6. DETERMINING FACTORS IN THE CONSTRUCTION OF HYDRO ELECTRIC POWER PLANTS IN THE AMAZON: REASONS FOR CLAIMING DAMAGE PAYMENTS [1]

José Alberto da Costa Machado [2]
Rubem César Rodrígues Souza [3]

1. INTRODUCTION

The hydrographic network in Brazil covers an approximate area of 8,512,000 km^2. It extends over almost the entire Brazilian territory and comprises eight main water basins (see section 2). Hydroelectricity currently amounts to 90% of the total energy mix in the energy sector. This dependence was caused by the use of this hydrographic network for generating electricity.

---

1 This work was carried out under the auspices of the South-South Cooperation Program for Eco-development (UNESCO) in order to subsidize a publication on Issues Concerning the Local and the Global Use of Water in the Amazon by the Center for Advanced Amazonian Studies of the Federal University of Pará.

2 Associate Professor at the University of Amazonas (Department of Economics). He holds a doctorate degree in Socio-Environmental Development from the Center for Advanced Amazonian Studies / Federal University of Pará and a Master's degree in Systems Engineering and Computer Science from the COPPE / Federal University of Rio de Janeiro. E-mail: zemachado53@hotmail.com

3 Associate Professor at the University of Amazonas (Department of Electrical Energy). He holds a doctor's degree in Energy Planning from the State University of Campinas and a master's degree in Mechanical Engineering from the Federal University of Itajubá. E-mail: rcsouza@internext.com.br / rubem_souza@yahoo.com.br

Up until the 1980s, the South, the Southeast and the Northeast regions most intensely exploited the use of their basins to generate electricity. This was because they were the more developed regions in the country and consequently the regions with the greatest demand for electricity. From the 1970s onwards, basins in these regions became economically less attractive to large investments. As a result, the vast unknown basins in the north of the country became an interesting prospect as studies identified them as demonstrating the best cost-benefit ratio for the construction of hydroelectric power plants.

These hydroelectric power plants were initially to serve the Northeast region, and supply consumers in the aluminum industry and in the field of metallurgy that had recently set up business in the Amazon (as was the case with the Tucurui hydroelectric power plant). They were also intended to serve isolated local markets (Manaus and Porto Velho). Afterward, they would serve potential consumers in the South/Southeast region. The intention was to take advantage of the rain and drought regimes at the basins at various times in these regions.

Plans for the development and implantation of hydroelectric power plants began to be implemented from the 1980s. However, this did not entirely correspond to the beginnings of the conflicting relationship between the electricity industry and the interests of the region. The objective of this exercise is to ascertain the nature of this conflict of interests. This is carried out by firstly examining the history and secondly, analyzing the consequences brought about by the changes on the region that occurred in the sector in the 1990s. The latter seeks to understand the driving force and the nature of the dynamics that led to the construction of hydroelectric power plants in the region. One fundamental question needs to be answered: which factors determine the demand for hydroelectric power plants in the Amazon?

2. ELECTRICITY IN BRAZIL AND IN THE AMAZON: A BRIEF RETROSPECTIVE

2.1. From regional operation to national integration

The development of the electricity industry in Brazil[4] can be divided into seven important phases: *early stages*[5], *implantation*[6], *regulation*[7], *expansion*[8], *consolidation, nationalization,* and *privatization*.

During the *consolidation phase* (1962-1973), procedures began in order to systematize and integrate the activities of participants whose actions were relevant to the sector. The first step would eventually lead the sector to a model of activity based on integration and on centralized management as demonstrated in the integration of Rio de Janeiro, Minas Gerais and São Paulo (1963) which took place after the Furnas Hydroelectric Power Plant began operating. They can also be seen in the creation of the Integrated Operation Coordinating Committee (1968), which was later replaced by Integrated Operation Coordinating Groups (1973), that was set up to broaden the scope of activities with regard to the integration and centralization of operations. These steps also included the comprehensive studies on demand trends and on possibilities for offering electricity in the Southeast by utilizing its own energy potential. The goal was to prevent energy shortages occurring in the most dynamic region of the country. In order to achieve this, initiatives were taken in order to use hydroelectric potential in the South and the North. This includes the construction in 1973 of ITAIPU and the creation of the Amazonian

---

4 The historical evolution of the sector can be found in *MEMÓRIA DA ELETRICIDADE* (2002) and *ESCELSA* (2002)

5 ***Early Stages*** (1879 – 1899): this is when small thermoelectric and hydroelectric power plants were established. They had a local influence and were designed mostly for public lighting or for supplying streetcar lines with energy.

6 ***Implantation*** (1903 – 1927): this stage is characterized by the financial support received from Canada (Brazilian Traction, Light and Power Company, a Canadian company known as "Light") and by the financial support received from the U.S.A. (American & Foreign Power Company, a North-American company known as "Amforp"). Various large hydroelectric and thermoelectric companies began operating during this phase.

7 ***Regulation*** (1934 – 1945): this includes publishing the Water Code, which was created by the National Council on Water and Energy, the regulation of the situation of thermoelectric plants, the regulation of the calculation of fees and the creation of state and federal companies to act as public agents in the production of energy.

8 ***Expansion*** (1952 – 1961): there was an increase in the number of federal and state companies (Furnas, Escelsa, etc.). The Ministry of Mining and Energy was created. ELETROBRÁS was established in order to coordinate the Brazilian electrical energy sector.

Coordinating Committee for Studies on Energy, founded in 1968. This Committee was at the origin of the creation of ELETRONORTE.

During the *nationalization phase* (1975-1986), this linked and centralized operation model became the major basis for the operation of the sector. Committees were created in order to achieve that goal. They include the Committee for Distribution in the South-Southeast and the Coordinating Committee for Operation in the North-Northeast (1975). Light Electrical Services, Inc. was nationalized in 1979. The National System for Supervision and Coordination of the Operation was established in 1979. The- Coordinating Group for Planning Electrical Systems was created in 1982. The first large hydroelectric plant, Tucuruí, started operating in the Amazon in 1984, making it possible for the North-Northeast Linked System to begin operating. Finally, the South-Southeast Transmission System was implanted in 1986. Its objective was to transport electrical energy from the Itaipu Hydroelectric Power Plant to the Southeast of the country.

The *privatization phase* (1988-1999) began with a comprehensive institutional review of the sector, which took place in 1988. This review guided all of the changes made in the electricity sector in the 1990s. In 1990, the National Privatization Program began to be implemented. A new regulatory agency for the sector was created in 1997 - the National Electrical Energy Agency (ANEEL); in 1990, the National Electric Energy Transmission System (SINTREL) started operating. Its objective was to make the generation, distribution and commercialization of energy sectors competitive. The Wholesale Energy Market (MAE) was regulated in 1998. This reinforced the distinction between the activities of generating, transmitting, distributing and commercializing energy. During this phase, the linked and centralized operational model maintained its consolidation process through the implementation of the National Operator of the Electrical System (ONS)[9]. Its objective was to replace the former Linked Operation Coordinating

---

9 Until 1998 ELETROBRÁS coordinated interconnected operations through the Linked Operation Coordinating Groups. In that year, as part of the reorganization in the electric sector, the National Operator of the Electrical System (ONS) was created. Its objectives were to manage the National Linked System and the basic energy transmission network in the country. Its institutional mission was to ensure continuity, quality and economy with regard to electrical energy supplies to users of the National Linked System. The National Operator of the Electrical System works to maintain synergic gains related to the coordinated operation, thus creating conditions for a fair competition among agencies in the sector. The ONS was created by Law 9.648/98 and Decree 2.655/98. Its operation was authorized by ANEEL through Resolution 341/98. The National Operator of the Electrical System took over the management of the National Linked System on March 1, 1999. The ONS is a non-profit civil society organization. It manages the National Linked System through the distribution of responsibilities among agencies (companies responsible for generating, transmitting and distributing energy). It follows the rules, methodologies and criteria established in the Network Procedures – approved by the agencies themselves and ratified by ANEEL. ONS (2000)

Groups (1998) in the management of the National Linked System (SIN). It was also responsible for putting the first level of the North-South interconnection into practice. This was a fundamental step for the integration of the electric sector in the country and also for the final adaptation of the sector to the interconnection and centralization of operations.

2.2. Evolution of the energy sector in the Amazon[10]

The national conditions for the use of regional hydroelectric potential began in 1934 when the ownership of waterfalls and the responsibility for regulating their use were turned over to the government, which was set up through the Water Code. The regulation of the price of electricity started to be based on its cost[11] rather than on the mechanisms that pegged it to the international price of gold. From the 1930s onward, during the Getúlio Vargas administration, there was a sharp increase in national industrial and energy sectors. This was especially true for oil and electricity. This increase was followed by a surge in industrial development (during that decade, the industrial sector grew 125% while the agriculture sector grew by only 20%). This triggered the first dynamic boost in the electric sector. However, contrary to what was happening in the rest of the country, where public and private initiatives began to take place in the Amazon (the number of private energy generation plants increased 30.9% in that decade), these changes did not happen. This was due to the lack of economic activity in the region. Up to 1939, a few early thermo-power plants generated all of the electricity in the Amazon.

