Through these auctions new power plants are granted and energy contracts to provide energy for the distribution utilities are closed. The success of these auctions is the key for the balance between energy supply and demand and, consequently, to reduce the deficit risk and rationing.

When defining the energy contracts price and the energy sources participation, the auctions also influence the tariffs paid by the consumers and the quality of the electric matrix in environmental terms.

The model established two energy contract environments: Regulate Contracts Environment – ACR and Free Contracts Environment – ACL. In the ACR, the energy sale is made through auctions that aim to supply the consumers with regulated tariffs. In the ACL, the generation companies sell their energy for the so called free consumers, through bilateral contracts that are not regulated by the government. Therefore, the energy in the ACL is not deal through the auctions promoted by the government.

3.2 Stages to implement a Hydropower Plant

The 1988 Brazilian Constitution in article 20 defined the hydraulic potentials as Federal property. Because of that, according to article 21 is a Federal competence to explore it, directly or through authorization, concession or permission, in articulation with the states.

Federal Law 9074, from July 7th, 1995, established that a hydraulic potential can only be granted after the definition of the "optimum river potential" by the Federal Government. The one interested in the potential may be responsible for develop the basic and the executive projects.

The same law also considers as "optimum river potential" every potential defined in a global conception by the best axis, physical arrange, water level, reservoir and power that constitutes the chosen alternatives in a river. The definition of the optimum river potential, according to Decree 4970, from January 30th, 2004, is ANEEL's competence.

To implement a hydropower plant, plenty studies are required, as we can see in Figure 11. Besides the planning activities (energetic policy, long term plan, decennial plan, supply and demand estimation and monitoring), related to the generation expansion, the stages to implement a hydropower plant are: Studies and Hydroelectric Inventories, Feasibility Studies, Energy Auction, Basic Project and Executive Project.

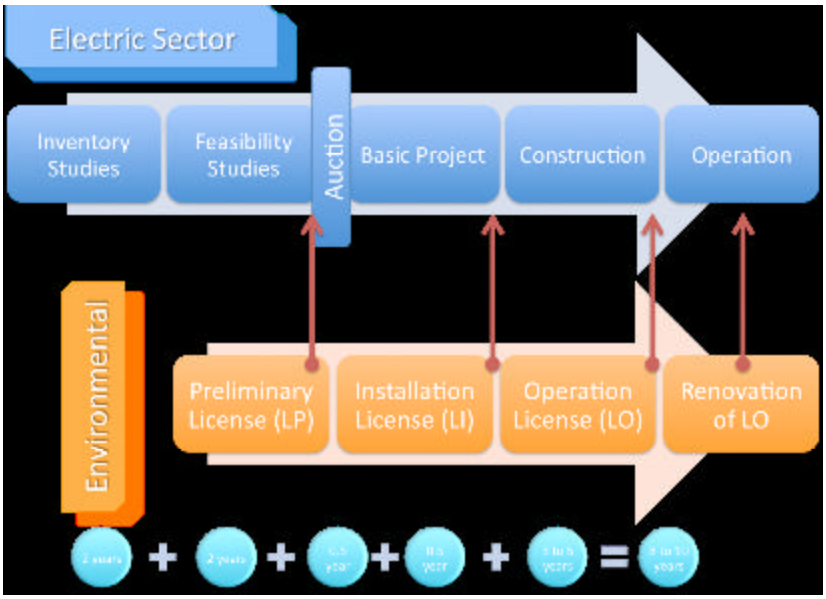


Figure 11 – Stages to implement hydropower plants

Only after finishing all these stages it is possible to start the plant construction. Evidently, also in the environmental and water resources spheres it is necessary to get permissions to develop the project.

3.2.1 Hydropower Inventory Studies

The Hydropower inventory is characterized by the conception and analysis of a variety of alternatives to explore a river hydraulic potential. These alternatives are compared aiming to select the one that represents the best balance between costs, energetic benefits and social and environmental impacts. This analysis is made based on secondary data, complemented by field data and adjusted according to cartographic, hydrometeorological, geological, geotechnical, water multiple use studies.

Therefore, in the inventory stage it is determined the optimum river potential considering the maximum energy to be generate with minimum negative effects to the environment in agreement to the multiple use of water scenarios (MME, 2007a).

From the inventory studies, a group of projects are selected to integrate the expansion planning. The standards and procedures to develop these projects were established in ANEEL's Resolution 343, from December 4th, 1998. Figure 12 shows an example of a river potential defined in the inventory.

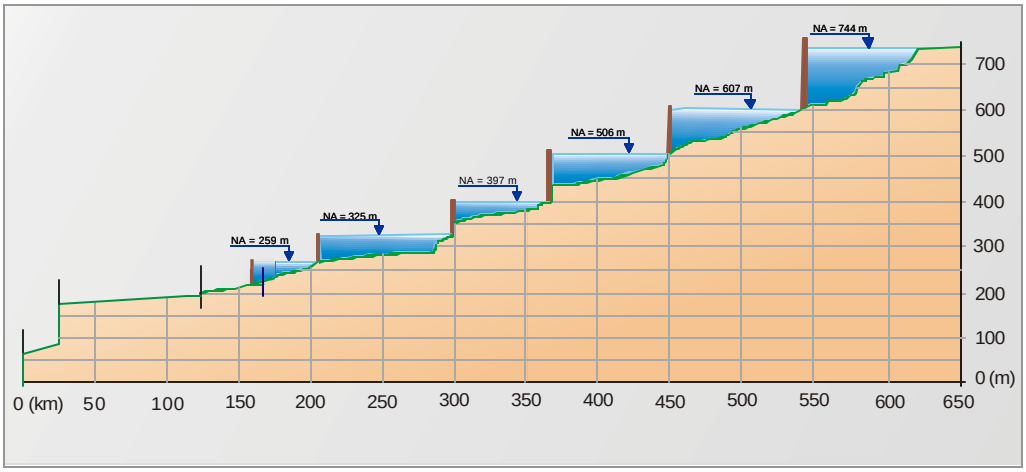


Figure 12 – River Division Defined in the Inventory Studies

Since 1998 it has been inventoried more than 60,000 MW, as we can see in Figure 13. It is interesting to notice that the major concentration of studies happened between 2001 and 2003, period related to the energetic crisis, showing that the private initiative responds to the economic signals: low demand leads to higher price that brings new investors to the sector.

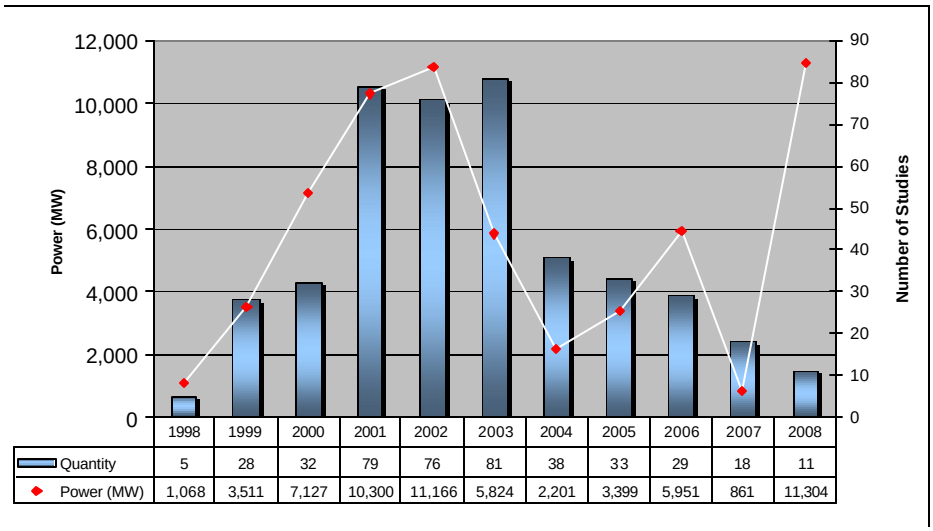


Figure 13 – Inventory Studies Approved
Source: SGH/ANEEL (2009)

