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RAPHAEL CHARLIE JEAN MASVIGNER

EDF AND THE BRAZILIAN POWER SECTOR

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Dissertação apresentada à Escola de Administração de Empresas de São Paulo da Fundação Getulio Vargas como requisito para obtenção do título de Mestre Profissional em Gestão Internacional

Campo do conhecimento: Strategy

Orientador: Prof. Dr. Tales Andreassi

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ABSTRACT

Electricité de France (EDF) is a leading player in the European energy market by being both the first electricity producer in Europe and the world's leading nuclear plant operator. EDF is also the first electricity producer and supplier in France. However, Europe, EDF's core market, is currently underperforming: the European sovereign debt crisis is lowering significantly the growth perspective of an energy market that has already reached its maturity. As a consequence, European energy companies are now looking at international markets and especially BRIC economies where economic growth potential remains high. Among them, Brazil is expected to keep its strong economic and electricity demand growth perspectives for the coming decades. Though Brazil has not been considered as a strategic priority for EDF after the Light reversal in 2006, the current economic situation has led the Group to reconsider its position toward the country. EDF's current presence in Brazil is limited to its stake in UTE Norte Fluminense, a thermal plant, located in the state of Rio de Janeiro. This report investigates the possibility and the feasibility of EDF's activities expansion in Brazil and what added value it could bring for the Brazilian power market. Considering that the status quo would not allow EDF to take full advantage of Brazil's future growth, this work is identifying the various options that are currently opened to EDF: market exit, status quo, EDF alone, local partner. For that purpose, this study collects and analyses the latest energy market data as well as generation companies' information which are necessary to give a relevant overview of the current brazilian power sector and to present EDF strategic options for the country.

Keywords: EDF, Brazil, UTE Norte Fluminense, MPX, entrance strategies, Brazilian power sector, electricity market, installed capacity, generation, utilities, partnership, power plants, country energy mix, transmission and distribution.

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TABLE OF ABBREVIATIONS AND ACRONYMS

ACL or FCE	Free Contracting Environment
ACR or RCE	Regulated Contracting Environment
AES	Apply Energy Services Inc.
ANEEL	Brazilian Electricity Regulatory Agency
ANS	Nuclear Safety Authority
CAGR	Compound Annual Growth Rate
CCEE	Chamber of Electric Energy Commercialization
CCGTs	Combined Cycle Gas Turbine Plants
CEMIG	Companhia Energética de Minas Gerais
CESP	Companhia Energética de São Paulo
CGE	Crisis Management Board
CHESF	Companhia Hidro-Elétrica do São Francisco
CMSE	Power Sector Monitoring Committee
CNPE	National Council for Energy Policy
CPFL Energia	Companhia Paulista de Força e Luz
COPEL	Companhia Paranaense de Energia
EDF	Electricité de France
EDF EN	EDF Energies Nouvelles
EIU	Economic Intelligence Unit
EPE	Energy Research Company
EPR	European Pressurized Reactor
ERDF	Electricity Distribution Network
ExCom	Executive Committee

FCE	Free Contracting Environment
GHG	Greenhouse Gas
GDF-Suez	Gaz de France-Suez
GW	Gigawatt
IEA	International Energy Agency
IPP	Independent Power Producer
JV	Joint Venture
MAE	Wholesale Electric Energy Market
MME	Ministry of Mines and Energy
MoU	Memorandum of Understanding
MW	Megawatt
ONS	National Power System Operator
PPA	Power Purchase Agreement
PROINFA	Incentives Program for Alternative Energy Sources
RESEB	Restructuring the Brazilian Electricity Supply Industry
RCE	Regulated Contracting Environment
RTE	Electricity Transmission Network
SIN	National Interconnected System
ToP	Take or Pay
TWh	Terawatt-hour

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1. INTRODUCTION

EDF is the leading power utility in France and one of the leading power companies in Europe. The current European sovereign debt crisis and the side effects of the 2008 financial crisis have reduced EDF's growth perspectives in its historical market, Europe. As a consequence, the Group is looking for new growth engines.

The Brazilian power sector, contrary to the European power market, offers strong future growth potential and opportunities for the private sector. Brazil has the largest electricity market in Latin America with a total annual consumption of some 472 000 GWh in 2011 and is going to continue to grow fast because of both a combination of economic and population growth along with measures to increase accessibility of electricity to the wider public (EPE, 2011). Brazilian population is expected to increase from 193 million in 2010 to 220 million by 2020 and economic growth is forecasted to pick up by almost 5 percent annually after 2013 according to the International Monetary Fund (IMF). Consequently, electricity consumption is set to increase by 4.5 percent annually. According to the Ministry of Mines and Industry (EPE, 2010), Brazil will have to install a total capacity of 152 GW by 2020 compared to 93 GW in 2006, in other words an increase of 63 percent. Therefore, Brazil needs substantial investments in generation, transmission and distribution. According to the International Energy Agency (IEA, 2011), the Brazilian power sector will need a USD 10 billion per year investments until 2030. These investments will have to be made mainly by the private sector and the current power market has been established in order to attract foreign investments. Consequently, Brazil offers many opportunities for foreign investors and international power utilities like EDF.

During my internship at the strategy division of EDF in the Paris's headquarter, I was in charge of making strategic plans for the Latin America area and I had the opportunity of briefly studying the Brazilian power market, one of the current burning issues for the company. With

this paper, I wanted to use the knowledge I acquired during this experience to continue my work on that subject and to go further in the research I initiated at EDF. This paper has for objective to evaluate the alternative strategic options of EDF in Brazil. To do so, an extensive explanation of both the dynamics of the Brazilian power market and the EDF's company profile are the prerequisites.

The first chapter is presenting the objective and the structure of the thesis. The second chapter will focus on the general description of the Brazilian power sector. First, an overview of the local electricity market will be given through the analysis of the markets fundamentals, the country energy mix, the supply chain of the Brazilian electricity market and the power sector economic characteristics (2.1). Then, the paper presents the different energy policies that have been implemented in Brazil since the creation of its electricity market (2.2). Finally, the last part will investigate on the framework and dynamics of the current power market model (2.3).

The third chapter studies the EDF company profile. First an extensive explanation of the Group business model as well as its activities in France, its historical market, in Europe and in the other parts of the world will be given (3.1). Then the study will discuss EDF financial results and the strategy for Europe and internationally (3.2).

The fourth chapter will show that EDF presence in Brazil can be an opportunity for both the company and the Brazilian power sector. EDF has an historical expertise in all the electricity supply chain and in each type of power generation and Brazil could directly benefit from this expertise if EDF was consolidating its presence in the country (4.1). On the other hand, Brazil is representing a strong growth engine for EDF that could profit from the local power market growth perspective and opportunities if the company was well positioned in the local electricity sector (4.2).

The fifth chapter will analyze the different strategic alternatives that EDF could choose for Brazil. First, the group activities in Brazil will be presented with a specific focus on EDF's

brazilian subsidiaries Light, that the group finally sold in 2009, and UTE Norte Fluminense, a highly profitable local generation asset (5.1). Then, the different strategic options (market exit, status quo, EDF alone, local partnership) of the company will be presented and evaluated (5.2). This paper will end with a case study which will try to evaluate the feasibility of a partnership between EDF and MPX, a Brazilian local power actor (5.3).Finally, the sixth chapter will be the conclusion of this thesis.

2. GENERAL DESCRIPTION OF THE BRAZILIAN ELECTRICITY MARKET

2.1 Overview Of The Brazilian Power Sector

2.1.1 Market Fundamentals

Since the 1990's, Brazil has become an important actor of the world energy landscape. Indeed, Brazil is the 10th largest energy consumer in the world and the 1st energy consumer in South America. Brazil's power consumption represents more than double the combined consumption of Argentina, Chile, Bolivia and Uruguay (EnergyMarketPrice, 2010). Brazil has consequently the largest electricity market of Latin America. In terms of installed capacity, Brazil can be compared to the United Kingdom or France even though it has a much bigger transmission network. Petrobras and Eletrobras, which are the two most important state owned power companies in Brazil, are also the most important energy actors in Latin America. Brazil has the largest capacity for water storage in the world and hydroelectricity represented 78 percent of its installed capacity in 2010 according to the EPE. Brazil's power situation could be then summarized as having a high hydroelectric potential located in far consumption areas, a complex transmission network due to the immensity of the country, an electric system dominated by public utilities, and a strong electricity demand that should double in the next ten years.

2.1.2 Country energy mix

Brazil has one of the world's largest shares of hydroelectricity generation in its energy mix: in 2009, electricity generated from hydroelectricity accounted for 84 percent, thermal plants accounted for over 13 percent, biomass about 5 percent and nuclear plants generated 3 percent (IEA, 2010). The high share of hydroelectricity in the country energy mix enables Brazil to have a large part of its power generation free of CO2 emissions. The country has about 2 000 power plants in use accounting for 112 GW of total installed capacity in 2011. Brazil's total installed capacity (112 GW) is nearly equal to the French one though the Brazilian territory is seventeen times bigger than the french one. In terms of installed capacity, in 2010, hydroelectricity accounted for 78 percent, thermal for 19 percent, nuclear for 2 percent and renewables for 1 percent.