The creation of the Single Electricity Tax (*Imposto Único sobre Energia Elétrica - IUEE*) by the Constitution of 1946 (although it was only implanted in 1954) and the creation of the Federal Electrification Fund (*Fundo Federal de Eletrificação - FFE*) made it possible for the sector to gather funds. This happened through public resources and made it possible for the second dynamic boost to take place in the sector. The Federal Government started creating its own distributors in various regions of the country. It also started making investments in the Amazon. In 1952, the Federal Government created the Manaus Central Electric Operation (*Centrais Elétricas de Manaus-CEM)*. There were other initiatives: in 1956, the State of Amapá established the Amapá Electrical Company (*Companhia de Eletricidade do Amapá-CEA)* and in the same year, the Pará Lighting Power Company *Companhia de Força e Luz do Pará – FORLUZ),* was founded. However, during this decade there were no significant energy initiatives in the Amazon, especially in terms of hydroelectric power plants. The reasons for this are described below:

---

10 This section is based on SOUZA (2000). Thus, where there is no specific citation, this is the reference.

11 The value of the fee to be paid for electrical energy should be defined based on operational expenses, taxes and fees, depreciation reserves and payment of the resources invested.

1 Public sector investments were minor and did not involve state governments. The main objective of the federal government was to supply major cities with energy. There was no commitment to rural municipalities;

2 The interests of other regions in relation to investments in the sector minimized the possibilities for the development of the sector in the North. At first, the objective of the distribution of the Single Electricity Tax among the units of the federation was to transfer resources to less developed regions. Regulation Decree 40.007 of September 20th, 1956 established that the Federation would receive 40%, states and the Federal District would receive 50% and municipalities would receive 10%. However, the criteria for the distribution were: population - 50%; electricity consumption - 40%; territory - 4% and electricity generation - 1%. It was obvious that Northern states were disadvantaged, for it was only in terms of territory that the States of Pará and Amazonas really had an advantage, but in general this criterion was irrelevant compared to the other criteria;

3 President Juscelino's goal plan, in which the energy and transportation sectors were responsible for 73% of the programmed investments and consolidated the control of other regions over access to the revenues generated by the Single Electricity Tax and by the Federal Electrification Fund. It overshadowed the needs of less dynamic regions.

Also, in relation to the second dynamic boost in the sector, Amazonian interests were not considered. They were neglected while great efforts were made in other regions regarding energy power plants.

In the 60s, concern with supplying the interior of the region with electric energy was on the agenda of the regional state public authority. In 1961, ELETROBRÁS was created, and planning in the electrical sector became its responsibility (until now, it was a responsibility of the National Economic Development Bank), as was the management of the Federal Electrical Fund. This was the reason for the establishment in 1963 of the Amazonas Central Electric Operations (*Centrais Elétricas do Amazonas, S. A. – CELETRAMAZON)*, of the Acre Central Electric Operations (*Centrais Elétricas do Acre* - ELETROACRE in 1965, of the Rondônia Central Electric Operations (*Centrais Elétricas de Rondônia, S. A.* - CERON) and of the Roraima Central Electric Operations (*Centrais Elétricas de Roraima* - CER), both of which were established in 1971. These were all government initiatives whose objective was to supply the interior of these States with energy and to replace the obsolete wood and diesel-powered plants. The potential of these initiatives was amplified by the establishment of a new federal policy for the development of the Amazon[12], which would obviously require an increase in the number of energy-generating facilities.

However, this third dynamic boost in the sector, which now specifically occurred in the region, came up against the interests of other regions. In 1969, due to a new federal development policy for the region, the Ministry of Mining and Energy established a tax incentive for distributors of electrical energy in the North and in the Northeast whose purpose was to expand their investments. This incentive involved giving them a discount on the income tax they would have to pay, making it possible for them to make investments. Despite the fact that this was a federal initiative to support its own policies, which were in progress, there were people who opposed it. In 1971, the tax rate decreased from 17 to 6%. In any case, it was in the 1960s that the region began having access to more energy. Thus, its consumption profile reached a new level (see Table 1).

TABLE 1: Per Capita use of electricity in the Amazon (in KWh/inhabitant).

State	1961	1970
Rondônia	97	38
Acre	24	30
Amazonas	22	114
Roraima	19	70
Pará	47	102
Amapá	186	173
Region	**43**	**101**

Source: Brazilian Institute of Geography and Statistics Foundation - IBGE (1991a).

12 This new policy was known as *Operação Amazônia* and was established through a set of legal tools from 1966 to 1967. Law n. 5.173 of October 27, 1966 established these basic guidelines: to establish development centers and stable population groups, to foster immigration, to encourage private capital, to develop infrastructure and to carry out research on potential natural resources. Economic guidelines were based on the implantation of the Northeast development model in the Amazon; industrialization via the substitution of funded importation for internal/external private capital, making the public sector responsible for attracting resources to the region via monetary and tax mechanisms and establishing infrastructure. Geopolitical guidelines were based on fostering the occupation of the region (especially borders) via interregional and international migration, meeting the level of occupation of Amazonian regions in other countries. The basic administrative structure of the new phase was the Superintendence for the Development of the Amazon (SUDAM) and the Bank of the Amazon (BASA), which was the funding source for SUDAM.

The total per capita consumption in the region more than doubled during the decade, and this despite the population growth by migration. Pará and Amazonas should be highlighted not only because the new development policy first had an effect in these regions but also because in other states public investments in the area of energy generation was to take place only at the end of the decade. Even though there was an increase in the use of electrical energy, the energy consumed in the region amounted to only º of the average national consumption, equal to 398 kWh/inhabitant. This demonstrates the inequalities in the way the region was dealt with in relation to other regions.

However, as pointed out in section 2.1, at the end of the 1960s, concerns with limitations of the water potential in the Southeast started to emerge. To counter this, the sector turned its attention to the North, especially to the Amazon. In the Coordinating Committee of Amazonian Studies on Energy (ENERAM) was created in 1968. The results of this Committee were the basis for the creation of ELETRONORTE[13] in 1973. For reasons unacceptable to Amazonians, the company was initially based in Rio de Janeiro and subsequently established in Brasília. ELETRONORTE began as a company *for* the region and not a company *of* the region, or at least a company *in* the region.

In 1974, by means of Decree no. 1.383, tax equality was included in the system. This meant that throughout the country the same fees would be applied for the use of electricity. The objective of this measure was to encourage the development of regions where the price paid for the service was high. A compensation system was created, the General Guarantee Reserve (RGG - *Reserva Geral de Garantia*), whose objective was to transfer resources from companies with revenues exceeding the maximum remuneration of 12% a year. This would guarantee that other companies receive at least 10% a year. Since the approval of federal administration taxes was a responsibility of the Ministry of Planning, the economic definition of these values was frequently used for other purposes, including combating inflation. This provision led to a dramatic decrease in remuneration levels in the national electrical sector. The financial damage was still worse in economically less dynamic regions. In addition, this same tax system contributed to maintaining regional inequalities. This aspect will be discussed later, when the National Linked System is analyzed.

In 1975, effective measures were taken so better use would be made of Northern potentials. However, they were not adopted for the benefit of the population. They were adopted to give support to investments in the areas of mining and metallurgy, whose demand for energy was high (Vale do Rio Doce and C. Ithoh, a Japanese company, had

---

13 ELETRONORTE was created by Law 5.824 of November 14, 1972. At first, its sphere of activity encompassed the States of Amazonas, Pará, Acre, Mato Grosso (north of the 18º south parallel) and Goiás (north of the 15 º south parallel) and the territories of Amapá, Roraima and Rondônia. In March, 1980, ELETRONORTE's sphere of actuation was altered. The State of Maranhão, the entire State of Mato Grosso and the area in Goiás, north of the 12 º south parallel, were included.

announced the establishment of an aluminum factory in Belém a year earlier). This is the reason why the Tucuruí Hydroelectric Power Plant was built in the State of Pará, which was ready in 1984. For this investment

> "*… the Japanese were gently exempted from spending any money by the Brazilian Government ... under the pretence of consuming only 30% of the electrical energy. This saved the Japanese seven hundred million dollars. In 1975, when construction began on the hydroelectric power plant, its cost was estimated at two and a half billion dollars. By the time it was inaugurated, nine years later, it had cost five billion and four hundred million dollars...*"(SOUZA, 1994).

David Zylberstajn (apud. Magalhães *et al,* 1996) commenting on the exogenous nature of the interests that had fostered the construction of this hydroelectric power plant, noted:

> "*The obvious injustice in relation to priorities concerning the use of the energy produced (currently largely excedent) clearly demonstrates the inadequacy and dishonesty of the motive* (referring to the use of energy for the development of the region). *The separation of the Tucuruí project from regional development is made clear by the existence of hundreds of thousands of unassisted or badly served citizens living in the surroundings of the hydroelectric power plant. The opportunities that were lost in terms of regional development are enormous".*

Table 2 shows the huge increase in electricity consumption in the North from 1970 to 1980. However, this increase did not have the same effect in the economy of the region because its objective was to serve specific companies. While the increase in consumption reached 432%, Table 3 demonstrates that the number of industrial establishments had grown by only 223.3%. Table 4 demonstrates that the participation of the North in the amount paid to industrial workers rose slightly from 0.81% to 1.97%. The value of production rose from 0.89% to 2.05% and the regional acquired value went from 0.99% to 2.58%. The increase seen by these indicators was not even close to the increase in energy consumption. This suggests that the fourth dynamic boost in the sector did provide benefits to the region, at least not at the same rate.