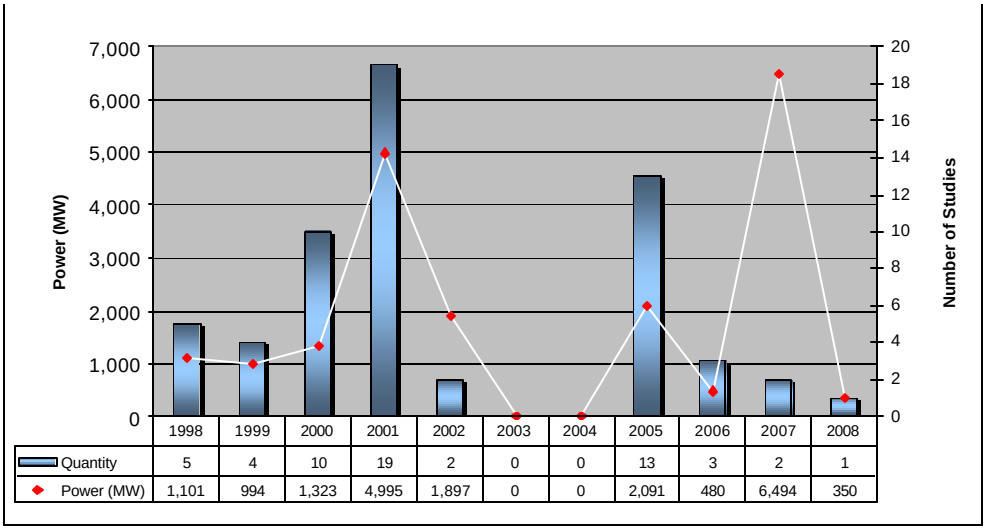
3.2.2 Feasibility Studies

In the Feasibility Studies is defined the global conception of a project specified in the inventory studies, intending to optimized the technical, environmental and economic aspects and also assessing the cost and benefits associated. This conception comprises the plant dimensioning, the local and regional infra-structure

required for it implementation, the reservoir and the influence area, other water uses and environmental actions (ELETROBRAS, 1997).

In this stage is defined the size of the plant, mainly the minimum power to be installed. Hydropower plants with power less than 30 MW, known as Small Hydropower Plants – PCH, in account of the fact that their grant process is simplified, are dismissed of presenting the feasibility studies. The PCHs only need to present the Basic Project according to the inventory studies approved, which it will be analyzed by ANEEL.

It is worth to emphasize that the Hydropower Plants Grant Auction are based on the Feasibility Studies for plants bigger than 30 MW (UHE). Assessing the list of Feasibility Studies approved, once again we can notice a concentration of studies approved in 2001, year of the energetic crisis. We can also see that in 2003 and 2004 no project was approved, period related to the change in the electric sector institutional model.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Quantity	5	4	10	19	2	0	0	13	3	2	1
Power (MW)	1,101	994	1,323	4,995	1,897	0	0	2,091	480	6,494	350

Figure 14 – Feasibility Studies Approved.
Source: SGH/ANEEL (2009)

Combining the lack of approved studies with the changes in the institutional model we can verify that the investors, mainly those involved in long term projects, are in opposition to surprises. While the rules are not well defined, there is not evolution in the investments.

3.2.3 Energy Auctions

The Auctions to buy energy from the new generation plants were established in Law 10848/04 and in Decree 5163/04, modified by Decree 5499/05. These auctions aim to assure the energy supply for the distribution utilities. These utilities, connected to National Integrated System – SIN, through the energy auctions promoted by the government, must guarantee all the energy necessary to supply their entire market, according to Law 10848 and Decree 5163.

The lowest tariff criteria (Decree 5163/04) is used to define the auction winners, that is, the winners are those who offers the energy for the lowest price per MWh to supply the demand stated by the distribution utilities. The contracts in this regulate environment are known as CCEAR and they are celebrated between the auction winners and the distribution utilities. Only after that, the plant is granted.

If we consider "A" as the year when the energy supply will begin, the schedule for the auctions execution is:

- In the fifth year before the year "A" (**Auction A-5**), is performed the energy auction for new generation plants.
- In the third year before the year "A" (**Auction A-3**), is performed the energy auction for new generation plants.
- In the year before the year "A" (**Auction A-1**), is performed the energy auction for existing generation plants.

The auction proposal for the system expansion considers that the increase in demand must be supplied by hydropower and thermo generation in an appropriated mix that assures a deficit risk of 5% in a minimal cost. As this generation plants require more time to be implemented the auctions are performed five years before (A-5).

On the other hand, as it is not possible to accurate predicted the demand growth for the next five years, there is a huge possibility that this difference will be detected and covered through the A-3 or A-1 Auctions. Evidently, the amount of energy to be contracted in these auctions is less than the amount contracted in the A-5, because they are complementary and adjustment auctions, respectively.

Since the sectorial model has been instituted in 2004, it has been performed 7 energy auctions; two of them were specific auctions for the Madeira Complex Hydropower Plants – Santo Antonio e Jirau, in Rondonia State. From the amount of energy negotiated in these 7 auctions, which is more than 17,000 MWmed, only 37% are energy from hydropower plants. The remaining energy is from thermo power plants, as we can see in Table 6 and Figure 15.

Table 6 – Amount of Energy Negotiated by Source of Energy

Hydraulic Source	**6,420**
Thermal Source	**18,858**
Oil	4,731
Natural Gas	1,942
Mineral Coal	1,498
Liquefied Natural Gas	968
Biomass	927
Diesel	582
Others	210

Source: CCEE (2008)

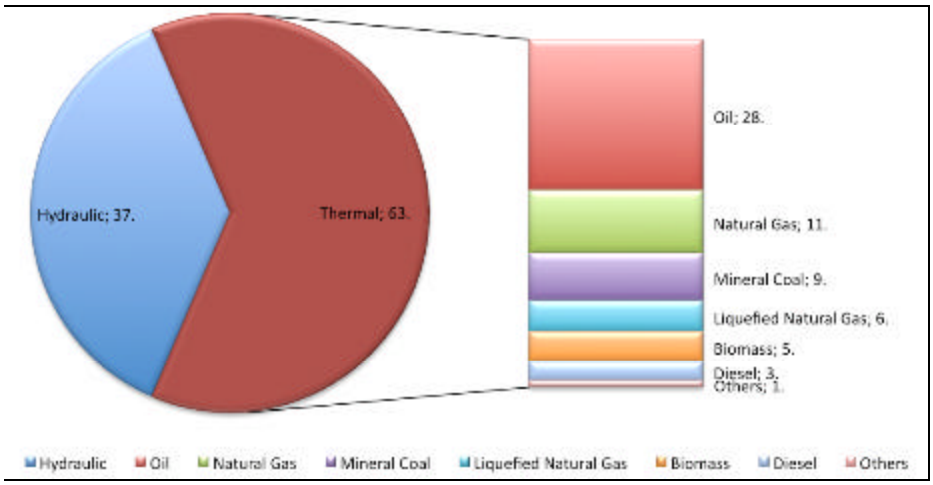


Figure 15 – Amount of Energy Negotiated by Source of Energy.
Source: CCEE (2009)

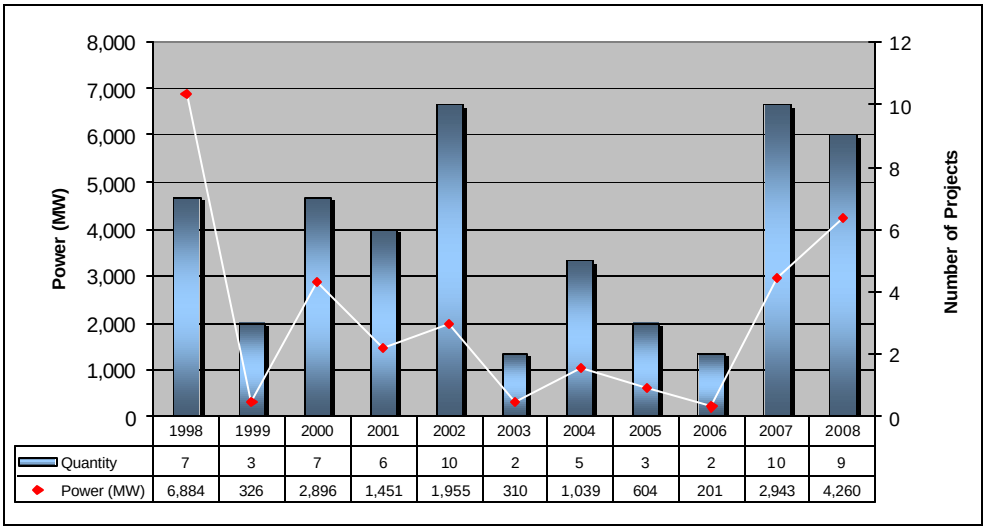
When the government established the auctions based on lower tariffs, in order to attend the ACR demand, the ACL was unable to contract energy from new hydropower plants. To solve this problem, it was allowed that part of the energy from the new plants could be sold in the ACL, for a price freely negotiated.