Figure 1: Country Energy Mix

	2010	2019	2030	CAGR 2010-2030
Installed Capacity (GW)	**112**	**167**	**217**	**+3.4%**
Hydroelectricity	**87**	**123**	**156**	**+3.0%**
Thermal	**21**	**33**	**33**	**+2.3%**
Nuclear	**2**	**3**	**7**	**+6.5%**
Renewables	**1**	**7**	**21**	**+16.4%**

Source: EPE (2011)

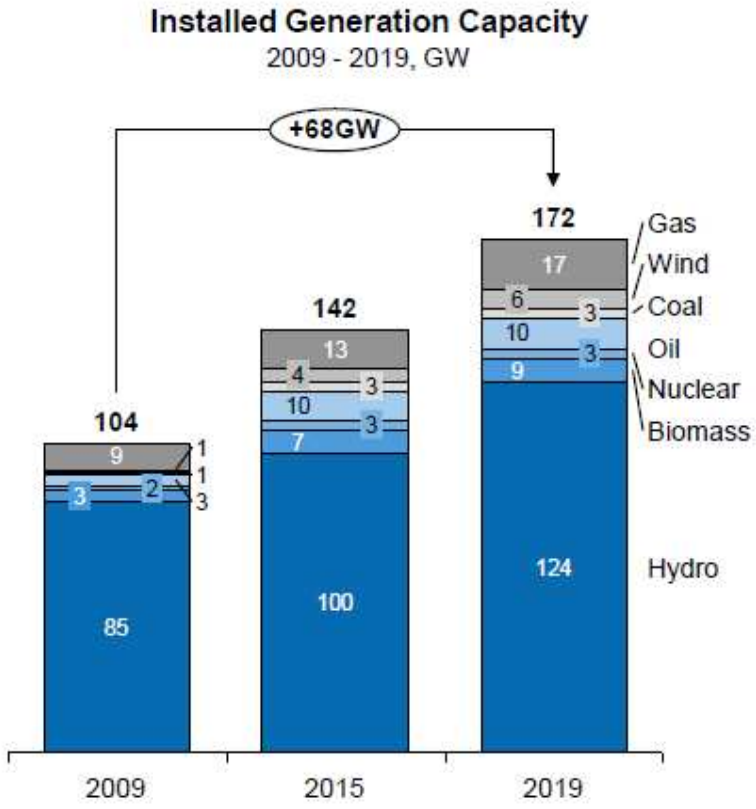
Brazil's national energy ten-year plan for 2010-2020 set the objective of increasing the installed capacity by 61 percent with 167 GW installed in 2019. The share of hydroelectricity in the country energy mix should be reduced from 78 percent to 70 percent because of the increasing importance of oil and wind energy which should reach respectively a share of 6 percent and 4 percent (EPE, 2010).

a) Hydroelectricity

Brazil has some of the world's largest rivers and hydroelectric power plants. If one part is already used to generate electricity, the hydroelectric potential is still immense and remains workable for generation use at a competitive cost. Indeed, so far Brazil has developed only 25 percent of its hydroelectric potential while France or the US for instance have respectively already developed 97 percent and 68 percent of their potential (Albouy, 2011).

The wall hydraulic system provides the major part of Brazil's electric production: in 2010, hydroelectricity accounted for 78 percent of the country installed capacity (which means 87 GW of the 112 GW installed capacity in 2010) and represented 80 percent of the electric consumption (378 TWh on a total of 472 TWh in 2011) (EPE, 2011). There are about 140 hydroelectric power plants in operations in the country. The main hydroelectric plants (installed capacity superior to 1 000 MW) account for 2/3 of the installed capacity (Enerdata, 2011). The hydraulic domination will continue in the long term despite the government's effort to diversify the country's generation mix: in 2019, hydro power will still account for 72 percent of the generation mix with an installed capacity of 124 GW (Figure2).

Figure 2: A hydro-based generation system



Source: Booz&Co (2010)

The high hydraulic period is generally occurring in March-April excepted in the South which generally has its hydraulic period during the second part of the year. The major basins are located in the region of Parana, Tocantins, Rio Sao Francisco and the Amazon regions. The Amazon region is going to undergo important power projects between 2011 and 2020 with the EPE's ten-year plan. Two important projects are currently in the pipeline in this region for 2012: the Jirau dam (3 750 MW) on the Madeira River and the Santo Antonio power plant (3150 MW) in the state of Rondonia. These projects were undertaken in order to strengthen the market integration of Brazil, Bolivia and Peru (Albouy, 2011). The highly controversial Belo Monte project (11 233 MW) should start operations in 2015 despite the strong opposition of environmental associations and local communities.

Belo Monte, once in operation, will become the third largest hydraulic dam in the world after the Three Gorges dam in China (22,5 GW) and the Itaipu dam (14GW) which is located at the border of Brazil and Paraguay.

It is important to note that though the majority of the big hydroelectric power plants projects are generally contested, because they can lead to damages of the eco-system or because of the displacement of local communities, they have also helped Brazil to drastically reduce its carbon dioxide emissions over the last decades. Indeed, according to the Ministry of Mines and Energy (MME, 2010), a smart combination of hydro and renewable energy use enabled Brazil to avoid 800 million tons of CO2 for the last 30 years.

b) Thermal

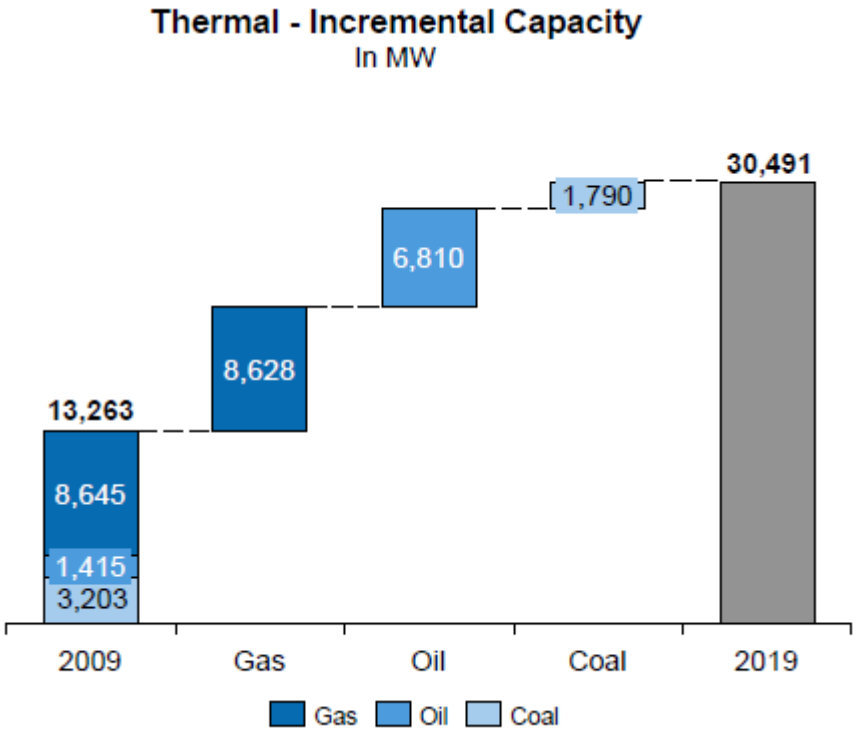
After hydro power, electricity production comes from thermal plants which generally use oil and gas. In 2010, thermal plants accounted for 19 percent of Brazil's energy mix with an installed capacity of 21 GW (Enerdata, 2010). In 2019, thermal plants should account for 20 percent of the country energy mix with an installed capacity of 33 GW, in other words a compound annual growth rate (CAGR) of 5 percent between 2010 and 2019 (Figure 1).

Thermal plants expansion in the Brazilian energy mix has been limited for a long time because of the insecurity of gas supply, principally coming from Bolivia, and because of the lack of adequate transport infrastructure (pipeline networks). In order to avoid an unpredicted lack of supply, the authorization of building a thermal plant in the country is only given if utilities can ensure public energy authorities that they have a reliable and constant access to gas. However, in order to cope with that situation, some thermal power plants are now adopting a hybrid system using both oil and gas which enables them to reduce their dependence on gas supply (Ambrosio and Costa, 2008).

Thermal plants expansion is also limited for another reason. Indeed, their functioning is generally conditioned by hydro plants' reservoirs levels. In a normal or humid period (with a high reservoir levels), an entirely flexible thermal plant would not work at all, as reservoir levels of hydro power plants would be sufficient to respond to the entire electricity demand. On the contrary, in drought periods (characterized by low reservoir levels), a thermal power plant could work during the wall period of drought, so that the reservoir levels can refill. The reservoir refilling can take from 1 to 2 years. Therefore, the functioning of thermal plants can be seen as either "everything" or "nothing", a situation that does not offer a sustainable solution for power utilities using thermal energy. In order to tackle that problem, energy authorities created ten-year energy plans, which regularly incorporate a quota of power plants projects that have to be realized (Silvain, 2008).

Despite these constraints, thermal energy is predicted to grow significantly in the coming years and especially gas thermal plants. In addition to diversifying the country energy mix, the recent discovery of off-shore natural gas by Petrobras and the investments that are planned to secure gas supply are confirming this tendency. In 2009, thermal energy accounted for 13,263 MW of installed capacity (24% coal, 11% oil, 65% gas). According to the Energy Research Company (2010), between 2009 and 2019, there will be an additional 17,228 MW thermal capacity mainly coming from gas (50%) followed by oil (40%) and coal to a lesser extent (10%) (Figure 3).

Figure 3: Thermal Installed Capacity



Source: Booz&Co (2010).