TABLE 2: Use of Electricity in Northern States (1970/1980.)

States	Use in GWh (1970)*	Use in GWh (1980)**
Rondônia	5.8	145
Acre	8.2	55
Amazonas	145.8	681
Roraima	3.9	36
Pará	263.2	1291
Amapá	8.3	107
Norte	**435.2**	**2,315**

* Source: IBGE (1991a)
** Source: National Energy Summary – 1989

TABLE 3: Institutions and People Working for the Industry in the North (1960/1980)

Year	Number of institutions		Workers	
	Number	Increase	Number	Increase
1970	3,196	—	40,229	—
1980	7,169	124.3%	130,093	223.3%

Source: Brazilian Institute of Geography and Statistics - IBGE (1991b).

TABLE 4: Salaries, Production Values and Industrial Transformation – North (1970/80)

Year	Salaries		Industrial Production Values		Industrial Transformation Values	
	Brazil (Cr$ 1.000,00)	Contrib.of the North - %	Brazil (Cr$ 1.000,00)	Contrib.of the North - %	Brazil (Cr$ 1.000,00)	Contrib.of the North - %
1970	12,637.981	0.81	118,427.561	0.89	54,837.311	0.99
1980	675,559.465	1.97	9,618,082.869	2.05	3,988,506.259	2.58

Source: Brazilian Institute of Geography and Statistics Foundation - IBGE (1991b).

In 1980, ELETRONORTE took over the energy generation system at the Pará Electrical Centers (CELPA), formed by the Miramar, Tapanã I and Tapanã II power plants. In addition, in 1980, the hydroelectric power plant of Balbina[14] began construction in the State of Amazonas with a total installed capacity of 250 MW. In 1982, the construction of the hydroelectric power plant of Samuel in the State of Rondônia began. By mid 1984, the transmission system at Tucuruí already began to serve part of the State of Pará. This was possible because of the connection with the São Francisco Hydroelectric Company (CHESF) that exported the exceeding energy on to ELETRONORTE. However, the reason the energy was passed on to ELETRONORTE by the São Francisco Hydroelectric Company was, above all, to guarantee that ELETRONORTE's large industrial consumers, like Albrás/Alunorte in Pará and Alcoa/Alumar in Maranhão, could be served. This energy also supplied the Pará Electrical Centers (CELPA). Very little of this extra energy went to the population or served regional interests. In 1983, ELETRONORTE began to transfer energy from Tucuruí on to the Maranhão Electrical Centers (CEMAR), and by 1984, the Goiás Electrical Centers (CELG) began receiving energy as well.

In 1995, a big opportunity arose in the electric sector (Laws no.8.987/95 and 9.074/95). This change involved promoting competition in the sector of energy generation and the free access to transmission while defining the basic network whose expansion would be subjected to bidding. This included the right for large consumers to choose suppliers and determine fees based on bidding prices or the market value. It also included the creation of Independent Energy Producers, the mandatory completion of unfinished projects and the creation of measures to facilitate the privatization process. The effects brought about by this change on the region will be analyzed in section 2. Currently (2001), the states in the North receive their energy supplies from isolated systems[15], except for the city of Belém and a few municipalities in the State of Pará. Table 5 demonstrates this distribution.

---

14 This is an example of how technical and supposedly scientific aspects may have an impact on the region in terms of the construction of hydroelectric power plants. Balbina did not generate as much energy as it was expected to. A huge area was flooded, which seriously harmed Indian populations (Waimiri-Atroar). It made it impossible to live in the areas surrounding the tributaries of the Uatumã and of the Abonari; the submerged forest was putrefied.

15 Electrical systems that are not linked to the National Linked System and that provide the rest of the country with electricity.

TABLE 5: Isolated Systems in the North – 2001

State	Company / Location	Installed capacity (MW)	
		Hydraulic	Thermoelectric
Amazonas	Eletronorte (Manaus)	250	339
	CEAM (Rural Areas)	—	144
Roraima	Eletronorte (Boa Vista)	—	90
	CER (Rural Areas)	10	15
Acre	Eletronorte (Rio Branco)	—	111
	Eletroacre (Rural Areas)	—	26
Rondônia	Eletronorte (Porto Velho)	216	80
	Ceron (Rural Areas)	—	81
Amapá	Eletronorte (Macapá)	40	70
	CEA (Rural Areas)	—	23
Pará	Celpa (Rural Areas)	33	116

Source: Based on the Electric Energy Information System Newsletter of Eletrobrás (2001)

The table above reveals that approximately 78% of the installed capacity in the region is generated from thermoelectric plants that use diesel oil or other fuel oils. It is worth emphasizing that operational costs at these plants are high, and require federal government subsidies in order to charge fees that are accessible to the population in the region. This masks the true situation in the region; enormous energy production potential though still relying on subsidies and favors. This is the real and awful truth, for despite the fact that the region has great potential, there is a chronic lack of services attending to the needs of the majority of the population living in the Amazon. According to Bertha Becker *et al*. and Magalhães, *et al*. (1996):

> *"It is estimated that in the North, 3,400,000 people do not have access to electricity. The problem is much more serious in rural areas. This is due to the fact that, in some states, energy supply services are restricted to capitals and large cities. Many of the people who live in rural areas do not have access to services of this nature."*

The worst cases in the country regarding rural area access to electricity are found in the states of Pará, Amapá, Acre and Roraima, where the percentage of the population with access to these services varies from 15% to 23%.

3. FACTORS THAT DETERMINE THE CONSTRUCTION OF HYDROELECTRIC PLANTS IN THE AMAZON

In order to analyze the factors that determine the demand for hydroelectric power plants in the Amazon, it is necessary to consider at least the following vectors: the ideology behind the large integrated systems created to meet the demand; the ethics of a supply based planning model; and the important methodology variables that determine supply requirements and the interests of identified participants.

3.1. The ideology beneath the large integrated systems created to meet the demand

Currently, the system of production and transmission of electric energy in Brazil is conceived and administrated in its entirety. The most important part of this system is the National Linked System (SIN). The SIN is the only system of its type in the world in terms of its size and characteristics. It is a large hydrothermal system, with multiple owners and in which most of the energy is produced by hydroelectric power plants. It is comprised of companies from the South, Southeast, Central West, Northeast and part of the North. Only 3.4% of the installed capacity for electricity production in the country is unconnected to the National Linked System. This electricity is produced by small isolated systems located principally in the Amazon.

National Linked System operations are coordinated by the National Operator of the Electrical System (ONS). This organization has already been referred to previously[16]. At year end 2001, its *installed capacity* was 67,987 MW, 60,994 MW, of which 50% was produced at hydroelectric power plants (at Itaipu), 5,027 MW was produced at thermal power plants and 1966 MW was produced at nuclear power plants. Hydroelectric power plants are responsible for most of its installed capacity, located at 12 different water basins in the different regions. Hydroelectric power plants are constructed where the river flow and levels can be better exploited, generally far away from consumer centers. This required that an extensive transmission system be developed in order to safely transfer

[16] More details on the relationship between the ONS and the SIN can be obtained in ONS (2002).

energy to consumer centers. These connections also make it possible for energy exchanges between regions, as well as enabling the sale of energy from one region to be to another. This becomes very beneficial with respect to differences in flow rates at different water basins.[17] By the end of 2001, the network comprised 70,033 kilometers of transmission lines carrying over 230 kV.

The participation of regions where there exists better hydroenergetic conditions in the National Linked System is compulsory in order to serve regions where there are adverse conditions. This normally involves the transmission of the available energy from the North and in the South to increase the amount of energy stored in the Southeast and in the Northeast. The operational and developmental reasoning behind the National Liked System determines certain aspects that characterize the regions. The following aspects are identified below:

a) Contribution for maintaining regional economic inequalities

With regard to the Southeast-Central West region, Table 6 demonstrates that in relation to the total National Linked System, this region possesses almost two-thirds of the total load. Production in this region no longer is sufficient and 4% of the load was imported from other regions. This was the case even when taking ITAIPU production into consideration. ITAIPU production represents 22.3% of total production in the National Linked System. Accordingly, if the National Linked System works to bring energy to high-energy demand areas, clearly the largest consumption region will benefit most from the system, as witnessed in the Southeast. If the National Linked System guarantees energy to the energy production sector with fees that are comparable for all regions, and if it so happens that the largest markets are found in these regions, then motivation for economic expansion to other regions will diminish.

This situation minimizes any eventual comparative advantages that are based on potential or effective energy availability for different regions. This situation obliges society to finance costly policies of regional decentralization, which invariably has little effect. In fact, according to the Brazilian Institute of Geography and Statistics (2001), for the period 1996-1999, the participation of the Southeast-Central West region to Brazilian

---

17 During periods when hydrological conditions are not favorable, thermal power plants contribute as a whole to supply the market. This complementary participation approached–_10.35% of the total production of energy in 2001. In order for this to occur, it is necessary that agents be interconnected and integrated within the system, with the objective of optimizing the use of available resources for the generation and transmission of energy. This would build trust and maximize availability of the supply thus reducing consumer costs.