Nonetheless, the auto-producers of energy, those who generates energy for their own consume, evaluate that the government policy that establishes that the lower tariff have to be offered for the consumers connected in a distribution utility, it is, in fact, subsidized by the free market, which presents the higher prices. From the amount of energy negotiated in auctions from January, 2005 to June, 2008, which represents 7,849MW from new hydropower plants, none was addressed to the auto-producers.

In the previously model, when the auctions were based on higher premiums, in the 1997 auction, from the 1,122MW of energy auctioned, 7% were purchase by the auto-producers. In 1998, the autoproducers acquired 19% from the 2,446MW auctioned; and, in 1999, the only hydropower plant offered in the a auction also was granted to the auto-producers. The auto-producers were also responsible to purchase 42% of energy auctioned in 2000; 48% in 2001 and 51% in 2002 (ABIAPE, 2008).

3.2.4 Basic Project

The power plant project detailing is made in the so-called Basic Project, according to the feasibility studies. In this stage, the budged can be defined with more precision in order to provide to the entrepreneur sufficient conditions to implement the plant. Also in this stage, the basic environmental project is developed. The criteria and procedures to develop the feasibility and basic studies were defined in Resolution 385, from December 4th, 1998.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Quantity	7	3	7	6	10	2	5	3	2	10	9
Power (MW)	6,884	326	2,896	1,451	1,955	310	1,039	604	201	2,943	4,260

Figure 16 – UHEs Basic Project Approved.
Source: SGH/ANEEL (2009)

3.2.5 Small Hydro Plants – PCHs

For the PCHs the grant process is simplified, auctions are not required. The entrepreneur receives only an authorization to implement the plant. Besides the simplified grant process, the PCHs receive a number of benefits from the government in order to increase the investments in this field (ANEEL, 2004). Among these incentives, there are:

- authorization free of charges to explore the hydropower potential (Law 9074/95 and Law 9427/96);
- a minimum discount of 50% in the tax to use the transmission and distribution system (Law 10438/02; Resolution 281/99 and Resolution 219/03);
- free energy trade with consumers or group of consumers with load equal or superior to 500 kW (Law 9648/98 and Law 10438/02);
- free energy trade with consumers or group of consumers in the isolated system, whose load is equal or superior to 500 kW (Law 10438/02);
- Exemption from paying the Financial Compensation (Law 7990/89 and Law 9427/96);
- Participation in the apportionment of the fuel consumption bill in the isolated system (Law 10438/02);
- Exemption from paying R&D (Law 9991/00);
- Trade of energy with distribution utilities using as price ceiling the normative value defined by ANEEL.
- Participation in the Energy Relocation Mechanism – MRE (Decree 2655/98, changed by Decree 3.653/00 and Resolution 169/01);
- Participation in the Program to Stimulate Alternative Sources of Energy – PROINFA, established to increase the energy produced by renewable sources (Law 10.438/02, Law 10.762/03 and Decree 4.541/02).

Considering this, the PCHs represent a fast and efficient way to promote the Brazilian energetic expansion and; therefore, to supply the growing demand of the national market. This kind of enterprise also helps the transmission system to attend the peripheral areas, in small urban areas and rural areas; besides that, PCHs complement the National Integrated System – SIN (ANEEL, 2004).

The new electric sector model, when introduced the incentives to small hydro plants, has attracted the private investors for the generation sector, stimulating the increase in the numbers of projects that have more competitive price and bring less environmental impacts (ANEEL, 2005). In this context, there has been a raising in the interest for this kind of plant.

However, the Federal State shouldn't allowed that the appeal for PCHs, because of the benefits offered, compromise the use of the entire hydraulic potential, mainly when the installed power is close to 30 MW, the limit for a PCHs. Obviously, the economic and financial feasibility is an important factor to be considered because the investor aim the profit, and there is no problem with that. Nevertheless, the government should search for the best way to explore the Union assets aiming the common interest.

The following figure presents a graphic that shows the evolution of the PCHs' basic project in the last years. It is remarkable the raise in the number of the studies approved since 2001, year of the energetic crisis, until 2004, when the new sector model was established, and the private investors ran away from the biggest projects, main target of the new sector model. After 2004, once again we can notice an increase in the numbers of projects approved, reflecting the State concern with this kind of plant.

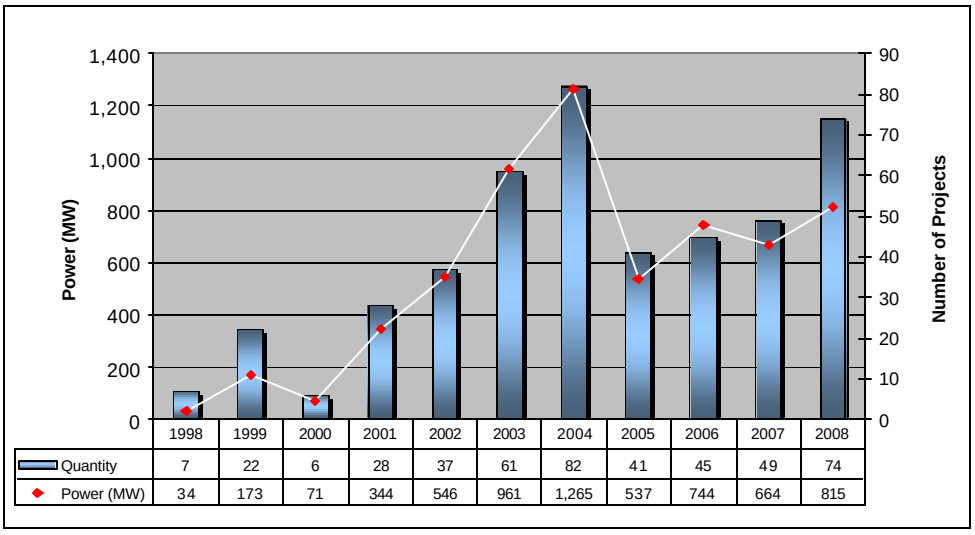


Figure 17 – Approved Basic Project of PCHs
Source: SGH/ANEEL (2009)

3.2.6 Environmental License

The environmental protection presents itself as a main and inseparable principle of the economic activity in the Federal Constitution. Therefore, it is not admissible private and public activities that violate the environmental protection. The Law 6938/81 established the environmental license as a preventive tool to protect the environment and join it preservation with the economic and social development.

It is important to emphasize that the Federal Constitution established in article 225 that everybody has the right to have an environment in balance, a common use good for the people and essential to assure a well quality of life. And the public power and the people have the duty to defend and preserve the environment for the present and future generation.

In this context, the environmental license is an authorization issued by the competent public institution to the ones interested in developed a certain activity according to the environmental legislation, intending to protect the collective right to an environment ecologically balanced.

The licensing process has three stages, each one evolving a different license: preliminary, installation and operation, following a logical sequence. However, not every economic activity requires an environmental license.

The Law 6938/81 specifies that activities that uses the natural resources and are considered potentially polluting must have environmental license. In the electric sector, it is always necessary to get a license; however, depending on the size of the plant, the process can be simplified or even dismissed.