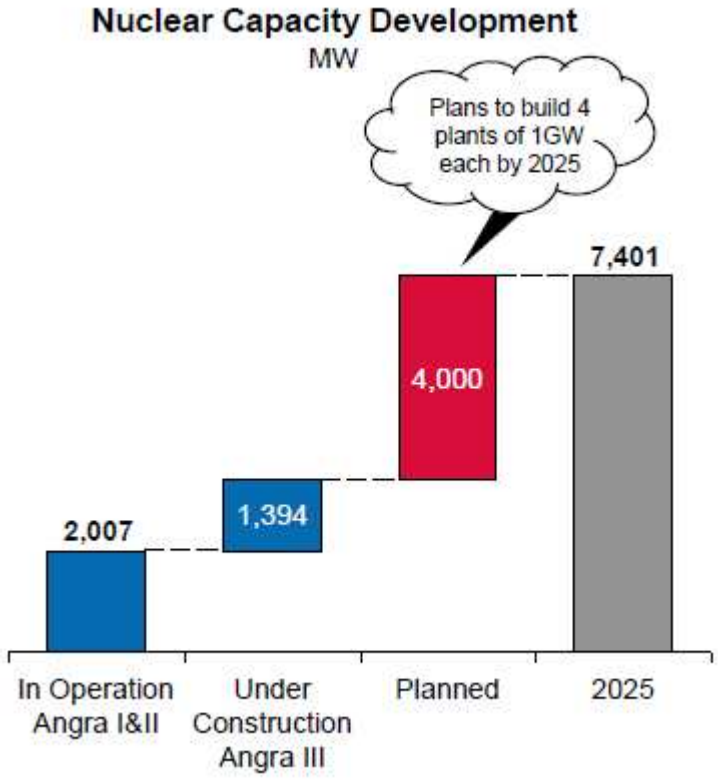
c) Nuclear

There are currently two nuclear power plants operating in Brazil, located in Angra dos Reis, Rio de Janeiro: Angra I (657 MW) which was connected to the grid in 1982 and Angra II (1,350 MW) which was connected in 2000. Both of them belong to Eletronuclear, a subsidiary of the major state owned utility Eletrobras. For the time being, nuclear power generation (operation and construction) as well as Uranium exploitation are kept as a public monopoly. However, private companies can supply equipment, services, and technology for nuclear plants (Rougier, 2011).

In 2010, the nuclear energy accounted for 2 percent of the country installed capacity which is a really low rate regarding Brazil's energy mix (Figure 1). However, in October 2006, the government announced that it will construct five additional nuclear power plants before 2025 which would double the actual nuclear installed capacity. In this perspective, the construction of a third nuclear power plant, Angra III, was launched in June 2010. This reactor, of a 1 400 MW

capacity, should be operational in 2015. Furthermore, the MME has planned to invest 210 M$ to extend the activity of Angra I from 40 to 60 years (MME, 2010). The national energy plan of 2009 included six additional nuclear reactors of 1 000 MW each till 2030. Four of them should be operational by 2025 (Figure4). After the Fukushima events, there were no changes of the government's position toward nuclear energy. In the coming six months, the locations of the future reactors should be announced.

Figure 4: Nuclear Installed Capacity



Source: Booz&Co, 2010

d) Renewables

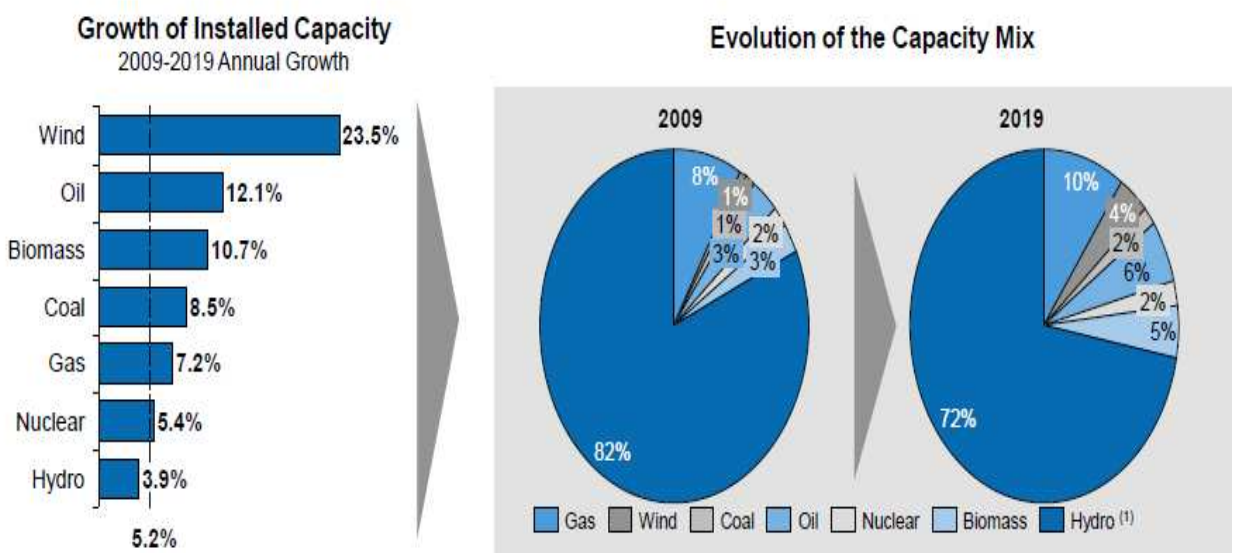
In 2010, renewables (excluded hydro energy provided by large dams) accounted for 1 percent of the country energy mix with an installed capacity of 1 GW (Figure1).

In 2002, the Incentives Program for Alternative Energy Sources (PROINFA) was launched to promote the development of renewable energies and lead their share to 10 percent of the national

consumption in 2010. However, the PROINFA program did not get the expected results: at the end of 2006, only 20 percent of the forecast installed capacity for 2008 was effectively constructed. On the other hand, the PROINFA deserves credit for having made Brazil the first wind energy producer of Latin America with an installed capacity of 1 100 MW at the beginning of 2011 (Meisen and Hubert, 2010).

If renewable energies part is still marginal in Brazil's energy mix, the potential of these energies is huge and especially for wind energy in the Northeast region. Indeed in 2001, the MME calculated a wind energy potential of 140 GW for the country and a new estimation which considered using turbines at a 100 meters high had brought this potential up to 300 GW. According to the National Wind Atlas, 30 GW of this potential could be used for electricity generation. Biomass potential is also huge even if it is mostly used as automobile biofuels. Indeed, it currently represents 27 percent of the country energetic matrix. Solar energy is currently quasi inexistent in Brazil, though in June 2011, it was inaugurated, by Electricité de France (EDF), the world largest nuclear producer, the first solar power plant of the country. The power capacity is 320 KW when the sun radiation is at its top level and the plant is supposed to be supplying 300 houses annually. Nevertheless, solar energy is still underexploited despite favorable climate conditions (Le Figaro, 2011).

Figure 5: Growth of Installed Capacity and Evolution of the Mix



Source: Booz & Company (2010)

With the prolongation of the PROINFA program and the government's increasing willingness to diversify its energy supply sources, renewables should have the fastest growth between 2010 and 2030 with a CACR of 16,4% (Figure 1). Wind energy and biomass will experience the fastest expansion between 2009 and 2019 with respective annual growth rates of 23.5% and 10,7% leading to a 4% and 5% installed capacity for wind energy and biomass in 2019 (EPE, 2010).

e) Biomass

Brazil is the third biomass energy producer in the world, after the United States and Germany. The annual growth of the sector is estimated at 12,5% over the past decade (Peirera, 2009). In 2009, biomass was accounting for 3% of the country installed capacity. It is forecasted that in 2019, biomass should have an installed capacity of 9 GW and account for almost 6% of the country electricity generation mix (Figure 2). 24,7 TWh have been generated in 2010, through the use of solid biomass. Other forms of biomass are still underexploited in the country. In terms of biomass energy, bagasse (fibrous sugar cane residue) represents the strongest growth potential.

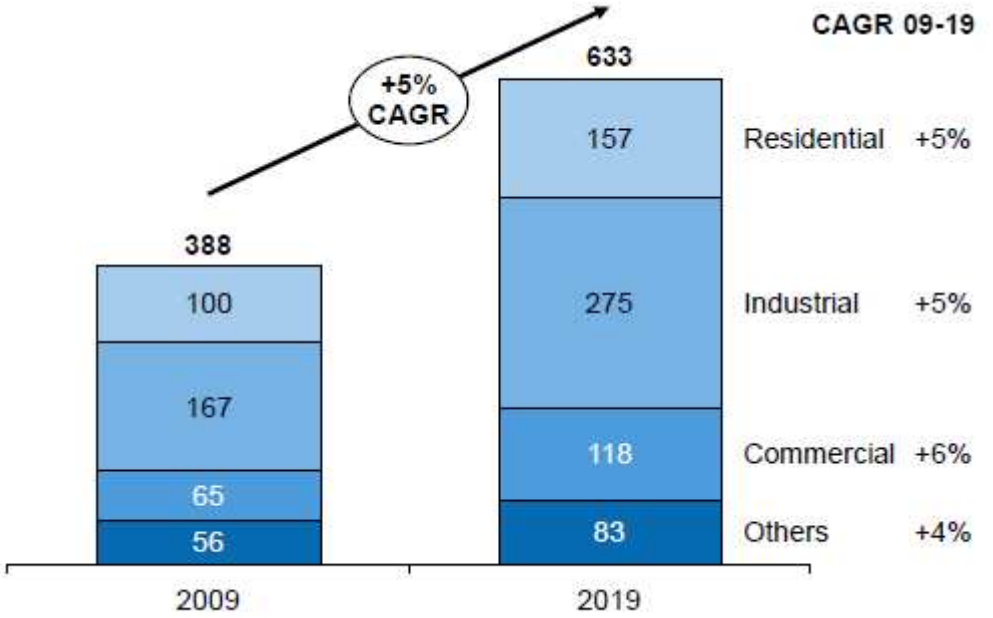
Biomass power generation can play an important role in complementing the current hydroelectricity offer in Brazil (Desplechin, 2010). Sugarcane harvest season is happening from May to November each year, which corresponds to the country drought period, where hydroelectricity production drops. Therefore, biomass generation could minimize the impact of dry seasons on the country electricity generation. Other benefits of biomass are both cost and reliability. Biomass facilities can be constructed faster and cheaper than hydroelectricity power plants and are more reliable. According to Mario Pereira, biomass will reduce costs of thermal plants by €8,5 M from 2012 to 2020, making it attractive for power utilities.