GDP remained at the same level and experienced only minor growth (during the period: 64.15% to 64.69%). Despite the fact that this region represents almost two-thirds of the total GDP of all regions in Brazil. At the same time, the regions importing energy (North and South) to the Southeast-Central West registered decreases in their participation to the Brazilian economy. The per capita GDP for this period increased by 19.28 % in the Southeast and by 23.68 % in the Central West while the North, which supplies energy, increased by only 10.74 %.

b) Over-exploitation of resources from peripheral regions to serve hegemonic regions

Despite the fact that the Southeast-Central West is the region that generates the most energy (59.7%, Table 6), Table 7 reveals that 54.67% of the total energy exchanged in the National Linked System benefit this region. This suggests that a large part of efforts of generating parks from other regions end up serving the insatiable Southeast-Central West. As a result, the region of origin reaps only extremely small monetary benefits. Transfer fees for exportation from one region to another are prohibited by the Constitution of 1988 (Art. 155, Paragraph 2., item XI, line b).

From the table, it can be seen that the North contributes 40.05% of the total energy exchanged. Thus, presenting us with a paradox: a needy region in all aspects, the Northeast, ends up providing energy to other regions with extremely small returns.

TABLE 6: National Linked System energy, in 2001, in GWh.

Indicators	**North**	**South**	**Northeast**	**Southeast + Central West**	Total	Observations
Load	20,412.10	60,660.30	46,341.00	202,990.80	330,404.20	**Imports**: Come from Paraguay and Argentina for the South. Come from the North (6,687.30) and from the South (2,416.56) for the Northeast. Come from the North (1,156.71) and the South (6,984.59) for the Southeast-Central West. **Exports**: From the North, 6,687.30 go to the Northeast and 1,156.71 go to the Southeast-Central West. From the South, 2,416.56 go to the Northeast and 6,984.59 go to the Southeast-Central West. From the Southeast-Central West, everything goes to the Northeast.
% relative to National Linked System	6.2	18.4	14.0	61.4	100	
Production						
Hydro	28,256.06	55,340.79	36,844.09	171,944.53	292,385.47	
Thermo	0	10,454.29	393.06	22,904.86	33,752.21	
Total	28,256.06	65,795.08	37,237.14	194,849.39	326,137.68	
% of National Linked System	8.7	20.2	11.4	59.7	100	
Importation	0	4,266.46	9,103.86	8,141.39		
% of load from the region itself	0	7.0	19.7	4.0		
Exportation	7,844.01	9,401.24		2,416.56		
% of Production + Import	27.8	13.4		1.1		

(1) ITAIPU production for Brazil was 72,733.91 and includes the Southeast Region. This figure represents 22.3% of the National Linked System and 35.8% of the Southeast + Central West load.

(2) Own load=consumption + losses in generation and transmission.

Source: Provided by the authors based on National Linked System Operations Report (2001)

TABLE 7: Inter-regional and international exchange in the National Linked System, in 2001, in Mwh

From	To	Total	% in relation to National Linked System national energy
South	Southeast-Central West	112,217,352	47.70
Southeast-Central West	Northeast	28,790,616	12.23
North	Southeast-Central West	14,067,684	5.97
North	Northeast	80,175,900	34.08
	National Total	**235,251,552**	**100.00**
Outside of Brazil	National Linked System (South)	51,125,988	
	General Total	**286,377,540**	

(1) MWmed is Average Megawatt. 1 MWmed-year = 8,760 MWh/year. This includes average energy for the examined time period. (2) Argentina, Uruguay and Paraguay represent countries outside of Brazil. (3) ITAIPU is included as a Southeast plant.

Source: Provided by the authors based on National Linked System Operations Report (2001)

Operations for energy potential in the North and South by the Southeast-Central West tend to increase. Table 8 reveals that the energy stored in the system in this region demonstrate a continual loss in storage capacity. In 1999, the maximum stored reached 71% of total capacity. This figure fell to 59.4% in 2000, and to 34.5% in 2001.

TABLE 8: Evolution of Energy Stored in the System in % of maximum storage capacity, 1999/2001.

Year	Southeast-Central West		South		Northeast		North	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1999	71.0	18.1	87.9	52.9	58.7	15.9	83.7	24.0
2000	59.4	22.1	96.2	29.6	71.2	27.5	83.7	29.0
2001	34.5	20.6	98.6	77.0	41.4	7.8	76.4	18.0

Source: Provided by the authors based on National Linked System Operations Report (2001)

c) Imposition of technical and management complexity according to increasing amounts of investment

The introduction of the National Linked System Operations Report of 2001 (ONS, 2001) confirms that SIN administration is extremely complex from a technical point of view. In the year 2001, 586 Norms and Instructions were revised and established in reference to real time operations alone; the Technical Database had 30 million entries. The Supervision and Control Systems for the Operation Centers in all the regions had to modernize as new Network Procedures had to be established in order to regulate National Linked System activities. Technical aspects are so complex that the report states that communicating "complex questions of a technical nature" to the public presents a new challenge to be met.

From a managerial point of view, the complexity is greater still. Faced with the fragmentation of the sector, the National Linked System began to explore a complex and diversified web of interests, of:

- generation agents;
- transmission agents;
- distribution agents;
- independent consumers (those with the right to select their electrical energy supplier);

- the Energy Supplier Market (responsible for energy sales transactions and purchases, through registration of bilateral contracts and accounting and liquidation of sales and purchases of electricity sales on the Short Term Market[18]);
- ANEEL (responsible for the regulation and monitoring of the sector[19]);
- importation and exportation agents;
- ITAIPU Commercial Agent for Energy**;**
- connected regulatory agencies (National Water, Petroleum and Telecommunications Agencies); and
- government representatives (Ministries of Mining and Energy, National Council on Energy Policies, Coordinating Committee of Planning and Growth).

The managerial and technical complexity of the National Linked System becomes a separate issue compared to the political will of government representatives or in relation to the interests of society. The end result is that the demands produced by the technical instruments of this nature tend to become unquestionable truths that need to be dealt with. Otherwise, severe threats of electricity blackouts and economic crises, among other things, would occur. Obviously, this scenario is the result of political choices that are made during periods of gigantic investment undertakings. These choices are based on an ideology of Brazilian power whereby economic growth is the priority at any cost. This ideology does not take other interests into account. Certainly, these choices are not the only options available in supplying energy needs. This is evident in the current focus of transformation in the sector, in search of de-verticalization[20]. This focus recognizes that gigantic vertical action compromises sector operations. Furthermore, the Small Central Hydroelectric Operations (*Pequenas Centrais Hidrelétricas – PCH)* will begin to take on greater importance in the sector in order to:

> *"meet demands near the load centers in areas on the peripheries of the transmission system and in areas that have been marked for national agricultural growth, promoting the remote regions of Brazil."* (ANEEL, 2002:41)[21].

[18] More information may be found on site www.asmae.com.br

[19] More information may be found on site www.aneel.gov.br

[20] Maintaining the interlinking and centralized operation as the backbone of the system.

[21] It is commonly said that interlinking operations increases energy availability in the generation park by 24%, with no investment in new plants or equipment (ROMA JUNIOR, 2001). However, as FERREIRA, 2002, states *"the relative losses in energy in an interlinking system are larger than those in regional systems that are interlinked due to transferring loads over long distances."*

On the other hand, the restructuring process that definitively consolidated the National Linked System includes the deverticalization of businesses as one of its central concerns. It also includes intense commercial competition and free access to the network as well as reducing the role of the State in business functions. Pursuing this logic will certainly bring about a constant increasing need to expand the National Linked System infrastructure, especially in relation to transmission lines. In fact, Table 9 shows that the high-tension transmission system increased by 11% in only 4 years. Forecasts from the National Linked System Operations Report (2001) predict increases of over 10,400 km of additional transmission lines. This represents an increase of over 15%.

This increase is not simply due to expected increases in the sector. It is also due to the increasing distances of generation sources from consumption centers. This situation drive increases in the number of transmission and high-tension lines. This leads to higher costs and more complex technology. Table 9 demonstrates that over half of the registered increase from 1997 to 2001 was for 750 kW lines.

d) Insurmountable structural limitations that force annexation of the North's power and the Southeast's needs

Table 6 shows that nearly 90% of electrical energy generated by the National Linked System is hydroelectric. As stated in ANEEL (2002:17), in spite of the trend to increase other sources *"there is every indication that hydraulic energy will continue to be the primary generation source for electrical energy in Brazil for many years."* This situation creates a serious problem for the future of the sector, as forecasts predict that hydroelectric power, as used today, will run out in two decades (ELETROBRAS, 1994:12). Table 10 shows that the basins located in the regions of largest energy consumption are becoming depleted. The basin of the Paraná River in the Southeast has already used 64% of its existent power and 75% of its stocked power. In the Amazon Basins (Amazon and Tocantins), which represent 51.1% of the total existing power in Brazil, only one fifth - of both existent and stocked power has been used.

TABLE 9: Extension of transmission lines in km, 2001.