The Preliminary License (LP) confirms the project environmental feasibility, approves it location and conception and defines mitigation measures to be taken in the next stages. In the LP is also defined the conditions to make the project compatible with the preservation of the environment affected by it.

To obtain the LP, the entrepreneur must develop an environmental impact study and the environmental impact report, which must be approved by the environmental institution. These studies must contain:

- Probable social and environmental impacts related to the project;
- Size and range of the impacts;
- Measures to eliminate or mitigate the impacts.

In the process to obtain the LP, the sectorial institutions located in the project area must be heard, and the environmental impacts and mitigation measures must be discussed with the local society in public hearings.

Once the LP is granted, the entrepreneur assumes the obligation to follow the project according to the requirements established by the environmental institution. If he doesn't, the LP can be cancelled.

After getting the LP, the project is detailed and the environmental control measures begin. The Installation License (LI) must be requested to the environmental institution before the work begins. At this point the environmental institution verifies weather the project is compatible to the previously stage.

The Installation License certifies that:

- The works can begin;
- The environmental institution accepted the project specification, environmental programs and implementation schedule.

? The conditioning factors from the LP were accomplished.

In the LI the environmental institution might establish environmental control measures in order to assure the environmental quality standards during the project implementation. The LI can also define new conditioning factors.

The Operation License (LO) authorizes the entrepreneur to begin his activities. It aims to approve the way the enterprise and the environment will live together and to establish conditioning factors for the continuous operation of the project.

The LO has three basic characteristics:

? Granted after the previously conditioning factors had been accomplished;

? Contains environmental control measures that will limit the enterprise operation;

? Specifies the conditioning factors necessary for the enterprise operation. This conditioning factors are mandatory and if not complied results in the LO cancellation.

3.3 Water Availability Reserve – RDH

Law 9984/00 establishes in article 7 that a hydropower grant requires a declaration of water availability reserve issued by the federal water agency, if the river is federal; or by the state water institution, if the river belongs to the state.

This tool aims to reserve the water discharge to be granted, allowing the investors to plan the projects that will need this resource. Specifically in the case of the hydropower plants, this RDH intends to guarantee that the water necessary to generate energy won't be used in a different way.

Therefore, the RDH assures the water necessary to the power generation, allowing the establishment of the guaranteed energy. However, it is important to say that the RDH do not grant the right to use the resource, it is used to reserve the water quantity necessary to make feasible the power plant.

In federal rivers, the Brazilian Water Agency (ANA) established through Resolution 131/03 the criteria to obtain the RDH. Therefore, ANA considers in it evaluation:

- The present and planned use for the water resources in the watershed; and
- The potential benefits of the hydropower plant, whose impact is preponderantly in nationwide.

4. DIFFICULTIES TO IMPLEMENT HYDROPOWER PLANTS

As we can see from the sectorial planning, the hydropower generation must prevail in the Brazilian electric matrix as the main source of energy. To accomplish this, theoretically, the energy auctions should reflect this perspective; that is, the auctions should sell more energy from hydropower plants and it should only be complemented by thermopower plants.

Nevertheless, this hasn't been happening. As we can see in Figure 15, only 37% of the energy traded in the auctions comes from hydraulic sources. Considering that about 4,000 MWmed from this amount belongs to Jirau and Santo Antonio plants, in the Madeira Complex, we can realize that the hydraulic energy is even more restricted.

When we assess the situation of the plants currently under construction, we see that the situation is also worrying, with significant delays. The following tables present the predicted schedule for operation from the plants granted (UHE) and authorized (PCH) and illustrates the problem.

Table 7 shows that 11 UHEs, summing more that 2,500 MW, have serious problems that prevent their implementation; therefore, their schedules are completely compromised. Four enterprises, about 2,300 MW, present some kind of obstacle, what must affect the implementation schedule and consequently the beginning of the operation.

Besides that, many of the 24 enterprises that don't have any obstacles for their implementation present other kind of difficulties to make viable. In this cases, the original schedule must be adjusted and postpone; however, these adjustments give the wrong idea that that everything is normal when, in the fact, the original planning are compromised.

Table 7 – Schedule to be in operation for UHEs

Status	Qtd	2009	2010	2011	2012	2013	2014	2015-16	No Prev.
No impeditive	24	826	2.213	1.646	644	859	859	788	-
Impeditive	4	-	-	-	-	1.050	150	2.100	-
Serious Impeditive	11	-	-	-	-	-	-	-	2.530
TOTAL	39	826	2.213	1.646	644	1.909	1.009	2.888	2.530

Source: *SFG/ANEEL - Relatório de Acompanhamento da Expansão da Oferta de Geração Hidrelétrica* (February, 2009)

Although, in theory, the PCHs cause less impact, because of their size (ANEEL, 2005), they also have finding difficulties in the environmental licensing process, as shown in the following tables.

From the PCHs that got the environmental license, 20 present serious problems to be implemented and don't have any perspective to be in operation. Other 65 have obstacles for their implementation and might have the schedule compromised. For the PCHs with no obstacles, applies the same said about the UHEs.

Table 8 – Schedule to be in operation for the PCHs with environmental license

Status	Qtd.	2009	2010	2011	2012	2013	No Prev.
No impeditive	77	900	276	-	-	-	-
Impeditive	65	-	308	238	1	-	264
Serious Impeditive	20	-	-	-	-	-	310
TOTAL	162	900	584	238	1	-	574

Source: *SFG/ANEEL - Relatório de Acompanhamento da Expansão da Oferta de Geração Hidrelétrica* (February, 2009)

For the PCHs with no environmental license, the situation is even more serious. Only 39 MW, from the 1,170MW that are in this situation, has any kind of forecast to be in operation.

Table 9 – Schedule to be in operation for the PCHs with no environmental license

Status	Qtd	2009	2010	2011	2012	2013	No Prev.
Impeditive	28	-	9	-	30	-	434
Serious Impeditive	45	-	-	-	-	-	696
TOTAL	132	-	9	-	30	-	1.130

Source: *SFG/ANEEL - Relatório de Acompanhamento da Expansão da Oferta de Geração Hidrelétrica* (February, 2009)

The tables above indicate the situation of the hydropower plants considering the original schedule. We can see that more than 4,000MW have no prediction to be in operation mainly because of environmental issues.

As it will be shown, we cannot blame only the environmental licensing process. Many other players and entities involved in the process have some of the responsibility, including the own agents and the problems inherent to the process.

It is premature to conclude that the Brazilian electric matrix will no longer be clean, mainly if we consider that the hydropower energy it is the main source. However, if remains the shortage of energy from the hydropower plants, along the time, we might see changes in the matrix structure that it will affects the Brazilian natural tendency to have a renewable matrix.

4.1 Difficulties in Obtain the Environmental License

The difficulty in obtain the environmental license has been indicated as the main reason why the power generation has not been increasing as expected and in a reasonable time.

The most part of the problems regarding the environmental license in Brazil happens in the first stage – Preliminary License. These problems include lack of appropriate government planning, lack of clear rules defining the role of the federal and state government, delays in defining the Terms of Reference for the environmental impacts studies (EIA), poor EIA, inconsistent EIA analysis, lack of a system to solve conflicts, lack of clear rules regarding the social compensation and lack of specialists in social issues in the environmental institutions (World Bank, 2008).

The insecurity brought by the uncertainties regarding the environmental licensing process contributes to the risk perception associated to the hydropower generation. To make the hydropower grant process more reliable, the government starts to require, as a condition to participate in the energy auctions, in Preliminary License.

If in one hand this requirement aimed to decrease the risk related to the environmental process; in the other hand, it became even harder for the hydropower projects to participate in the auctions. Therefore, the Brazilian energy demand had to be

supplied with thermopower plants, more expensive and more polluting than the hydroelectrics.

There is another complicating aspect regarding the preliminary license requirement to participate in the energy auctions. While we can have one or more entrepreneurs developing studies to auction, only one of them can request the license in the environmental institution. Therefore, we have a paradox in the process. Which player will ask for the environmental license? The first one that developed the studies or the government? These questions still unanswered and it is delaying the process for the projects with more than one player.