2.1.3 Electricity supply and demand

Despite the impact of the financial crisis in 2009, the country's electricity demand growth has maintained a high level in the country, at around 5 percent annually. The key drivers of the Brazil's power consumption are population growth (from 192M in 2009 to 207M by 2019) coupled with a better income distribution, high GDP growth (an average of +4,5% per year by 2019), high foreign investment growth and strong competitiveness of local based industries (KPMG, 2009).

In 2011, the total electricity consumption in Brazil represented 472 TWh and was divided into industrial (43%), residential (26%), commercial (17%) and other consumption (14%). Between 2009 and 2019, the power consumption compound annual growth rate (CAGR) should stay at 5 percent (Figure 6).

Figure 6: Power Consumption by sector 2009-2019 (TWh)

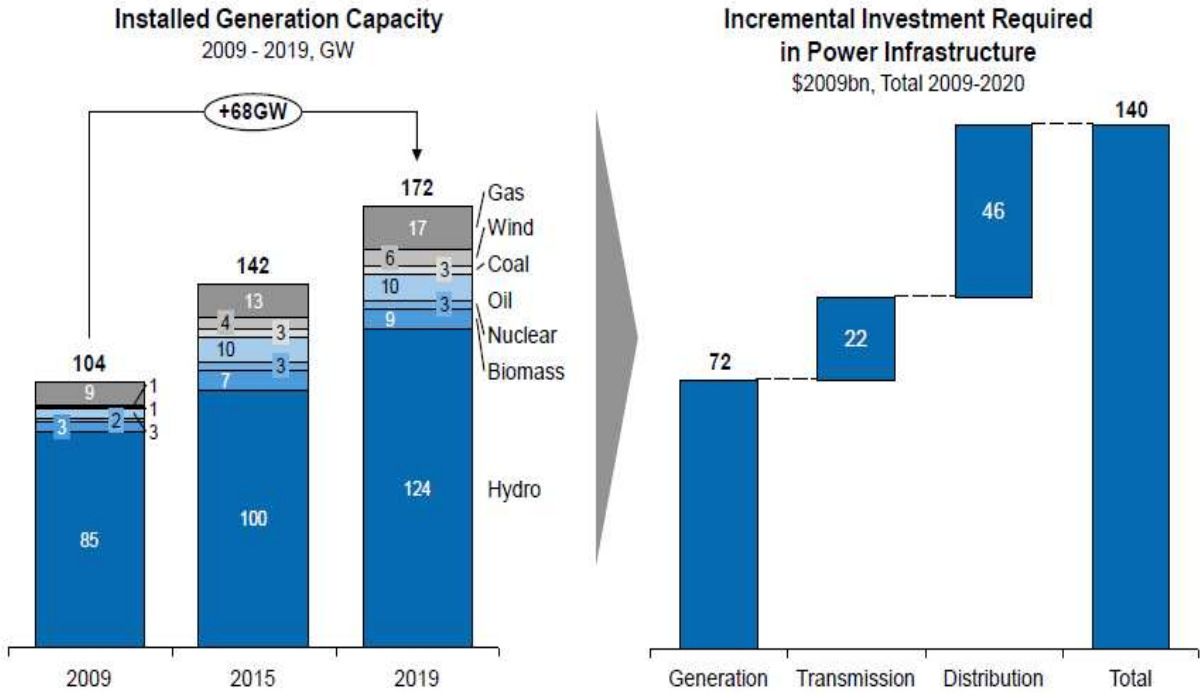


Source: Booz&Co (2010)

Thanks to the market reforms of 2004, the supply-demand balance is now stable. However, it is important to note that there are important disparities between regions: the south east and center east regions are highly consumerist and are electricity net importers while the northern regions, despite having the highest demand growth rate in absolute value, keep being low-consumption regions. Furthermore, in the short term, without hydro effect, the supply demand equilibrium is still under pressure and relies heavily on reservoir levels (Albouy, 2011).

In order to efficiently address the growing electricity demand (+68GW by 2020), the Energy Research Company (EPE, 2010) is forecasting a 140 billion dollars investment by then so that the power infrastructure can maintain the supply-demand balance stability (Figure 7).

Figure 7: Additional capacity planned and required investment by 2020



Source: Booz&Co (2010)

Because Brazil consumes more electricity than its own production, the country imports energy which mainly comes from Paraguay and the Itaipu dam. However, by reducing network losses and with the EPE's investment plans, Brazil's electricity imports should be reduced in the short term. In 2006, Brazil was importing 10 percent of its electricity production and it should be around 5 percent in 2020 (IEA, 2010).

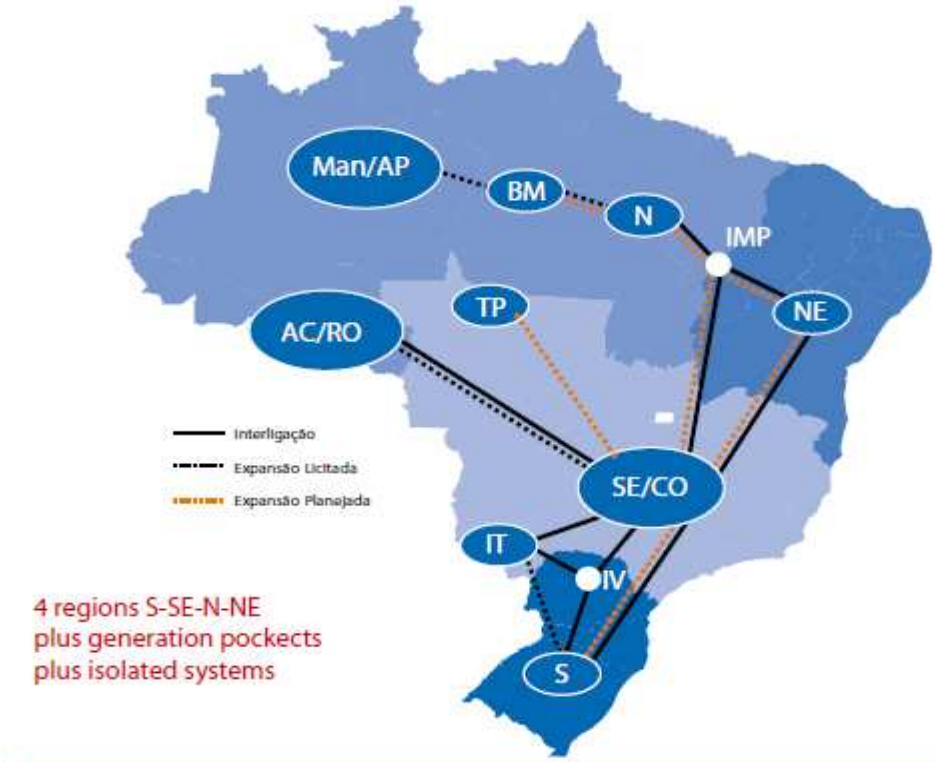
2.1.4 Transmission and distribution system

Transmission is a major challenge for Brazil because of size of the country (5th largest in the world) and because of the huge distance between where electricity is generated and where it is actually consumed. Indeed, the major hydro dams, which supply more than 70 percent of the local demand, are situated in outlying regions, far from Brazil's economic activity. Transmission has remained a public monopoly until recently, managed both by federal (Eletrobras) and state

owned companies (CEMIG, COPEL, and CTEEP). Private companies remained marginal (ISA, Terna) though they finally penetrated the market during the last decade (Losekann, 2008).

The National Interconnected System (SIN) gathers four traditional sub-systems which are the South (S), the South East and Center West (SE/CO), the North (N) and the Northeast (NE). Each sub-system is associated to hydro basins and sub-systems that are interconnected (Figure 8).

Figure 8: Sub-systems and Interconnections



Legenda			
SE/CO	Sudeste/Centro-Oeste	IT	Itaipu
S	Sul	AC/RO	Acre/Rondônia
NE	Nordeste	BM	Belo Monte
N	Norte	TP	Teles Pires/Tapajós
MAN/AP	Manaus/Amapá	IMP	Imperatriz
IV	Ivaiporã		

Source: EPE (2010)

Contrary to the transmission sector, the distribution has been largely privatized and almost 64 percent of the Brazilian distribution companies are now private (Figure 9).

Figure 9: Brazil's main distribution companies

Company	Controlling shareholder	Concession area	Sales (GWh)	Sales (%)
Cemig	MG State Govt	Minas Gerais	20,221	8.0%
Eletropaulo	AES Corp.	São Paulo city	31,642	12.5%
CPFL	VBC Group	São Paulo State outside São Paulo city	36,135	14.3%
Copel	PR State Govt.	Parana	17,524	6.9%
Energias do Brasil	EDP	São Paulo, Rio Grande do Sul	15,863	6.3%
Celesc	SC State Gvt	Santa Catarina	15,157	6.0%
Light	EDF	Río de Janeiro City	19,139	7.6%
Equatorial (Cemar)	GP Investimentos/Pactual	Maranhao	2,793	1.1%
Ampla (Cerj)	Enersis	Rio de Janeiro	6,832	2.7%
Others	Mostly private sector		87,594	34.6%
Brazil Total			**252,900**	**100.0%**

Source: EnergyMarketPrice (2010)

2.2 Energy Policy Of Brazil

The current Brazilian energy policy is based on the primary reforms implemented by the law of 1998. This law had several objectives: promoting energy savings, a stronger protection of the environment and promoting renewables, guaranteeing oil supply, favoring gas for electricity production, encouraging free competition and attracting private investors in the energy sector, increasing local competitiveness on the international market (Melo, Neves, Pazzani, 2011).

Considering only the power sector, the tipping point was the law of 1994, two years before the arrival of the Cardoso administration. Indeed, for the first time, Brazil clearly softened the entrance conditions for the electricity market.