Year	Tension in kW												Total and % 97/01	
	230	% 97/01	345	% 97/01	440	% 97/01	500	% 97/01	600CC	% 97/01	750	% 97/01		
1997	30,816.9	—	8,989.6	—	5,936.1	—	13,972.2	—	1,612.0	—	1,783.0	—	63,109.8	—
2001	32,537.3	5.6	9,023.5	0.4	6,667.5	12.3	17,510.1	25.3	1,612.0	0	2,683.0	50.4	70,033.4	11

Source: Provided by the authors based on National Linked System Operations Report (2001)

TABLE 10: Brazilian Hydroelectric power in MW, as of December 2000.

Water Basin	Existent		Stocked		Remaining		Used (total, % per Basin in relation to Existent and Stocked)			
	MW	%	MW	%	MW	%	MW	%	%	%
Amazon River	105,410	40.5	31,889	19.4	73,510	77.0	592	1.0	0.5	1.9
Tocantins River	27,540	10.6	24,831	15.1	2,709	2.8	5,394	8.9	19.6	21.7
North Atlantic/ Northeast	3,402	1.3	2,047	1.2	1,355	1.4	303	0.5	8.9	14.8
São Francisco River	26,319	10.1	23,847	14.5	2,472	2.6	10,473	17.3	39.8	43.9
East Atlantic	14,092	5.4	12,037	7.3	2,055	2.2	2,367	3.9	16.8	19.7
Paraná River	60,378	23.2	51,708	31.4	8,670	9.1	38,580	63.8	63.9	74.6
Uruguay River	13,337	5.1	10,903	6.6	2,434	2.5	294	0.5	22.0	2.7
Southeast Atlantic	9,617	3.7	7,327	4.5	2,290	2.4	2,508	4.1	26.1	34.2
BRAZIL	**260,095**	**100**	**164,599**	**100**	**95,496**	**100**	**60,511**	**100**	**23.2**	**36.8**

Source: ANEEL, 2002:18 and 30.

This overview makes it impossible to imagine another alternative to the supply of electrical energy via the National Linked System to the larger consumption regions. In terms of production dynamics, this would involve annexing power from the North. The following is foreseen in the official planning of ELETROBRAS, 1994: 90:

"In the period 2005/2015, it will be necessary to count on hydroelectricity from the Amazon region in order to supply the North and South. Operations of these plants will begin in the last fifth of the 2005/2010 period with the Belo Monte

Hydroelectric Plant on the Xingu River. This will promote integration of the North/Northeast and South/Southeast systems via Tocantins. In this way, the electrical energy market in Brazil will be supplied by a single national system. This will be the case at least for the isolated systems in the North that represent less than 1% of the total."

As a consequence, the rivers in the Amazon Region will start to be dammed, not because of the needs of the region but so that the region can meet the demands of other regions. National planners impose this condition and there is little scope for these regions to avoid these obligations. Finally, as previously mentioned, the electricity sector is dependent on the National Linked System. There is no other place for expansion of the system other than the Amazon. The beginning of natural gas use for thermal generation has already been identified in different regions in the Amazon. Again, this presents us with another paradox. The region will resolve its energy needs with less damaging sources and yet it will be obliged to accept huge hydroelectric plants[22] to supply other regions. The financial returns to the Amazon will not justify the damage to the environment and to the resources. This vision of the future (2020) of the official planners is stated below:

"Technological advances in transmitting huge blocks of energy over long distances are associated with the drying up of the sources of electric energy in certain regions. These advances provide a relatively rapid process of integration in the Brazilian electrical system.

The Amazon Region tends to be the largest source of energy in relation to generation, transmission and distribution. The Amazon will be integrated into the national network and this will bring about an increase in efficiency and an optimization of resources." (ELETRONORTE, 1999:156)

This situation is not unique to the Amazon. Power generation in the Amazon is finite. According to the National Linked System annexes, a situation will eventually arise when all growth possibilities for hydroelectric power for the National Linked System are exhausted. This inter-relatedness implies that the Brazilian system is held hostage by the very element that allows for its growth. This element is hydroelectricity.

---

22 This is foreseen in Xingu for Belo Monte as well as Altamira; in Tapajós for TA-1; in Madeira for MR-1; etc.

4. THE ETHICS OF A SUPPLY BASED PLANNING MODEL

The operations of the National Linked System, described in the previous section, would not be responsible for causing problems if the planned expansion was based on real social needs and commitments that are in harmony with development objectives throughout all the country's regions. Unfortunately, this does not happen in this way. Projections of demand only take in account market forces. Official planning of the Brazilian electricity production sector becomes a self-serving practice. This is why the greater the demand, the more optimistic scenarios become. The priority is to efficiently serve every aspect that is demanded by economic growth and expansion. With this perspective in mind, the sector plans to meet the demands regardless of the conditions while considering this to be the optimum plan for the sector. Under these circumstances, any effort to reduce the demand that leads to an increase in energy production becomes inconsistent. Social and environmental costs are the inevitable externalities of this relentless conjecture. The premise being that there is a need to supply energy for "development" regardless of the value of the end uses of the energy concerned.

From this point of view, the planning model examines the trend toward growth in the market and analyzes the decisions of large government funded investments. It also identifies the objectives of the important projects while taking into consideration the currents of large migratory flows. Estimates have also been formulated on the potential market based on these flows and they serve as the foundation for planning the expansion of energy supply and consequent generation requirements. Little or no consideration is given to the effective importance these demands may have for society. For instance, environmental costs are not taken into consideration and neither are ethical foundations, as today, they would have to be justified in light of current thinking. An alternative was proposed and demonstrated by Carvalho and Jannuzzi (1994:7-33). This alternative begins by estimating the future energy market by identifying the real needs for goods and services. The alternative anticipates a certain level of societal well being. Energy demands required for all the sectors necessary in the production of these goods and services are then identified. This identification serves as the basis for planning supply growth. In order for this process to succeed the author identifies three basic ethics that simply cannot be ignored: prevalence of a general desire and will to treat the public utility as common property; transparency in the planning and decision-making processes, and harmony with the environment. The results of the application of this method are the numerous constant factors in official planning, which is detailed in Table 11.

TABLE 11: Official estimates of needs and consumption for the generation of electrical energy compared to estimates based on socially effective needs, for the year 2015

Comparative Items	Annual Consumption (MW/year)
1- Alternative Model	
1.1- With no energy conservation programs	560,409,364
1.2- With energy conservation programs	459,920,000
2- Official Model	
2.1- Immediate Scenario (III)	
2.1.1- With no energy conservation programs	767,200,000
2.1.2- With energy conservation programs	661,900,000
2.2- Most Optimistic Scenario(IV)	
2.1.1- With no energy conservation programs	867,000,000
2.1.2- With energy conservation programs	743,300,000
Difference between official intermediate scenario and alternative without conservation	36.9%
Difference between official intermediate scenario and alternative with conservation	43.9%
Difference between most optimistic scenario and alternative without conservation	54.7%
Difference between most optimistic scenario and alternative with conservation	61.6%

Obs.: this table does not include self-production segments (consumption and generation).

Source: Based on CARVALHO and JANNUZZI, 1994: 29 and ELETROBRAS, 1994:18, 80.

Clearly, the differences shown of the assumed ethics of the supply based planning model enlarge consumption forecasts and the subsequent needs for the generation of electrical energy. This creates expectations among all the stakeholders (contractors, equipment producers, financing banks, etc.). These groups may apply pressure so that the forecasts become reality. This perspective and the resulting ethics eventually create the basis for a future that is not necessarily the only future possible.

5. IMPORTANT METHODOLOGY VARIABLES TO DETERMINE SUPPLY REQUIREMENTS

This situation, centered on supply and the resulting ethics, could be minimized in terms of its effect on the Amazon. Instead, truly regional interests could be prioritized in ELETRONORTE that guide activities in the region. The development of scenarios has been the primary resource for planning initiatives in the Amazon. In particular, these scenarios have served as the basis for determining future demand projections for electrical energy in the market place. This methodology seeks to use global and national scenarios as conditioning factors that most influence the future of the region. In this way, a scenario for the region is based on a combination of internal processes and behavior that are observed in terms of global and national conditioning factors. Global scenarios are incorporated as exogenous determining factors for Brazil's future. The confrontation between international uncertainties and expectations vis-à-vis internal national processes is submitted to mediation from Brazilian social participants. This process finally concludes with probable national scenarios. For the Amazon, these scenarios have been part of an *object* system and are built on the combination of the effects of various external variables (national and international) and current internal processes, which are in the process of maturing. This combination also includes mediation from participants with interests in the region[23].

The nature of the applied methodology deserves separate analysis in order to examine its foundations. However, the intention here is to analyze the origin of the conditioning factors that end up gradually defining the forecasts for electrical energy demands and subsequent ELETRONORTE efforts to provide for those demands. Firstly, there are the international and national conditioning factors that define the possibilities and limits for the region. Selecting these factors involves denying other options that are not necessarily included in the interests based on the dynamics of international and national economic and political systems. This configuration of regional interests is based on a concept of the future that is grounded on external interests. This becomes even more explicit when the premises that are used to construct regional scenarios are analyzed.