Among the problems related to the licensing problems, we have the excessive time required by environmental institutions to issue the Term of Reference (ToR) for the EIA. The maximum time officially established is 30 days, however, the mean time observed is 394 days. Table 10 presents the mean and total time involved in the licensing process.

Table 10 – Mean Time

Status	Issue ToR	EIA Development	1st Public Hearing	Last Public Hearing	LP	LI Requirement	LI	LO
Legal Value (IBAMA)	30	-	270			-	150	-
Average	394	220	239	24	82	144	132	1100
Accumulated	394	613	852	876	958	1103	1235	2335

Source: World Bank (2008)

The delay in issuing the ToR makes the entrepreneurs begin to develop the EIA even before it. For that reason, usually the studies don't fit the standard established by the environmental institution. For that we have many studies revision, which demands more time to have the process concluded. The reduction in required time to issue the ToR would significantly contribute to reduce the licensing process period.

Another extremely relevant point that makes the environmental licensing process hard refers to the fear that the environmental institutions' employees feel in suffer any law suit regarding the Environmental Crime Law and Administrative Improbity

Law. These laws define criminal responsibility to government's employee, even when it is done in good faith.

On account of that, the employees responsible for the environmental licensing process develop a conservative behavior, asking for complementary information aiming to postpone the final decision. This fear, associated to the bad quality of the studies, increase the necessary time to issue a license that in average is almost 3 years.

Additional to this, we notice that there are a few sectors in the Brazilian society that are against the hydropower plants. This position is not always based on technical arguments but in ideological aspects. And they use all the legal tools to avoid the development f the hydropower projects.

Aiming to diminish the risk related to the environmental license, the hydropower projects have been developed restraining at maximum the environmental interference, what makes the plant to be smaller, less efficient and more expensive, limiting the scale economy benefits and the regularization capacity.

Additionally to the list of restrictions applied to the hydropower plants, we have the interferences with the indigenous areas. As this problem hasn't been regulated yet, any interference must be decided by the National Congress, what makes the problem even harder.

The uncertainties in the environmental licensing process associated to the need of more energy, make the electric sector search for projects that bring less impacts instead of those with better cost-benefits relation. As an example, we have the Belo Monte Plant with many environmental problems that has been postpone even considering that it is more economic attractive than others.

Considering that, the marginal expansion cost that should be growing along the time, showing the scarcity of energy, presents a oscillatory behavior, what can be seen in the energy auctions, as shown in Figure 18. If the projects with better cost-benefits relation were feasible, the average energy price would increase e not decrease as we have seen.

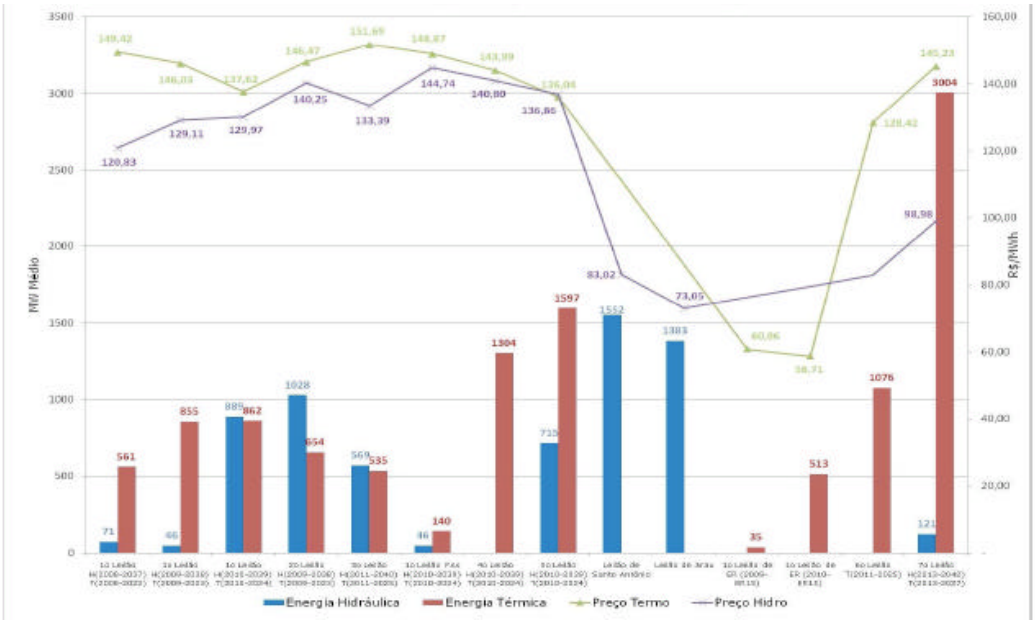


Figure 18 – New Energy Auctions Results
Source: CCEE (2008)

Reflecting the raise in the environmental demands, the brazilian storage capacity has growing very little. The last big plant with regularization capacity was built in 1998. The restrictions applied to the storage capacity of the hydropower plants contributes to reducing the safety of the whole electric system in cases of hydrological adversity, constructing of more plants to supply the drought period and more energy from the thermopower plants.

The following Figure shows a comparison between the evolution of the installed power and the storage capacity. In the graphs, we can see that mainly after 2000, there was a decrease in the storage volume, reflecting the recent characteristics of the hydropower plants.

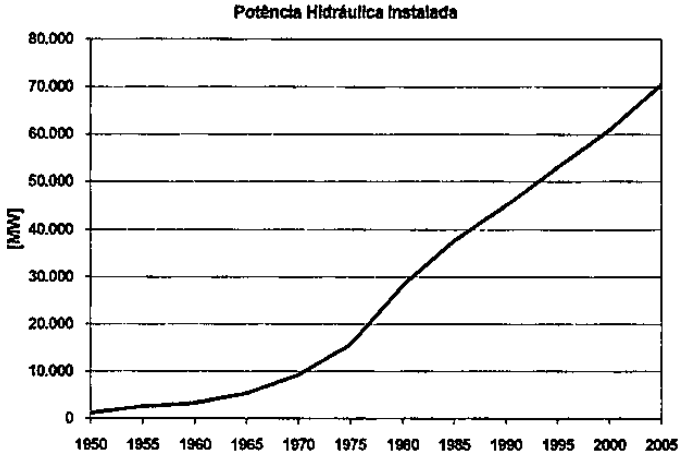


Figure 19 – Installed Power
Source: TCU (2008)

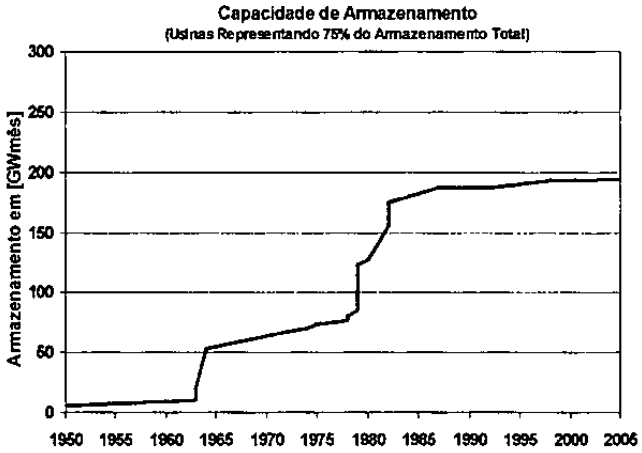


Figure 20 – Storage Volume Evolution
Source: TCU (2008)

4.2 Public Prosecutor's Office Action

Related to the social and environmental issues, the Public Prosecutor's Office – MP acting has contributed to hamper the hydropower projects. The Federal Constitution from 1988 attributed to the MP functions and technical conditions that surpass other public institutions, including the Judiciary (World Bank, 2008).

The unlimited autonomy that the prosecutors have and the fact that there is no hierarchy in the institution are important aspects related to the difficulties to implement a hydropower project. The prosecutors develop technical and administrative

acts typical from the environmental institutions. Besides that, they use the veto and police power to intimidate and restraint the civil servants and authorities acting.

The MP uses it wide power to interfere in issues that are not direct or clearly under it legal or technical competences, in an open disrespect to other institutions. Thus, the MP is interfering in the energetic matrix definition in the environmental licensing process and in the environmental impacts valuation, attributions from the Ministry of Mines and Energy and from the environmental institutions.