2.2.1 The power sector before the 1990's: A fully state owned model

Until 1960, a so called electricity market was nonexistent in Brazil. At that time, each state was independently dealing with its energy needs, and operation and planning were limited to independent power utilities' will. However several factors pushed towards a more integrated market system. At that time Brazil's industrialization, combined with rapid growth, was going along with increasing energy needs and especially an increasing electricity demand. Rapidly, the need to move towards power market integration and the creation of synergies between the existent dispatched power utilities were becoming necessary in order to best respond to electricity rapid demand growth (Melo, Neves, 2011).

A decisive step was taken in 1962 with the creation of ELETROBRAS, a state-owned power utility, created by the federal government. The main objectives of ELETROBRAS were to plan and coordinate the entire electricity sector at a national level. Under the supervision of the Ministry of Mines and Energy (MME), ELETROBRAS became the major shareholder of all the federal power entities and a minor shareholder in the different state-owned power utilities.

While the federal government, through ELETROBRAS, was planning and coordinating the energy policy of the north and north east regions of Brazil, other state-owned companies were duplicating the same model in the remaining regions. The most important ones were Companhia Estadual de Energia Eletrica (CEEE) in Rio Grande do Sul, Companhia Paranaense de Electricidade (COPEL) in Paraná, Companhia Energetica de São Paulo (CESP) in the São Paulo region and Companhia Energetica de Minas Gerais (CEMIG) in the Minas Gerais region. At that time, all these state-owned companies were vertically integrated and were therefore present in all the electricity supply chain: generation, transmission and distribution (Lock, 2005).

In 1973, Brazil and Paraguay launched one of the most important energy projects in their history with the creation of ITAUPU Binacional. Located at the border between Brazil and Paraguay, ITAIPU Binacional constructed a 14 GW dam on the Parana River. The Itaipu dam stayed for a

long time the most important hydroelectric dam before being outdone by the Three Gorges dam (22.5 GW) in China in 2006.

Up until the 1990's, the brazilian power sector remained under the government's control. However, the 1980's were about to show the limits of a fully state owned model.

2.2.2 First Reform of the electricity market: 1990's

In the 1990's, Brazil started liberalizing and opening its economy. This liberalization led to new market entrants and especially private companies willing to profit from Brazil's economy fast growing potential. Some of the public companies went private while the strongest one went global, such as PETROBRAS, expanding their activities outside Brazil, and private investors started entering in local companies' capital (Costa, 2009).

Parallel to that movement, Fernando Henrique Cardoso in office at that time started liberalizing the energy sector which was becoming obsolete. In the 1980's, the fully state-owned model was indeed reaching its limits. The global implementation of subsidized tariffs for electricity and the revenue shortfall in the sector were leading to delays in constructions and a lack of financings for new power projects. This situation was digging the gap between a growing electricity demand and an insufficient energy supply, which was also growing but at a lower path (Almeida, 2005).

In 1995, with the implementation of both the RESEB project (Restructuring the Brazilian Electricity Supply Industry) and the federal law n. 9 074, the Cardoso administration and the MME had two main objectives: promoting competition in the power sector and attracting foreign private investors. The aims of the RESEB were clear: decrease the presence of the state in a sector where private companies can be more efficient than state-owned utilities, gather funds for the desired new power projects and finally keep public debt under control. In order to promote

competition, this model established new market status for the economic agents such as the “free consumer” which could now choose its own suppliers, the independent power producers (IPP) as an alternative to public power producers, and traders which could just buy and sell electricity without having any owned power utilities (Melo, Neves and Costa, 2009). The new model also established free access to the transmission and distribution grids and strengthened the position of self-producers.

a) The new energy institutional organization

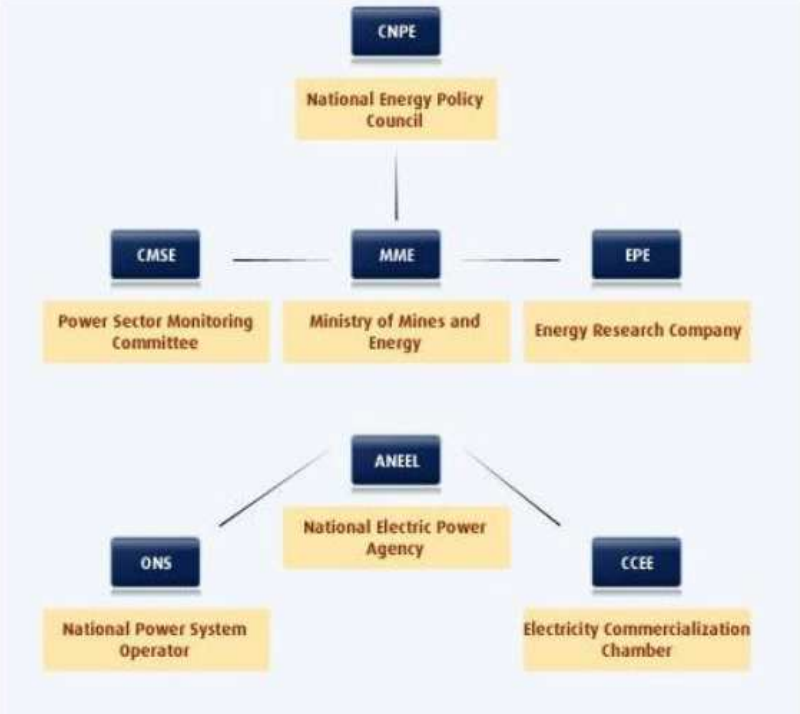
In the 1990’s, the government decided to change the role of the state from a main owner of country power assets to a regulator and an energy policy maker (Almeida, 2008). Therefore, in order to manage the progressive liberalization of the country’s electricity market, the federal government created various state entities.

In 1996, the Brazilian Electricity Regulatory Agency (ANEEL) was created and replaced the Department of Water and Electrical Energy (DNAEE). ANEEL, as an independent regulatory entity, became in charge of regulating the production, transmission, distribution and commercialization of electricity in the country. To support ANEEL’s operation, the National Energy Policy Council (CNPE) was created in 1997 and became in charge of formulating the country’s energy policies and ensuring the right energy mix for each region.

To complete the Brazilian power sector reorganization process, another main step was taken in 1998 with the federal law 9648/98. This law gave birth to two additional regulatory entities: the National Power System Operator (ONS) and the Wholesale Electric Energy Market (MAE). The ONS, created in May 1998, is a non-profit entity which, under the control of ANEEL, is in charge of controlling and managing generation and transmission on the interconnected electricity system (SIN). It also has to ensure to the utilities operating on this system a free access to the transmission network and unanimous treatment through the use of transparent rules (Melo,

2011). Soon after, in July 1998, the MAE was created as an environment to regulate the electricity purchase and sale transactions for all the country's interconnected system. All utilities with an installed capacity exceeding 50 MW and all distributors with annual sales bypassing 100 GWh had to then be a part of the MAE and respect specific market agreements. The Ministry of Mines and Energy (MME) was maintained as the highest political instance for issues relative to energy (Figure 10).

Figure 10: Brazilian Energy Authorities



Source: EnergyMarketPrice (2011)

b) Private investors' market entrance

Following the implementation of the RESEB project, generation and distribution markets were partially liberalized leading to a privatization of several state-owned utilities and to the arrival of foreign investors. On December 1996, the Brazilian electricity sector comprised 62 entities in total. ELETROBRAS, the major power utility in the country, was operating on the electricity sector with its four main subsidiaries: ELETRONORTE, ELETROSUL, FURNAS and CHESF.

There were 27 state utilities, also associated with ELETROBRAS and 31 public and private entities (Figure 11). ELETROBRAS and its subsidiaries accounted for more than 40% of the installed capacity in the 1990's (OECD, 2005).

The privatization process officially started in 1998, when the federal government decided to privatize GERASUL (Centrais Eletricas Geradoras do Sul), a state-owned power utilities based in Florianopolis. GERASUL was acquired by GDF Suez, a french power company, which is now the first foreign investors in Brazil in terms of installed capacity. In February 1999, ELEKTRO (Electricidade e Serviços), the former distribution unit of CESP, was bought by Enron International after a public offering. Soon after, the generation companies which were belonging to CESP, Paranpanema and Tietê, were acquired respectively by Duke Energy Corporation and AES (Applied Energy Services Inc.), two US power companies. Other private companies such EDF (Electricité De France) and Iberdrola decided to focus only on the distribution business and acquired local retailers (Defueilley, 2000).

Electricity generation and transmission, which were operated by ELETROBRAS and its subsidiaries up until the 1990's, were now operated by both private and public entities (Eletrobras, 2002) Nevertheless, despite the re-organization of the brazilian power sector and its liberalization, the electricity market remained strongly dominated by the state owned utilities. Indeed, in 2002, ELETROBRAS and its subsidiaries were still accounting for more the 40 percent of the country installed capacity and the three main state-owned utilities (CEMIG, CESP, COPEL, CEEE) represented more than 30 percent while private companies only accounted for less than 5 percent of the total installed capacity (Figure 11).

Figure 11: Private and state-owned electricity generation companies

COMPANY TYPE	PARTICIPATION (%) 1996	PARTICIPATION (%) 1998	PARTICIPATION (%) 2002
ELETROBRÁS system	40.0	38.0	40.5
State-owned Utilities	36.0	34.0	31.3
ITAIPU - Brazil's share	9.5	9.5	9.6
ITAIPU - Brazil's import	9.5	9.5	9.6
Auto-Producers	4.7	5.7	4.1
Private/Municipal	0.3	3.3	4.9

Source: ELETROBRAS (2002)

2.2.3 The 2001-2002 supply crisis

Despite the Cardoso administration's efforts to tackle power market inefficiencies and to avoid the supply demand gap issue, its reforms did not prevent Brazil from facing one of the most important energy crises in its history.