The Structural Analysis[24] technique was employed in order to define and interpret the region and to design its future. This technique considers the region as a complex system comprised of sub-systems that are linked to areas of knowledge – dimensions. It begins by qualifying the variables according to their ability to influence and determine the *object* system and then establishes a hierarchy of variables. This technique is based on identifying social partners in the Amazon and the ability of each to influence the

23 Details of the scenarios (global, national and regional) and the methodology used can be found in ELETRONORTE, 1999.

24 The Structural Analysis technique is one of the various techniques used in the methodology of building scenarios.

future of the region. The system associates different values to these participants in terms of power structure. The region was represented by 39 variables[25], of which 18 of these were considered to be external to the region while 21 were considered to be internal. They were distributed according to economic (7 external, 10 internal), socio-cultural (2 external, 4 internal), environmental (1 internal), institutional policies (9 external), technological (3 internal) and spatial (3 internal) dimensions. Table 12 illustrates this distribution.

There is a strong presence of external variables (nearly half) as well as economic variables (also nearly half). This is as true for internal as much as external origins as well as for the totally external nature of the institutional policy variables. The environment issue – the largest differential in the region – is represented by a sole variable. This simple classification and positioning of the variables permits an interpretation of the demand-planning model as one that is strongly influenced by economic issues. This model is almost completely distorted in terms of environmental concerns. It is shaped completely by external sources in institutional policy issues, which are considered as variables.

[25] Descriptions of all of these variables may be found in ELETRONORTE, 1999:143-147

TABLE 12: Defining variables of scenarios in the Amazon that determine the demand for electrical energy

Dimensions	Areas	
	Internal	**External**
Economics	*Regional Economic Dynamics, Private Investments in the Region, Public Expenditures and Investments in the Region, Production Structure, Transportation Supply, Energy Supply, Communication Supply, Regional Demand for Electrical Energy, Regional Demand for Goods and Services in the Region, Non-legalized Economic Activity*	*National Economic Dynamics, Demand for Natural Resources and Agricultural and Animal Breeding Products, Demand for Bio-products, Demand for Genetic Information, Global and National Demand for Energy Intensive Products, Global and National Demand for Manufactured Products, National Demand for Electrical Energy*
Socio-cultural	*Regional Population Dynamics, Socio-cultural Standard, Social Situation, Agricultural Issue*	*National Population Dynamics, Migratory Flow to the Region*
Institutional Policies		*Role of the State, Environmental Policy, Land Policy, External Trade Policy, National Defense Policy, Indigenous Policy, Regional Development Policy, Education and Science and Technology Policies, Energy Policy*
Environment	*Availability of Natural Resources*	
Technology	*Forms of Exploiting Natural Resources, Scientific and Technological Capacity of the Region, Information Technology Network*	
Space	*Urbanization, Continental Integration, Distribution of Socio-economic Activities in the Region*	

Source: Based on ELETRONORTE, 1999:143-150

There is the creation of a hierarchy of variables in order to identify those that have a greater ability to determine the future behavior of the conditioning factors and thus the region itself. This process involves grouping the variables into four categories: explicable variables, linking variables, autonomous variables and result variables. The first two categories are considered to be the most important in determining the *object* system. This is why they are treated with significant emphasis. The autonomous and result variables, and the conditioning factors, which may alter their behavior, are considered to be less important in terms of explaining the *object* system. This is why they are omitted in the analysis phase of determining factors for the future. Table 13 shows the distribution by area and category. The way in which they fit into the category demonstrates the importance of the model conferred to the variable in the methodology, planning and hierarchy. The final importance given to each variable is indicated at the foot of the table.

With respect to the 19 most important variables in terms of defining the region's future for ELETRONORTE activity planning, which entail hydroelectric enterprise, the following variables can be validated:

- Nearly half (9) are from the external sphere. Among these, seven variables are identified from the institutional policy area. This means policy definition and public agency decisions. The other two variables come from the economic domain. One of these received the highest importance rating (Demand for Natural Resources and Agricultural and Animal Products). The other variable (National Economy Dynamics) represents the principal demand for electrical energy in other regions of the country. It is clear that the planning model is strongly influenced by external factors and brings about decisions that strongly depend on non-regional factors;

- Not a single variable from the socio-cultural domain is among the most important variables identified. The only variable from the environmental domain focuses solely on the availability of natural resources. This variable does not focus on conservation issues or sustainable use and protection. It is clear that this planning model is truly refractory as regards to social and environmental issues;

- Issues of great regional importance are not considered to be important within the model. This is the reason for their treatment as autonomous or result variables. This is the case for the categories Demand for Bio-products, Demand for Genetic Information, Global and National Demand for Manufactured Products, Global and National Demand for Energy Intensive Products among others. This clearly shows that the model is not committed strictly to regional issues. The model is applied to the Amazon more in terms of making it function than in terms of making it more dynamic.

TABLE 13: Classification of the variables used in defining scenarios for the Amazon according to their importance in determining the future of the region.

	Area/Category	Types according to ability to determine regional future			
		Explications	Linked	Autonomous	Results
Internal	Economics		*Public Expenditures and Investments in the Region, Private Investments in the Region, Regional Economic Dynamics, Transportation Supply, Energy Supply, Communication Supply*	*Production Structure, Non-legalized Economic Activity*	*Regional Demand for Electrical Energy, Regional Demand for Goods and Services in the Region*
Internal	Socio-cultural			*Regional Population Dynamics, Socio-cultural Standards*	*Social Situation, Agricultural Issue*
Internal	Institutional Policies				
Internal	Environmental		*Availability of Natural Resources*		
Internal	Technology	*Information Technology Network*	*Forms of Exploiting Natural Resources*	*Scientific and Technological Capacity of the Region*	
Internal	Space		*Continental Integration*	*Urbanization, Distribution of Socio-economic Activities in the Region*	
External	Economics	*Demand for Natural Resources and Agricultural and Animal Breeding Products*	*National Economy Dynamics*	*Demand for Bio-products, Global and National Demand for Manufactured Products, Global and National Demand for Energy Intensive Products, Demand for Genetic Information*	*National Demand for Electrical Energy*
External	Socio-cultural			*National Population Dynamics*	*Migratory Flow to the Region*
External	Institutional Policies	*Role of the State*	*Regional Development Policies, Energy Policy, Environmental Policy, Education and Science and Technology Policies, National Defense Policy, Indigenous Policy*	*Land Policies, External Trade Policy*	

Final Hierarchy of the Variables

1. *Demand for Natural Resources and Agricultural and Animal Products*
2. *Role of the State*
3. *Information Technology Network*
4. *Regional Development Policy*
5. *Energy Policy*
6. *Environmental Policy*
7. *Education and Science and Technology Policies*
8. *National Defense Policy*
9. *Indigenous Policy*
10. *Public Expenditures and Investments in the Region*
11. *National Economy Dynamics*
12. *Private Investments in the Region*
13. *Regional Economy Dynamics*
14. *Forms of Exploiting National Resources*
15. *Availability of Natural Resources*
16. *Transportation Supply*
17. *Communication Supply*
18. *Energy Supply*
19. *Continental Integration*

Source: Based on ELETRONORTE, 1999:148-150

In this model, identifying the most important variables enables the selection of the most important conditioning factors for the future (current real processes and events). These factors are chosen for their abilities to alter the status of the variables. Selecting the conditioning factors implies building a model of the Amazon that allows for intervention. It is appropriate to keep in mind the planner's interests, which is essential to this equation. This process creates a false reality that is based on the planners' proposals and commitments. The Amazon that emerges from this process is stripped of its true interests. The plans formulated for the Amazon become techniques that serve as a basis for the interested social partners to use in order to apply pressure for the effective running of the hydroelectric plants, which are anticipated in these plans.

6. METHODOLOGY TO PROVIDE VISIBILITY FOR THE INTERVENING SOCIAL PARTNERS IN THE PROCESS OF THE CONSTRUCTION OF HYDROELECTRIC PLANTS IN THE AMAZON

The fact that plans exist to construct hydroelectric plants in the Amazon does not necessarily suggest that they should be established even if they are inappropriate. Hopefully, this is what will be achieved when the rights of the social partners concerned are taken into consideration. The World Report on Dams (World Dam Commission, 2000:18-20) takes the following approach to this issue:

> *"... we need to consider the proposed development projects for water and energy resources within a much broader scenario (...) This means that new voices, perspectives and criteria must be incorporated into the decision-making process. It also means that we must adopt an approach that is capable of obtaining consensus on the decisions made (...) (taking into consideration the) rights and nature and magnitude of the possible risks to all involved parties (...). Including rights in the context of a proposed project is an essential step in identifying the demands and prerogatives (or acquired rights) that may be affected by the project (...) (and should play) a formal role in the consulting process and later on, in negotiations on specific project agreements (…). Traditionally, the definition of risk is restricted to constructing companies or institutional investors in terms of capital to be applied and expected returns. These individuals assume these risks themselves and have the power to define the degree and type of risk they wish to assume. They can explicitly define the acceptable limits of these risks. In contrast, a Global Study demonstrated that there is a much larger group of people that are obligated against their will to take risks that are administrated by others. As a rule, those that run involuntary risks have little or no active voice in water and energy policies in general. They have no voice in choosing specific projects or in the development and establishment of a project. (...). Finally, as in the case of rights, the risks must be identified, given names and definitively confronted. This demands recognition*

> *of the risk that is extended to a larger group and should not include governments and construction companies. This risk also includes the people that are affected by the project. This risk also involves the environment as public heritage.*
>
> *(...) An approach like this allows for decision-making processes that are focused on seeking negotiated results carried out in an open and transparent fashion. These results include everyone that is effectively involved in the issue – helping to resolve the numerous and complex issues involving water, dams and development."*

How are the important social participants defined in ELETRONORTE planning related to the employment of hydroelectric plants? This question is dealt with in ELETRONORTE (1999:169-180) as noted below:

> *"Two different analyses of social partners were performed in order to determine the Amazon scenarios. The first sought to understand the potential of the partners in terms of the object system. This included examination of how the partners acted and what the means and instruments were that influenced their most definitive concrete variables, particularly explicatory variables. The second analysis concentrated on analyzing the relationships among partners. It sought to understand the power structure and the different importance levels that defined policies and control of the State.*
>
> *These two analyses will define the methods that will form the policy structure of the Amazon scenario based on coalitions and alliances that could define, with support or resistance, different representations of the reality and of policy definition."*

There were 27 social partners defined with different interests and different levels of involvement in the future of the Region. These partners were split into two groups – internal and external partners – according to their position in the context or in the *object* system[26], illustrated in Table 14.