Therefore, constantly the hydropower plants projects are taken to the Judiciary, compromising it implementation schedule. The MP action makes hard to establish the priorities that are economic and environmental important, to define the space organization and to establish goals to supply the energy demand.

4.3 Energy Price Volatility

The classic supply and demand curve suggests that a good is offered as much as it price increases. When the price is low, there is no interest in produce the good. This reality has reflecting in the brazilian energy market. Usually, the energy price in the spot market is very low, increasing only in a lack of energy perspective. Figure 21 shows the energy price evolution in the four brazilian markets (South, Northeast, North and Middle West/Southeast) since the 2001 energy rationing.

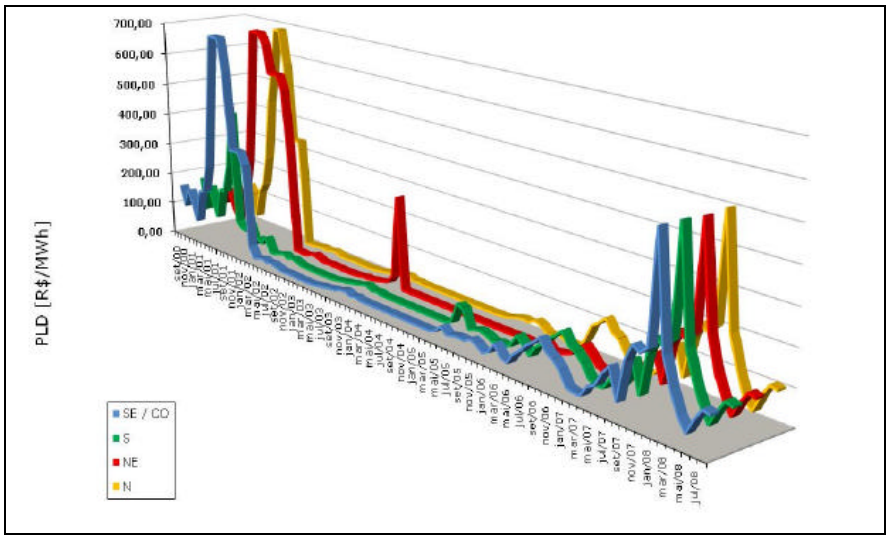


Figure 21 – Energy price evolution during the time
Source: CCEE (2008)

As it can be seen in Figure 21, in 2001 rationing period, the energy price reached the ceiling price allowed by ANEEL, reflecting the energy scarcity. However, after this period, the energy price dropped down and almost reached the minimum price. The price stayed in this level until 2006; but, in 2008, when there was a risk of energy scarcity, the price raised again.

Associated to the price volatility it is the amount of Power concessions and authorizations granted along the time. In the periods when the energy price is high the amount of grants raise, reflecting the interest in produce more energy. On the other hand, when the energy price is low, the rhythm decreases. Table 11 and Figure 21 indicate this behavior.

Table 11 – Amount of Concessions and Authorizations Granted

Type	1998 - 2003	2004	2005	2006	2007	2008
UHE	54	0	9	2	2	3
PCH	486	70	60	55	25	105
UTE	776	160	110	128	110	371

Source: ANEEL (2009)

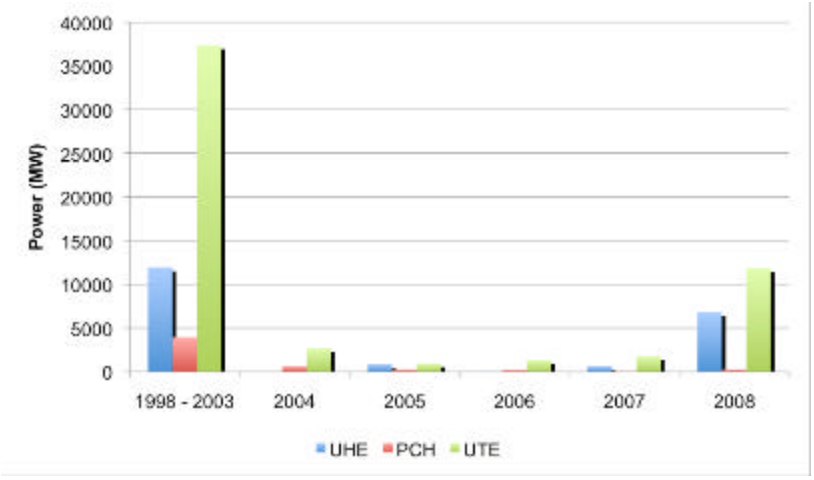


Figure 22 – Energy price evolution along the time

Source: ANEEL (2009)

We can see that the thermopower plants price presents a response time that is faster than the hydropower plants price, on account of the fact that it grant process is simpler. The hydropower potential, because they belong to the Union, has a more complex grant process, as it was described in section 3.2.

The process to build a thermopower plant, including the project stage, grant, construction and operation rarely goes over 3 years. A hydropower plant, on the other hand, takes at least 10 years, from the inventory study to the operation stage. Considering that, the thermopower plants take a great advantage over the hydropower plant because it developing period is considerably small. However, the energy produced through the thermopower plant is more expensive and polluting.

When we compare the number of concessions granted with the number related to sector expansion, we can see a difference between the two numbers caused by the difference in the energy price from the grant period to the construction time, plus the difficulties in environmental licensing. Taking into consideration the long time to implement a hydropower project, frequently the energy price has decreasing what doesn't stimulate the project implementation, mostly in the cases that there is no power purchase agreement – PPA already negotiated.

In those cases, the entrepreneurs use some measures to postpone the beginning of the construction, hoping that the energy price increases. In many situations, they use the licensing process to justify the delays in construction schedule.

Besides that, there are many speculations in the hydropower market. Some agents get the grant but in fact they don't have real interest in build the plant. They are only interested in sell the grant rights. In the same way, these speculators postpone the construction until they find someone interested in buy their grant.

Usually this kind of behavior is more common in small hydro plants where the process is free of charge and the grant is normally not associated to a power purchase agreement. This behavior was also found in the previous sector model for UHE, when the auctions didn't require a PPA.

Another point that deserves to be mentioned regarding the energy price refers to how the energy tariff is defined in Brazil. According to the present model, the energy price is not directly transferred for the final consumer tariff because the tariff is only calculated each four years.

Therefore, when the energy price rises in the spot market, which indicates that the market is foreseen lack of energy, the final consumer doesn't notice the

decrease in the energy supply once it tariff still the same. As the tariff doesn't change immediately, there are no incentives to reduce energy consumption, what contributes even more for the deficit risk. In the next tariff revision, maybe 4 years later, the consumer will realize that the energy is more expensive; however, at that time the supply will be normalized.

4.4 Hydropower Project Supply

With the market model, the federal government transferred to the private sector the responsibility in expanding the Brazilian generation. Therefore, studies that used to be developed by Eletrobras, a state-owned company, were no longer developed, reflecting a restrain fiscal policy. The federal government cut the budget which affected the mainly the infrastructure sector (World Bank, 2008).

However, as it was said before, the private sector answers to the financial stimulus – the energy price. While the energy price is low there are no incentives to invest. To worse the situation, the period between the lack of energy perception, when the price raises, and the implementation of a hydropower plant, are not compatible.

For that reason, it is not possible to supply the demand only with projects developed in the period of energy scarcity, because these projects required a long period of maturity. Recognizing this problem, the government reestablished the planning figure through the MME and in 2004 created the Energetic Research Company – EPE, a state-owned company, in order to provide planning support and also to develop studies related to the energy sector.

On the other side, aware that the balance between energy supply and demand has not been appropriated, the private investors have invested in studies and projects. As shown in Figure 13, Figure 14, Figure 16 and Figure 17, there was a great amount of studies and projects in the period of the 2001 rationing. Afterwards, there was a decrease in the following period, when the energy price was low, and recently the process has restarted, foreseeing a raise in the energy price. Nowadays, there are 1,600 studies and projects been developed, as presented in the following table.