The new market based model was still coping with a lack of investments for generation expansion and with high electricity tariffs for consumers. Indeed, between 1990 and 1999 the installed capacity expanded by 28% thanks to the promotion of competitiveness in the power sector and its liberalization, while the electricity demand increased by 45% during the same period of time (OECD, 2005). The initial spark of the supply energy crisis was the drought that hit Brazil at that time. In a country where hydroelectricity accounts for 78 percent of the total installed capacity, a drought is directly impacting reservoir levels. Additionally to that energy shortage (coming from extremely low reservoir levels), the delays in the generation expansion, the ineffectiveness of the state and the MAE, and a complex electricity pricing model**,** strengthened the Brazilian power crisis.

In order to tackle the supply crisis, the Cardoso administration created the Crisis Management Board (CGE). The CGE became the highest energy authority during the crisis and had the power to implement electricity rationing and blackout, impose special tariffs and bypass the established

energy legislation. At the same time, the government implemented a quota system based on historical and target consumption for all agents, applying bonuses for those who were managing to reduce their consumption level and penalties for those who were over consuming. To support that system, a secondary market was created so that the consumers could trade their quotas surplus. The MME promoted the launch of emergency plants which led to the construction of more than 2 GW additional thermal power plants (Melo and Neves, 2009).

The management of the crisis by the Cardoso government led to mixed results. If the administration did manage to reduce historical consumption by 20%, indicating an efficient demand side management, the rationing strongly impacted electricity tariffs. Indeed, between 1995 and 2002, the price of electricity in nominal term increased by 140% because of demand's contraction (World Bank, 2010). As a consequence, generation and distribution companies experienced a severe loss in their revenues which fell by 20% leading to many local utilities' bankruptcies. Last but not least, the government debt increased by 200 US millions because of the bonus payment established by the quota system

This supply crisis underlined the inherent weaknesses of the new market based model implemented by the Cardoso Administration: constant imbalance between electricity demand and supply, difficulties enhancing investments incentives and bad formulation of sector planning. Consequently, reforming the institutional model of the Brazilian electricity market was about to become one of the top priorities of the Lula administration.

2.2.4 Second Reform of the Electricity Market: 2004

A major step was taken in 2004 with the reform of the electricity market launched by Lula soon after his arrival into office. The main objectives of this reform were first to ensure energy supply security, then to lower the electricity price and finally to connect all the population before 2008.

Furthermore, the continuing expansion of the country installed capacity should now follow three priorities: the development of the hydroelectric potential, balancing hydroelectric production with gas production and increasing the part of renewables in the country's energy mix (Andres and Guash, 2007).

In 2003, the energy policy underwent its first turnaround. Lula's administration decided to put a clear stop to the movement of privatization launched by its predecessor Cardoso and to put the government back in the center of the brazilian electricity sector. The former energy institutions were strengthened and two new major energy institutions were created in 2004. The Energy Research Company (EPE) was created in order to develop and coordinate a long term planning for the electricity sector and the Electric Sector Monitoring Committee (CMSE) which has to monitor electricity supply and evaluate power services within the MME (Figure 10). Despite the strengthening of the government's role, it is important to note that the new model was still based on the idea of attracting long term investments and fostering competition (Costa, 2009).

In March 2004, the federal law 10.848 created the Chamber of Electric Energy Commercialization (CCEE) which replaced the former market, the MAE. This law also set up the new regulatory agenda of the power sector and created two new environments: the Regulated Contracting Environment (RCE) and the Free Contracting Environment (FCE). The RCE was based on a public auction system where the distributors acquired the electricity they had to buy at a cap price set by the government, in order to meet consumers' needs (Melo, 2011).

The FCE created an exchange platform where all the negotiators, distributors excluded, could freely negotiate their power purchase agreements (PPAs) (Figure 12). The CCEE, under the supervision of ANEEL, got the responsibility of administrating both market environments, the FCE and the RCE.

Figure 12: The Free Contracting Environment (FCE) and the Regulated Contracted Environment (RCE)

Source: Chamber of Electric Energy Commercialization

The keys of this model are to ensure supply security as well as the requirement that all consumption in both the RCE and the FCE needs to be a 100 percent contracted. In the RCE, distributors must contract 100 percent of the forecast demand over a five year period with long term auction contracts. In the FCE, free consumers have to follow the same rule even if it is not compulsory for them to sign long term contracts.

The new reforms implemented by the Lula administration helped correct the market imperfections of the former model by ensuring supply for all consumers thanks to the RCE and by favoring competition on the FCE. Besides, the MME could now plan in advance the future needed capacity expansion and the private or state-owned utilities which were winning the auction and were obtaining guaranteed long-term contracts (Andres, 2007).

2.3 Economic Framework of the current market model

The first brazilian market model, known as the MAE, was based on a short term pricing system and led to the supply crisis of 2001-2002 because of insufficient investments and the progressive diminution of the reservoir levels during the two years following a drought period. In normal or humid periods, the electricity market price could be really low (4 to 5 R$/MWh) for several years. On the contrary, when reservoirs levels were starting to reach critical levels (because of drought period or because of a lack of investments), market prices were skyrocketing and could stay extremely high during 6 months to a couple of years depending on weather conditions. Therefore, spot prices were linked to reservoir levels which appeared as an unbalanced model (Albouy, 2011).

As a consequence a new model was established in 2004 in order to achieve four objectives: fair electricity tariffs, guaranteeing the supply security (and avoid or at least minimize the probability of a new energy crisis), build a stable regulatory framework and create an adequate long term planning based on domestic demand growth. This model is based on three market environment: the Regulated Contracting Environment (RCE), the Free Contracting Environment (FCE) and the short term market (Costa, 2009).

2.3.1 The Regulated Contracting Environment

The Regulated Contracting Environment (RCE) is currently the major electricity market in Brazil accounting for 70 percent of the energy bilateral contracts. On that market and according to the federal law 10.848 implemented in 2004, distributors must ensure that their market demand is totally covered by the electricity contracts they purchase through a public auction system. The EPE, in charge of the long term planning, produces the official capacity expansion plan which integrates this bidding process for new power plants. Therefore, according to the

anticipated distributors' needs for the coming periods (2011 to 2019 for instance), new power plants projects, either imposed by the EPE's expansion plan or suggested by power producers, are put up for auction (Melo, Neves, 2011).

Distributors mainly purchase energy from generators but can also, under certain conditions, purchase electricity from the Incentives Program for Alternative Energy Sources (PROINFA), from the Itaipu dam (only for South, South East and Central West consumers) and from generators that are already directly connected to the buyer's distributor system.

The RCE auction system was created so that private and public utilities could coexist in the same competitive environment. To attract private investors this system has established clear and transparent rules so that public utilities cannot be favored. Therefore, RCE can be seen as a competitive and regulated environment that aggregates the distributors' total demand in periodic auctions that generators share after having competed for the best offer through the bidding process (Almeida and Pinto Junior, 2005).

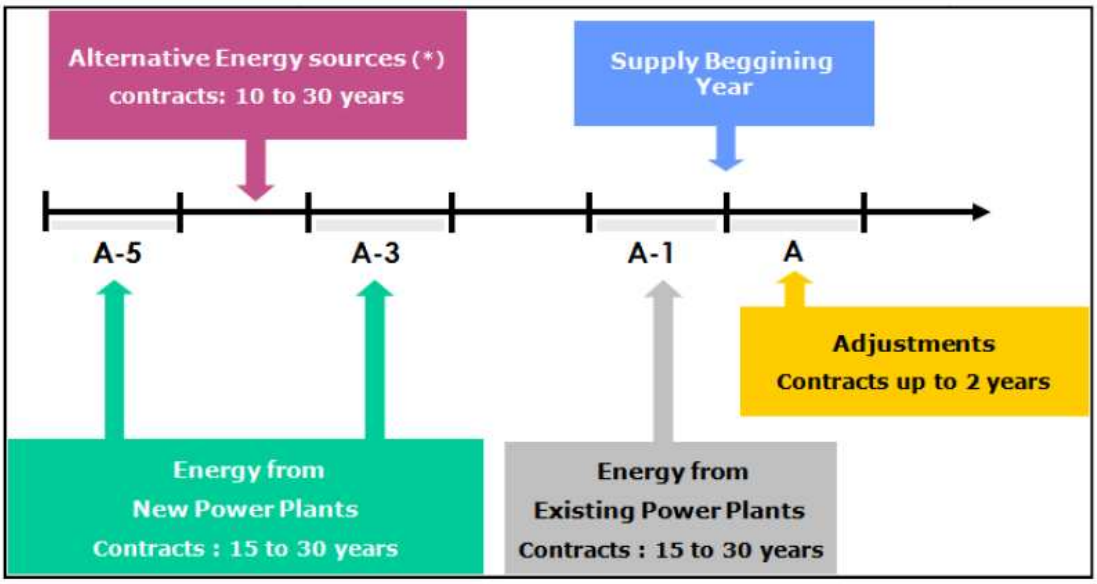
There are three different types of auctions in the RCE: auctions of energy from existing power plants, auctions of energy for new power plants and auctions of energy adjustments. While auctions from existing power plants are used to cover current electricity needs, auctions from new power plants will be covering the expected demand growth. Adjustment auctions are used to cover an eventual additional electricity need that was not forecasted before and that needs to be covered. Each auction is associated with a delivery date and contract duration. For existing energy auctions, the contract has to be delivered after one year (A-1) and its duration can be from 5 to 15 years. For new energy auctions, there are two different schemes: A-3 auctions are mainly for thermal projects (gas, fuel and diesel) and have to be brought into service after three years. A-5 auctions concern hydroelectric and thermal projects which take more time to be constructed like coal plants for instance. A-5 auction plants have to be brought into service after five years. The durations of the contract set by A-5 and A-3 auctions can be from 15 (thermal

plants) to 30 years (hydroelectric plants). The new energy auctions winners are then registered in the EPE's plan as "committed generation" and are added up to projects already in construction or already operational. For adjustment auctions, contracts are signed between one generator and one distributor only, the delivery date can go until one year and have a maximal duration of 2 years (Picon, 2011).