[26] Two participants appear simultaneously on the external and internal lists. This emphasizes that the internal segment of the region includes broad social participation particularly from ecologists and regional development agencies.

TABLE 14: Important Social Participants in the Construction of the Amazon's Future

External Participants	Internal Participants
- Ecologists - Construction Companies - Businesspersons from the Financial Sector - National Businesspersons - National Agricultural Industry Businesspersons - States enterprises - Transgressor Groups - Various Religious Groups - Catholic Church - Multi-lateral Financial Institutions - International Timber Companies - Military - Federal Regional Development Agencies - Pan-amazon Countries	- Sub-regional Development Agencies - Landless Agricultural Workers - Scientific Community - Indigenous Communities - Ecologists - Local Businesspersons - Large Property Owners - Illegal Appropriators and Sellers of Public Land - Extraction Method Minority Groups - Federal Regional Development Agencies - Rural Producers - Liberal Professionals - Urban Workers

In the methodology, Structural Analysis of the Participant Variable was applied to define importance level in terms of the influence exerted by each group of social partner on the *object* system. This included the differentiated effect of each group's decisions and the instruments available to them in terms of affecting the Amazon's future. This table of hierarchy is outlined below:

TABLE 15: Hierarchy of the Social Participants

1. Federal Development Agencies	**13.** Ecologists (endogenous)
2. States enterprises	**14.** Scientific Community
3. National Agricultural Industry Businesspersons	**15.** International Timber Companies
	16. Military
4. Federal Development Agencies (endogenous)	**17.** Rural Producers
	18. Large Property Owners
5. Sub-regional Development Agencies	**19.** Catholic Church
	20. Landless Workers
6. National Businesspersons	**21.** Various Religious Groups
7. Multi-lateral Financial Institutions	**22.** Illegal Appropriators and Sellers of Public Land
8. Local Businesspersons	**23.** Extraction Method Minority Groups
9. Construction Companies	
10. Ecologists	**24.** Indigenous Communities
11. National Businesspersons from the Financial System	**25.** Liberal Professionals
	26. Transgressor Groups
12. Pan-amazon Countries	**27.** Urban Workers

Based on this hierarchy it can be said that:

- The 10 most influential partners on the *object* system are: the Federal Development Agencies; States; National Agricultural Industry Businesspersons; Federal Development Agencies (internal); Sub-regional Development Agencies; National Businesspersons; Multi-lateral Financial Institutions; Local Businesspersons; Construction Companies and Ecologists. Among these, the Local Businesspersons are the only completely internal entity. This is because the Federal Development Agencies have strong ties to the Federal Government. Furthermore, the Sub-regional Development Agencies depend on decisions from the Federal Public Agents and National Businesspersons. This implies that the planning model assumes external uniformity among partners who influence the fate of the region.

- The government, in its federal capacity, is the most important partner in the Amazon. The federal government acts through State Development Agencies and Sub-regional Development Agencies. The regional governments (state and municipal) are not considered important and are not even mentioned among the 27 partners in Table 15. The population living in the region select the governments mandates. This confirms that the planning model functions, with the understanding that the federal government is the most important partner in the public sector and that the state and municipal governments are insignificant.

- The private sector nationally also has a significant position in the hierarchy. This sector is represented by National Businesspersons from the Agricultural and Animal Breeding Industry Sector, Construction Companies and National Businesspersons from other sectors. The regional private sector is represented “generically” as among the 10 most important partners. The sector is represented by Local Businesspersons and demonstrates that the planning model considers the non-regional businesspersons to be more important for the region’s future.

- National Ecologists are included among the most influential partners. This implies that the planning model acknowledges that the regional environmental agenda is primarily defined outside of the region. The Multilateral Financial Institutions (World Bank, IDB, etc.) are also included among the 10 most influential partners and this affirms that the possibility of funds represents a huge power centre as concerns the region, and.

- The regional participants that have been most affected by large hydroelectric plants in the past (rural producers, extraction method minority groups, indigenous communities, etc.) are last on the list. They are therefore considered with low importance in the analysis of the planning model.

To what extent does this methodology affirm the amount of political power partners wield over their causes, or how much power they might amass by way of alliances? A second hierarchy was developed to interpret the extent of power that these accumulated inter-relationships grant each partner. This new hierarchy differs from the partner-variable relationship, which represents the influence of partners on the *system*. The new hierarchy represents the power relationship that exists among partners as well as the subtle political and ideological games they play among themselves. A number of adopted conceptual assumptions tend to disguise what really takes place in practice. The document states:

> *“The primary difference between the two treatments is found in the absence of the Public Institutions (Regional and State Development Agencies). They are not part of the power game, but they are a focus of conflict among partners. From a conceptual point of view, these institutions become much more of a tool for negotiation, pressure and political influence for the social partner, than an independent partner with its own power.”*

> *The Public Institutions are emphasized as regards the variables of the system (analysis of the partner's power), but they do not represent a political partner who negotiates and fights for space and influence with the representative of interested social groups such as Businesspersons, Workers or Extraction Method Minorities, etc."* (idem, pp. 177).

This position may even be considered to be conceptually valid for partners that are genuinely part of the public sector. However, under no circumstances can it be extended to the states. This is especially true when dealing with the electricity sector, which acts competitively in an environment where the notion of the private sector serves as the driving force. In reality, this does not happen in practice, even with regard to the truly public sector. Moreover, public positions are sought out precisely in order to augment the power behind the social dominance of partners' demands. They are the assumed representatives of the more powerful partners. The methodology ends up confusing this issue. Even though this is true, the result of the partner-partner analysis is extremely close to the previous hierarchy. The power structure in the Region is represented in Table 16 below:

TABLE 16: Power Structure in the Amazon

Social Participants	Power Potential
National Agriculture Industry Businessperson	255
National Businesspersons	249
Multi-lateral Institutions	233
Local Businesspersons	228
Construction Companies	197
National Businesspersons from the Financial System	166
Ecological Groups	156
International Timber Companies	152
Pan-amazon Countries	135
Large Property Owners	124
Scientific Community	121
Rural Producers	103
Military	97
Extraction Method Minority Groups	92
Religious Groups	87
Transgressor Groups	75
Landless Workers Movements	74
Illegal Appropriators and Sellers of Public Land and Unofficial Miners	66
Urban Workers	61
Liberal Professionals	59
Indigenous Communities	58

Based on this hierarchy, the following statements apply:

- Even when public sector states and agencies are removed, external partners still have an enormous presence in defining regional policies. Local

Businesspersons are the only completely internal partners in the region. Ecological Groups represent a coupling between internal and external Ecologists from the previous hierarchy, and Large Property Owners commonly live outside of the region.

- The power of the social partners, situated at the top of the list, represent about five times the power of those situated at the bottom of the list. Furthermore, the bottom of the list represents those most affected by the hydroelectric plants.

- Even partners considered as having some power in the region, such as the Scientific Community and the Military, are not included in the group of powerful partners in the region. The power they exercise is equal to half the power held by Businesspersons.

This is how planning priorities for the region are defined. Furthermore, in seeking alliances in order to install hydroelectric plants, it is evident that ELETRONORTE would never replace a partnership of National Businesspersons with the Indigenous Communities.

7. CONCLUSIONS

Due to regional economic apathy, the Amazon was not included in what was considered as the original dynamic surge in the electricity sector. This surge took place in the 1930s and 1940s with the second surge occurring in the 1950s. During this time, little attention was paid to the energy sector and capital was blocked according to distribution criteria for resources that penalized the region. These criteria included the standardization of other resources in terms of their access. Criteria were defined in accordance with the performance of Juscelino's Plans (*Plano de Metas)* that favored transportation and energy sectors in the more dynamic regions of the country.

The third surge began with federal political support in developing the region. However, despite this impetus, initiatives at this time did not succeed. The mechanisms that were used for the regional capitalization of the sector were minimized in terms of their power. This maintained the region's per capita consumption rate at a mere quarter of the national average, equal to 398 kWh/resident at that time. The fourth surge began to put regional hydroelectric potential at the service of interests that were not located in the region itself. This came about via the National Linked System because of the need to supply electricity intensive industries (aluminum, iron, etc.) or because of the need to supply energy to other regions in the country.