Table 12 – Amount of Studies and Project being developed

KIND	PHASE	QUANT.	POWER (MW)
INVENTORY	INV-PHASE OF DEVELOPMENT	279	-
	INV-PHASE OF ACCEPTED	40	1,567
	INV-PHASE OF ANALYSIS	15	15,170
	INV-COMPLEMENTATION	7	506
	INV- PARALYZED	2	278
	INV-ANALYSIS TO PROCEED	81	2,852
	TOTAL	424	20,373
PCH	PB-PCH -PHASE OF DEVELOPMENT	528	1,744
	PB-PCH -PHASE OF ACCEPTED	57	521
	PB-PCH -PHASE OF ANALYSIS	20	365
	PB-PCH -COMPLEMENTATION	17	173
	PB-PCH -ANALYSIS COMPLETION	166	1914
	PB-PCH - ANALYSIS TO PROCEED	238	2,888
	TOTAL	1,026	7,604
UHE	VB-UHE -PHASE OF DEVELOPMENT	130	10,334
	VB-UHE -PHASE OF ACCEPTED	5	717
	VB-UHE -PHASE OF ANALYSIS	8	12,076
	VB-UHE -PARALYZED	8	2,821
	VB-UHE -ANALYSIS TO PROCEED	3	2,000
	TOTAL	155	28,298
UHE	PB-UHE -PHASE OF DEVELOPMENT	7	1,765
	PB-UHE -PHASE OF ANALYSIS	16	6,607
	TOTAL	23	8,372

Source: SGH/ANEEL (2009)

It is important to say that many studies and projects mentioned above have been developed for more than one interested, manly in PCHs. Besides that, we also have EPE developing studies in competition with private investors. This means public money being invested instead of private money. Besides that, because EPE is a state-owned company, it has a great competitive disadvantage once it has restrictions to make services contracts and other legal restrains.

Still related to the possible conflicts in studies development, many cases refer to speculative process where the investors are only interested in create difficulties

for the other competitor and later obtain some economical advantage. Hence, it is not expected that all studies will be concluded, what diminishes the expected final amount.

Even considering the conflicts and speculative cases, the amount of studies and projects are considerably great. Nevertheless, despite the great amount in many stages, at this moment there is no project to be auctioned because of the lack of the environmental license. Thus, in the short-term there are no projects to provide the expected energy expansion – about 4,000MW/year, accordingly to the decennial plan for 2007-2016. It will also take many years to rebuild a project portfolio appropriated to the national interest. In this period, the thermopower generation in the electric matrix will increase.

4.5 Insufficient Personnel

Assessing the amount of studies and projects approved by ANEEL, as shown in Figure 13, Figure 14, Figure 16 and Figure 17, we can notice that approvals are at maximum 144 per year, and the average in the 3 years with higher quantities – 2001, 1002 and 2003 – is 134 studies.

Considering the performance in the most productivity years and the amount of process that has been analyzed in ANEEL, according to Table 11, we can see that the amount of studies is much higher than the agency personnel capacity. Even considering that a significant part of the studies that are been developed will not be concluded, the number is still substantial.

Analyzing the numbers related to projects and studies that have already been done, it is preoccupant the amount of inventory studies whose analysis even have been started by ANEEL. To this amount we still have to add other 40 studies that are in acceptance stage (a stage previously the analysis). These studies sum 4,400 MW of power that are not available and could contribute to diminish the pressure and conflicts in the later stages.

Differently from the PCHs' basic project, that demands the environmental license to have their analysis started, the inventory studies that have not been yet analyzed by ANEEL are a liability that must be solved by the Agency.

ANEEL has only a few employees that works with studies and projects analysis. Until 2008, there were only 12 regulation specialists analyzing projects and studies from the whole country. Nowadays, the number raises to 20; however, the new employees still need to be trained to fully accomplish their activities.

Taking into account the reduced personnel, in case of important projects, like the Madeira River Power Complex for example, a great number of employees left their currently activities to be dedicated to those analysis. Because of that, other areas, like the inventory studies are impaired.

Therefore, we have a dilemma: the amount of studies approved and ready to be implemented is beneath the ideal; but, in the other hand, the government has no condition to analyze the amount of new projects that have been present by the investors, in the regulatory agency or in the environmental institutions.

5. MEASURES TO ASSURE THE HYDROPOWER PARTICIPATION IN THE SECTOR EXPANSION

In order to have the hydropower plants competing in the energy auctions with the thermopower plants, it is necessary to adjust the required time to supply the demand with the required time to implement the hydro plant. For that, we have to keep a stock of studies and projects available for the investors.

In principle, it doesn't matter whether the State or the private investors develop these studies. However, it is not reasonable that the State invest money in studies that the private initiative is willing to invest. The State, more specifically, the EPE must develop studies that are not attractive for the private investors, as those located in indigenous areas or under environmental protection.

For those cases that the private investors have interest in, is much more productive that the State follows the studies development instead of competing for them. And to do this, both ANEEL and EPE have prerogative. Beyond that, when following the studies development, the government can foreseen if there is a scarcity of energy risk, due the lack of studies and projects, and has enough time to provide them.

Besides that, we can avoid conflicts with the environmental institutions, especially IBAMA, that it will receive only one environmental study. Incases where the conflict already exists, the reasonable solution is that the ToR be issued on ANEEL's behalf that forward to all agents concerned.

As IBAMA only will receive one study, this study would be developed together by all concerned investors. The diagnosis analysis could be done in partnership and the other analysis could be done individually.

In a certain way, for the environmental institution this solution is interesting, because it will have to assess the environmental impact in the different alternatives proposed by the agents and points out the one that brings more benefits to the environment. For ANEEL this solution would also be appropriated because the Agency could closely follow the studies development and would have better conditions to plan it activities.

ANEEL already works at this way with ANA – Water National Agency – regarding the water resources grant. This indicates that this solution is technically feasible and provides more reliability to the process taking into account that we have government institutions dealing with the issue.

On the other side, it is not sustainable that the private initiative only develops studies when we have unbalance between energy supply and demand. It is necessary to have incentives to make the studies development a continuous activity, keeping an amount compatible with the energy supply expansion.

Following these considerations, in the revision of Resolution 395/98, regarding PCHs, a percentage of plants in a river is destined for those who elaborated the inventory studies. Therefore, a study that is developed by the investors, who takes all the risks, counts on a good incentive to be done.

Moreover, it is not reasonable to have a great number of studies and they keep waiting for approval in the government institution, in this case ANEEL, because of personnel shortage or bureaucracy. The personnel issue is a problem for almost every public institution so it should not be the focus point. Therefore, we should to find a solution by simplifying the procedures and the analysis; but not compromising the final result quality. The amount of personnel it is a consolidated situation and hence it is necessary to surpass this issue and find the best solution.

An important aspect when dealing with the present sector model is that the product we are interested is the energy itself and not plant constructions. This means that we can not be concerned about the technology proposed by the agents to construct a plant and to generate energy. Our focus point has to be the amount of energy generate from that plant.

Considering that, and also considering the personnel restrictions, it is clear that ANEE must center it attention in the issues that are directly related to the hydropower, making the process quicker. For example, in issues related to estimated parameters that involve statistics' studies, as the hydrology studies, for instance, ANEEL must pay attention in order to avoid data manipulation that may affects the hydropower potential.

This approach is possible because who is responsible for the plant project is the company's engineers. So, considering that they will apply the best techniques and they are certified professionals, other aspects of the project, those that not depends on statistical data or value estimation, shouldn't be ANEEL's concerned. In Resolution 395/98 revision, ANEEL has already embraced this concept, aiming to make the process quicker and to solve the liability problem.

The Resolution 395/98 revision has also the purpose of avoid speculation. As the process used to free of charge, many agents ask a study register only to create difficulties for other agents or to create a stock to sell later. To solve that, ANEEL start to require a guarantee deposit that will be returned after the plant starts it operation.

Regarding the viability studies, the agents have interest in develop them aiming to get an advantage in the auction because of the knowledge acquired. Therefore, as soon as we make these studies available for other agents less information asymmetry we will have. The main point is to assure that all concerned agent receive the extensive and necessary data necessary to develop their proposal and make a better offer, which means a lower energy price.