Wind projects were previously excluded from the longer term auctions system because of their relatively high price compared to hydro power projects. However, as price of wind power have been falling these last years, the government enabled wind projects to be included in the A-5 auctions. During the energy power tenders of 2011, energy authorities opened A-3 auctions as well as reserve power tenders just for wind power, small hydro plants and biomass. The success was straightforward: after the auction process, the EPE declared that 76% of the projects registered in Brazil's A-3 and reserve power tenders were won by wind projects, with an installed capacity potential of 11GW (Bayani, 2011).

The RCE had to be an attractive structure for private investments. To do so, the RCE established clear and transparent rules which allowed no place for abuses of power from public utilities. Furthermore, the RCE regulatory framework prevents form market collusion and therefore market price manipulation. The auction system of the RCE is also offering long-term bilateral contracts that ensure investors will be able to sell their electricity from 15 to 30 years which will contribute to a direct risk reduction for them. Finally, by gathering all distributors in the RCE and since generators are now signing contracts with these different distributors, the risk is shared between all RCE participants, buyers and sellers.

Figure 13: Auction Model in RCE



Source: *CCEE*

In addition to the creation of an efficient environment for regulated competition, the RCE also established a long-term market that is able to guide expansion capacity by addressing correctly the electricity demand growth and by generating fair electricity tariffs. The results of the RCE have been positive so far, managing both to attract private investments and to meet expected electricity demand growth despite several delays in the construction of generation projects (MME, 2010).

2.3.2 The Free Contracting Environment

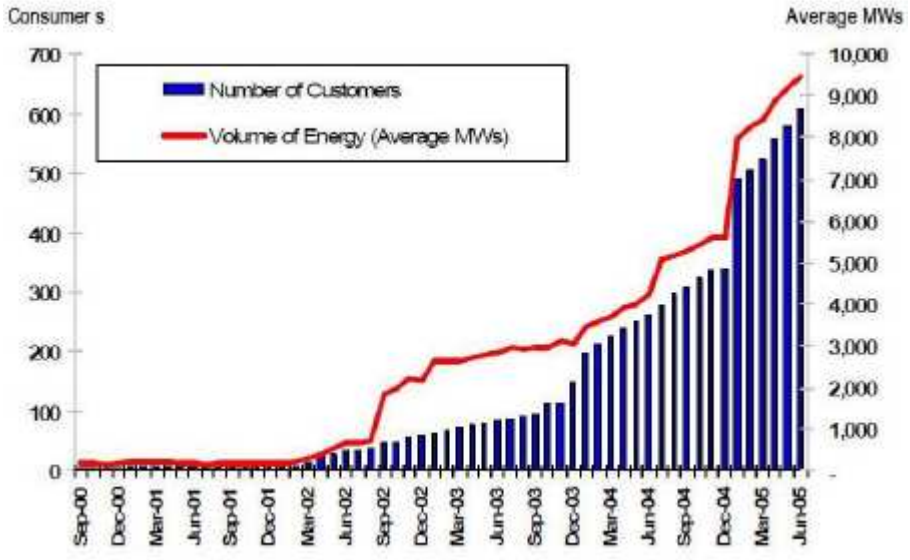
The Free Contracting Environment (FCE) is an environment where consumers, known as “free consumers” (in opposition to “captive consumers” of the RCE), are free to choose their electricity suppliers (Costa, Neves, 2009). The FCE comprises free consumers, traders, power importers, independent power producers, state owned power producers. In the FCE, agents set freely the conditions, the duration, the price and the quantities of their energy contracts. There is one exception though for state-owned producers which have to keep using public auctions for

their contract under the supervision of ANEEL. The FCE accounts for almost 30 percent of the total electricity consumption.

The free market and the status of “free consumer” exist since 1995. However, since the last decade, several federal laws have constantly changed the free market conditions of entrance and perimeter. Finally, in 2004, the federal law 10.848 defined the new rules of the free market with the creation of the FCE. The main evolution is that under the FCE model, “captive consumers” from the RCE can now migrate to the FCE and become “free consumers” under certain conditions. Indeed, if “captive consumers” want to become free consumers they have to inform their distributors that they will be leaving the RCE one year in advance. On the other way round, to return from the free market to the regulated markets, consumers have to inform distribution companies five years in advance and then, distributors, according to their needs, can shorten this period or not (ANEEL, 2010).

From 2004 to 2008, lots of consumers moved from the RCE to the FCE (Figure 14). With this new environment medium-sized consumers became aware that they could save money on the FCE which could be more appropriate to their needs. Besides, consumers were also attracted by low electricity prices in the FCE coming from the energy surplus that had been generated during the rationing period. However, this tendency has come to an end as the balance between electricity supply and demand has been recovered.

Figure 14: Evolution of the free consumer's market

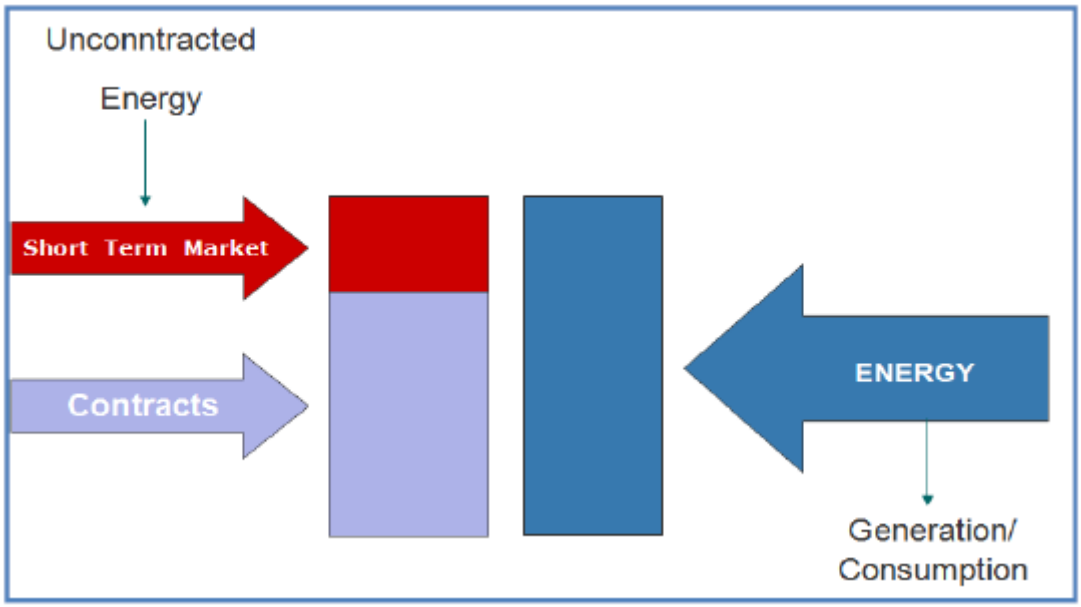


Source: ANEEL

2.3.3 The short-term market and spot price

One of the responsibilities of the CCEE is to set the short term price (spot price) and determine the monthly accounting of the short term market. There is a difference between the effectively consumed and produced electricity and the energy that is contracted in both RCE and FCE (Figure5). This difference enables the CCEE to set a spot price for electricity thanks to a mathematical model that uses the data of the ONS. The short term price structure depends on a wide range of technical factors that the ONS incorporates in its mathematical model such as levels of reservoirs, historical data on consumption levels, demand and supply projections, availability of thermal and hydroelectric plants, cost of fuels, etc… This short term market is used as a basis for agents to make their arbitrage on the RCE and the FCE markets (Lock, 2005).

Figure 15: The short term market



Source: CCEE 2010

3. EDF – Company Profile

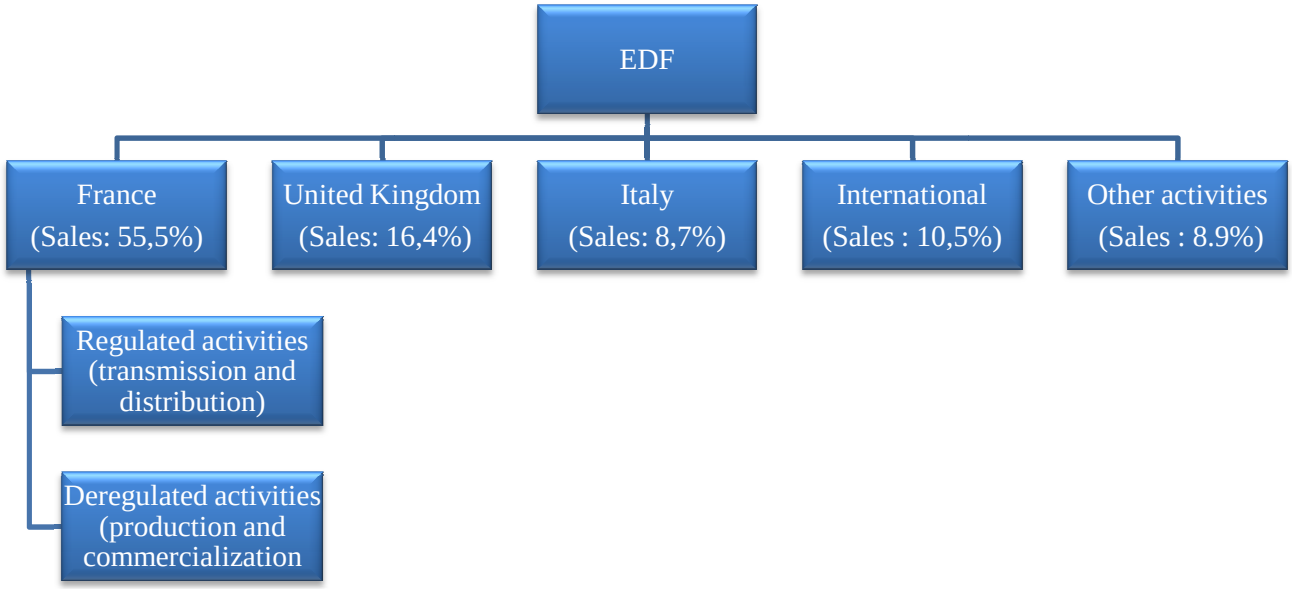
3.1 Overview of the Group

Electricité De France (EDF) is the electricity market leader in France as well as one of the leading companies in the European energy market. The group is present in all areas of electricity: generation, transmission, distribution, trading and commercialization. While generation, trading and commercialization are deregulated activities, transmission and distribution are regulated activities respectively operated by two EDF's subsidiaries, RTE and ERDF (Maury, 2011).