This National Linked System was the backbone of the electricity industry in Brazil. The system's logic is based on links and centralized operations that contribute in:

- Maintaining a concentrated economy in the Southeast and consequently, maintaining regional inequalities. This system guarantees energy for the production sector with comparable tariffs in all regions in the country. Important markets are located in this region, yet limited direct economic expansion is observed in other regions.

- Committing natural resources to peripheral regions, like the Amazon, in order to benefit dominant and more economically dynamic regions by the over-exploitation of hydroelectric power. This provides little financial or economic income for the region.

- Technical and Managerial complexity in the Brazilian electricity sector that is consistently independent in terms of political will or social demands. Additionally, there is greater demand for bigger investments in order to meet the developing dynamic of the National Linked System.

- Imposing realistic conditions and limits on the electricity sector. The overwhelming demands for power is such that we are beginning to witness the first phases of exhaustion in terms of pushing the Amazonian capacity to its limit in order to serve the needs of other regions, especially the Southeast. This deprives the region from using these resources for select development focused goals and forces the region to tolerate the socio-environmental impacts that result from the construction of hydroelectric plants.

The supply based planning model used for the electricity sector is based on consumption forecasts and the consequent needs of electrical energy generation on market trends. However, the real needs of society are not taken into account. This creates expectations for contractors, equipment producers, financing banks, etc. who then apply pressure in order to realize their projects. This scenario leaves little flexibility for other visions of the future.

The ELETRONORTE planning strategy for the Amazon is based on what are basically economic variables that are totally incoherent in terms of social and environmental issues. In terms of institutional policy issues, these variables are unequivocally composed by external sources. The variables selected in the development of the Amazon model are based on allowing for flexibility that permits intervention. The strategic planning referred to involve social partners that are identified as power sources in the Amazon. Essentially, they are external and are primarily from the federal public sector and non-regional Businesspersons. The most influential social partners are shown to have as much as five times more power than the partners that are directly concerned the implantation of the hydroelectric plants. The interests of these influential parties end up being incorporated into priorities of the ELETRONORTE plans.

Conclusions drawn from these statements reveal that the region had been neglected in the past and that its future role in the electricity sector has been predetermined. Any vision that involves integrating the Amazon with other regions in Brazil always involves appropriating power from the Amazon in order to benefit the more dynamic regions. Now, more than ever, the region has a resource providing electrical energy that is vital to the Brazilian economy. However, it is also equally true that the other regions have never before been so dependent on the natural resources (hydroelectric power) of the region. Therefore, if over-exploitation is inevitable, then it should at least benefit the region and provide the best economic returns to serve the people of the region and the local environment. A situation could be envisaged whereby damages are paid by the hydroelectric plants for their imposed self-serving policies. Machado (2002) has the following observations on the issue:

> *"...the location of any hydroelectric plant in any region unequivocally occurs for reasons of the national system that almost always completely ignore regional interests.*
>
> *Therefore, after the plant is installed, the internal dynamics of the region are completely shaped by the logic of the system. The population in the region is re-located and is either forced to move or because of the newly generated economic attractions. The power of the rivers is diminished and their natural functions in the ecosystem are lost, as they are seen as mere sources of energy. The lands are flooded and natural economic activities, which they had previously sustained, become impossible to maintain. Immigrants flock to the region and add to the problems and social demands. Finally, development options become definitively bound to the obligation to generate energy in order to serve other distant regions. Obviously, this is something that responds to national demands. Authorities in charge of the issue cannot allow regional authorities and social agents (governors, mayors, businesspersons, etc.) to make independent decisions on the fate and direction of activities. The area in the region where the plant is implanted becomes an enclave of external interests. Autonomous management by the people and their directors is expropriated."*

What is the price of this form of obligation? Some argue that compensation will be derived through royalties and the generation of new jobs, etc. and thus represents the social returns expected from the enterprise. However, the self-determination of these regions is rooted in our cultural ambitions based on federalism. As witnessed in the Amazon, this has been the driving force for enterprises of this nature. However, regions must not be allowed to continue damaging their own interests. If a region is being denied its right to decide its own path for its proper development, then this suggests an imposed undertaking and fair compensation will be sought.

BIBLIOGRAPHY

ANEEL - Agência Nacional de Energia Elétrica (National Electrical Energy Agency). 2002. *Atlas de Energia Elétrica do Brasil*. Brasília: ANEEL, 153p.

CARVALHO, J. F. DE, AND JANNUZZI, G. DE M. 1994. *Aspectos Éticos do Modelo de Planejamento do Setor Elétrico. In: Revista Brasileira de Energia,* Vol. 3 Nº 2 – 1994. Campinas-SP: UNICAMP/Núcleo Interdisciplinar de Planejamento Energético-NIPE.

COMISSÃO MUNDIAL DE BARRAGENS. 2000. *Barragens e Desenvolvimento: um Novo Modelo para Tomada de Decisões – Um Sumário*. Home page: www.dams.org. Londres: Earthscan Publications.

ELETROBRAS - CENTRAIS ELÉTRICAS BRASILEIRAS S.A. (Northern Brazil Electrical Centers, Inc.). 1994. *Plano Nacional de Energia Elétrica 1993-2015 – Plano 2015, Relatório Executivo Síntese*. Rio de Janeiro: Eletrobras/Diretoria de Planejamento e Engenharia.

ELETROBRAS - CENTRAIS ELÉTRICAS BRASILEIRAS S.A. (Northern Brazil Electrical Centers, Inc.). 2001. *Boletim do Sistema de Informações de Energia Elétrica*. Rio de Janeiro.

ELETRONORTE - CENTRAIS ELÉTRICAS DO NORTE DO BRASIL S.A. (Northern Brazil Electrical Centers, Inc.). 1999. *Cenários Sócioenergéticos para a Amazônia 1998-2020 (Versão Técnica)*. Brasília: ELETRONORTE/Gerência de Estudos e Projeção de Mercado.

ESCELSA - ESPÍRITO SANTO CENTRAIS ELÉTRICAS S.A. (Espírito Santo Electrical Centers, Inc.) 2002. *Official Site* (links Empresa and Pesquisas). Home page: www.escelsa.com.br. Vitória: ESCELSA.

FERREIRA, OMAR C. 1992. *O Sistema Elétrico Brasileiro*. Home page: http://ecen.com/eee32/sistelet.htm.

IBGE - FUNDAÇÃO INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (Brazilian Institute of Geography and Statistics Foundation). 2001. *Contas Regionais do Brasil 1999*. Rio de Janeiro: IBGE, 111p. (Contas Nacionais; n. 6).

IBGE - FUNDAÇÃO INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (Brazilian Institute of Geography and Statistics Foundation). 1991a. *Geografia do Brasil – Região Norte*. Vol. 1. Rio de Janeiro, IBGE.

IBGE - FUNDAÇÃO INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (Brazilian Institute of Geography and Statistics Foundation). 1991b. *Geografia do Brasil – Região Norte*. Vol. 3. Rio de Janeiro, IBGE.

MACHADO, J. A. C. 2002. Renúncia à autodeterminação regional: uma conseqüência das hidrelétricas que exige indenização. (Exposition at the International Workshop on the Problem of Local and Global Use of the Amazon's Water). Belém: Núcleo de Altos Estudos Amazônicos da Universidade Federal do Para/Programa de Cooperação Sul-Sul para o Ecodesenvolvimento (UNESCO), 12 a 14/06/2002.

MAGALHÃES, S.B.; BRITO, R. C.; CASTRO, E.R. 1996. *Energia na Amazônia*. Museu Emílio Goeldi. Universidade Federal do Pará, Associação de Universidades Amazônicas. Vol II, Belém.

MEMÓRIA DA ELETRICIDADE. 2002. *História: uma cronologia da história da eletricidade no Brasil*. Home page: www.memoria.eletrobrás.gov.br. Rio de Janeiro: Memória da Eletricidade.

ONS - OPERADOR NACIONAL DO SISTEMA ELÉTRICO (National Operator of the Electrical System). 2002. *Sistema Interligado Nacional*. Home page: www.ons.org.br/ons/sin/index.htm. Rio de Janeiro, ONS.

ONS - OPERADOR NACIONAL DO SISTEMA ELÉTRICO (National Operator of the Electrical System). 2002a. *Operação do Sistema Interligado Nacional – Dados relevantes de 2001*. Home page: www.ons.org.br/ons/documentos/index_publicacoes.htm. Rio de Janeiro, ONS.

ROMA JUNIOR, V. 2001. Um sistema de indicadores de sustentabilidade para usinas hidreétricas na Amazônia: o caso da UHE de Tucuruí (Masters Dissertation Project). Manaus: Universidade Federal do Amazonas / Centro de Ciências do Ambiente.

SOUZA, R. C. R. 2000. Planejamento do Suprimento de Eletricidade dos Sistemas Isolados na Região Amazônica: Uma abordagem multiobjetiva. (Doctoral Thesis). Campinas/SP. Universidade Estadual de Campinas – UNICAMP.

SOUZA, MÁRCIO. 1994. *Breve História da Amazônia*. Editora Marco Zero, São Paulo/SP.