Assuring the competition between the concerned agents, the worries about the ceiling price are reduced because they all have conditions to offer their best price. Thus, we can define the ceiling price based on the marginal cost to expand the generation instead of a reference value for each hydropower project.

In the UHEs' basic projects, the analysis must be focused in the parameters related to the Concession Contract – minimum power, assured energy, numbers of machines, spillway discharge, etc). Once again, the technology used is not ANEEL's concerned as long as the entrepreneur delivered the purchase power and energy.

This kind of measures can give agility for the process. It can also allow the Agency to give more consideration to the inventory studies. These inventory studies require an especial attention because they will be the reference for the following studies. An inappropriate choice in this stage can compromise the best use of the hydropower potential and it will cause delays along the process.

Because of the inventory studies complexity, it is not possible to analyze only the aspects listed above. It is necessary to have a wider overview. In the present scenario, issues, like the definition of the plants location versus the environmental impact, have a great importance and is one of the main causes for the delays in implementing a hydropower plant.

Additionally, it is important to say that in the inventory studies the environmental licensing process hasn't begun yet. The environmental institutions enter in the process only in viability stage, for UHEs, and in basic project stage, for PCHs.

Therefore, when a study arrive in the environmental institution, it general conception is already defined. There is little space for changes and a lot of pressure over the environmental institution to get the study approved.

If the environmental institution decides for a change in the dam's water level, aiming to diminish the reservoir, there will be a huge impact in the amount of energy that will be generated. If there were any sign of this change during the inventory studies, the inventory studies could be changed to find the new best way to use the hydropower potential.

In this context, it is important that the environmental institution discloses it decision during the inventory stage. This decision wouldn't be final but it will be very important to indicate the difficulties to implement some projects. In that case, it would be possible to review the inventory studies, aiming to adjust it in a way that it will cause less environmental impacts. If the present model remains, it will still be very hard to achieve the best choice, considering both the economic and environmental aspects.

Moreover, if there is an environmental assessment in the inventory stage, it is expected that the time required to issue the ToR will be smaller, which it is very important considering that, nowadays, it takes a long time, as seen in section 4.1.

The electric sector have already introduced in the inventory stage the Integrated Environmental Assessment – AAI – and this assessment can be submitted, with some modifications, to the environmental institution analysis. The AAI was created to complement and consolidate the social-environmental studies, aiming to highlight the

cumulative and synergic studies resulting from the negative and positive impacts created by the plants.

It is important to emphasize that many times the inventory studies already consider the minimum impact to the environment. However, the inventory studies doesn't register the part of the hydropower potential that is not been used because of the environmental restrictions. Therefore, it looks like that the electric sector is using the whole potential and it is not concerned with the environment, what it is not the truth.

It is relevant that the inventory studies dismiss an alternative only because of technical reasons, describing the criteria used. With this, it will be registered that the environmental issues were considered in alternative selection. Hence, with consistent technical studies it will be easy to defend the choice alternative.

It is also important to draw attention to the fact that the hydropower plants not only bring negative impacts. UHEs pay a financial compensation for the cities affected by reservoir, can help control the floods and they are an important development tool, contributing for the tourism, fishery and other related activities.

The awareness of the importance of hydropower plants for the local development and national growth must disclose for the whole society. It is not acceptable to avoid hydropower plants only for ideological reasons. Institutions like the Prosecutors' Office must promote the public debate and not inhibit it, as it has been done, threatening the civil servants that manifest themselves in favor of the hydropower plants.

The public institutions can't be above the own State and the Constitution. At the same way, these institutions' rules, mainly those with veto and police power, can't be interpreted and used according to it own free-will.

It is necessary that there is respect and strengthening of institutions' role along the hydropower implementation process. It is not admissible that for each IBAMA's decision there is a lawsuit from another public institution.

Issue like this only contributes to raise the risk perception of the investors, because it shows how fragile the process and the institutions involved are. Besides that, lawsuits demand an extra time to be solved, delaying even more the whole process.

6. CONCLUSION

The lack of energetic alternatives in a medium term, the energetic safety and the global warming make extremely necessary the use of the brazilian hydropower potential. Potential that is mainly in the amazon region. Brazil needs to be ready to explore it potential in an efficient and social responsible way.

New plants must be planned, built and operate to supply the energy demand. However, we know that the hydropower plants interfere in the environment and cause people involuntary relocation; there are many ways to conciliate energy generation with the social and environmental issues.

Make the Brazilian society and the government be aware that the hydropower generation was and will be an important advantage for Brazil, comparing to other countries, it is the great challenge.

To achieve this advantage, Brazil needs to improve the investment environment, with low risks, with better regulatory agencies and judiciary's performance and an environmental licensing process more efficient. However, the market signals or the incentives won't be effectives if the investors weren't able to implement the plants.

Nowadays, we see that the demands regarding the hydropower environmental license are huge and the benefits that these plants brings regarding the greenhouse effect are not take into consideration. A hydropower plant licensing process is more demanding than the thermopower plant process, which causes a bigger global impact. The assessment has been restricted to the local scale, it has not been analyzed the synergic impact brought by all the thermopower plants installed in Brazil.

By now, the increase of the thermopower plants in the energy auctions is due the lack of hydropower plants projects available to be auctioned. And this happens because there aren't enough studies approved and also because of the environmental issues. If these difficulties continue, slowly we will see a change in brazilian's electric matrix.

The deficiencies involved in the process to implement a hydropower plant need to be overcome in order to create an environment attractive for the investors that

are searching for new opportunities. Attracting investors is the only way to keep competitiveness and to assure low tariffs.

It is important to reinforce that the delays associated to the hydropower plants' project approval frustrates the market and raise the project costs; and, consequently, the energy price. The investments in generations were perceived as riskier, reflecting the importance of a regulatory environment that can offer positive incentives for the investors.

Despite the difficulties, the private initiative has been developing studies and projects, expecting an unbalance between energy supply and demand – with energy price increase – what cannot be sustainable with this scenario doesn't happen. Therefore, to keep the private investors interested it is necessary to offer benefits that stimulate the development of these studies.

While the private investors are developing studies and projects to increase the energy supply, the government mustn't compete with them. The government must only proceed with there is a disarrangement between what it has been developed with what it was demanded. Consequently, it is necessary an active and responsible planning from the MME and EPE, and this planning must realize, in a reasonable time, the deficit risk in order to avoid a rationing.

The government, through the regulatory agency, must assure competition conditions for all the concerned agents, aiming to minimize the information asymmetry between the ones who elaborate the studies with the others. The government still must have conditions to analyze and approved the studies in the speed demanded by the market.

This is a crucial point that needs to be solved. Improvements regarding the PCHs have already been done through the Resolution 395/98 revision. But it is still necessary make some progress regarding the inventory studies and viability projects. For the inventory studies, the challenge is make the analysis faster and more efficient, so the hydropower plants can be sooner made available for the society. For the viability projects, the main issue is solve the procedures with the environmental institutions when there are more that one investor interested, aiming to aggregate more quality to the studies, considering that it will be more than one alternative.

Quality is, in fact, the main key to speed up the process; even regarding the engineering project or the environmental studies. Well elaborated studies accelerate the projects analysis and approval.

The world financial crisis made every government decrease the energy growth projection for the next years. So, that can be Brazil's great opportunity to solve the problems related to the hydropower plants, mainly those related to the environmental licensing process and the amount of projects ready to be auctioned.

Having a good projects portfolio and an efficient and transparent regulatory environment, the electric sector can be a solid and rentable business chance, in a moment when the international market is looking for safer opportunities in a long term. To not take advantage of this window to attract investors it will be harmful to the society that it will pay more for the energy in the future years.

The energy supply needs to follow the demand raise generated by the economic growth. The supply raise can be done through hydropower plants, cheaper and more efficient, or through the thermopower plants, dirtier and more polluting. There are still the nuclear plants, but they take a very long time to be built, and other sources of energy, the so-called alternative sources, that are few and more expensive. The society will have to decide.

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