Since its creation in 1946, resulting from the nationalization law of 1 450 power companies, the french government has stayed the major shareholder of the Group. In 2012, EDF is still owned at 84.5 percent by the french government despite the partial privatization that the state owned group underwent in 2005. At the end of 2010, EDF's global sales were accounting for 65.2 billion euros, generating 630.4 TWh worldwide. The group has an average of 37 million customers worldwide and about 161 000 employees with 105 393 of them located in France (EDF, 2011).

If EDF is an historic energy player in France (55,5 percent of its sales in 2010), the group also has a strong position in the UK energy market (16,4 percent) with its subsidiary, EDF Energy and in the Italian energy market (8,7 percent) with Edison. International markets accounted for more than 10 percent of its global sales (Figure16).

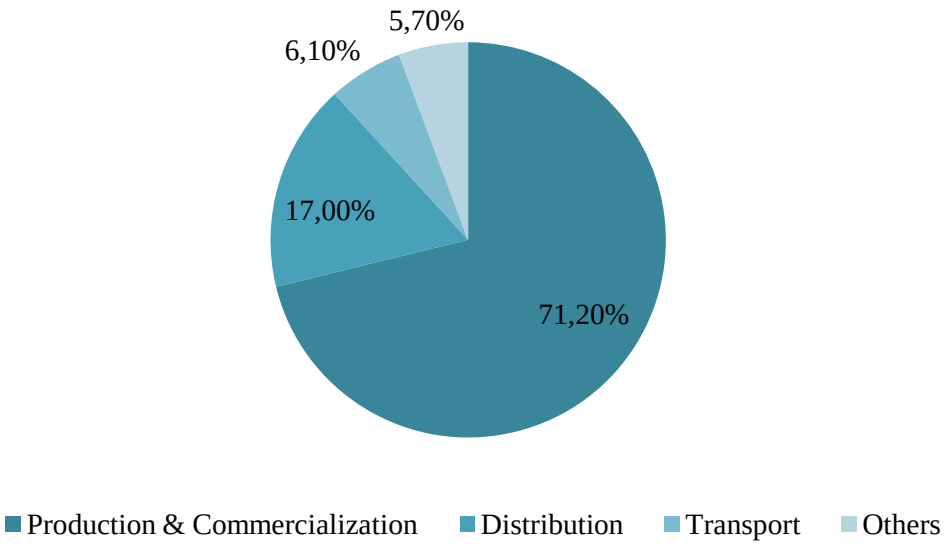
Figure16: Overview of the Group Activities



Source: EDF (2010)

In 2010, in terms of global sales, production and commercialization accounted for 71,2 percent of EDF's turnover, distribution accounted for 17 percent, transport accounted for 6,1 percent and the other electricity related activities accounted for 5,7 percent (Figure17).

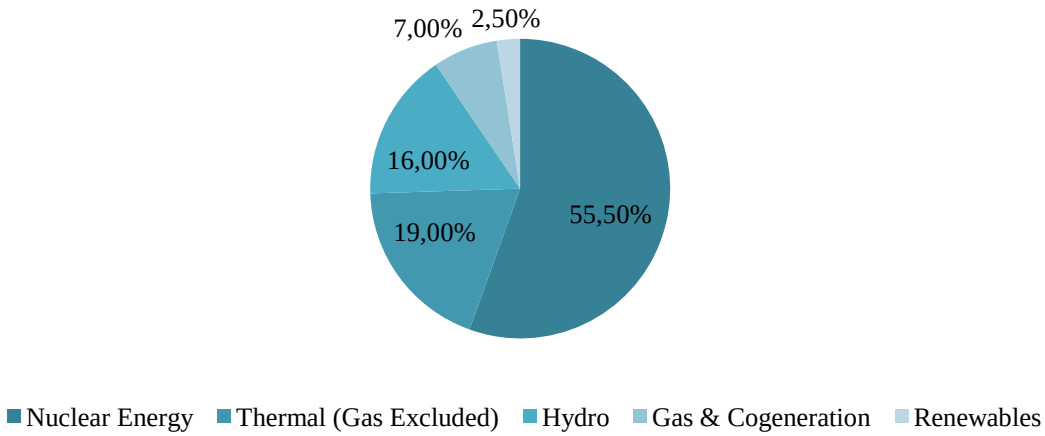
Figure17: EDF Revenue repartition 2010



Source: EDF (2010)

In 2010, in terms of installed capacity worldwide, nuclear energy accounted for 55,5 percent of EDF's energy mix, thermal energy (gas excluded) accounted for 19 percent, hydro energy accounted for 16 percent, gas and cogeneration accounted for 7 percent and renewables accounted for 2,5 percent (Figure18). Renewables are directly managed by a subsidiary of EDF known as EDF Energies Nouvelles (EDF, 2010).

Figure18: EDF Installed Capacity Worldwide



Source: EDF (2010)

3.1.1 EDF, leader on the french electricity market

a) Generation and Commercialization

EDF is by far the number one electricity producer in France in front of Gaz de France (GDF) and E.ON France. In 2010, its installed capacity on the french territory was 97,2 GW and its electricity production reached 470,2 TWh at the end of the year. EDF is in charge of all the 58 nuclear reactors of the country. In addition to its exclusivity on the french nuclear fleet, EDF is also operating thermal and hydro power plants in the country (Maury, Vottero, 2011).

As the world leading nuclear power plant operator, EDF's energy mix relies heavily on nuclear energy. In terms of installed capacity in the french territory, nuclear power plants account for 65 percent, hydro power plants accounts for 20,6% and thermal plants account for 14,4 percent (Figure19). In terms of generation, the part of nuclear energy is increasing at 86,7 percent while the part hydro and thermal energy are decreasing, respectively accounting for 9,7 percent and 3,6 percent (Figure20).

Figure19: EDF Installed Capacity France (GW)

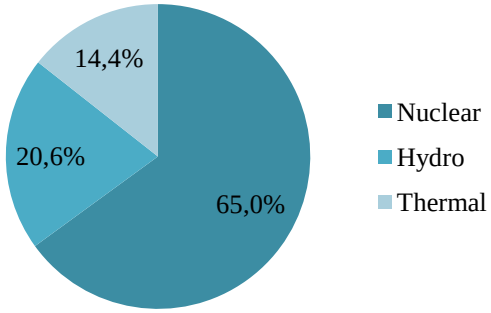
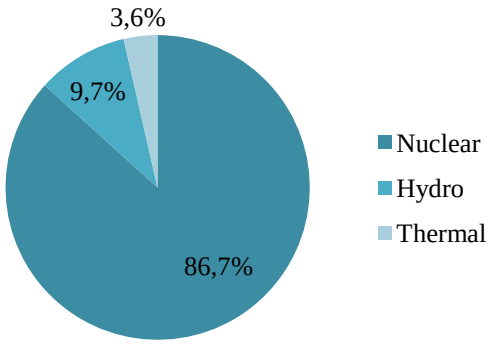


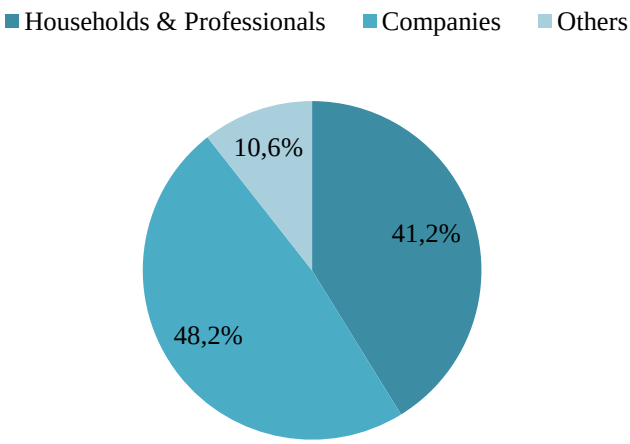
Figure20: EDF Generation France (TWh)



Source: EDF (2010)

EDF is also the first electricity supplier in France. Thanks to its historic monopolistic position on the french power market, it has a large customer portfolio (27 million customers in 2010) including households, professionals, companies, regional and local authorities. In 2010, its market share in electricity commercialization was 83,4 percent and its total electricity sales represented 411 TWh. Since the energy market liberalization, EDF is also selling gas. In 2010, its market share in gas commercialization was 4 percent and its total gas sales represented 21,5 TWh (EDF, 2010).

Figure 21: Electricity Sales France (TWh)



Source: EDF (2010)

In terms of EDF's sales in France in 2010, companies accounted for 48.2 percent, households and professionals for 41,2 percent and others (territorial and local authorities, local distribution companies) for 10,6 percent (Figure21).

b) Transmission and distribution

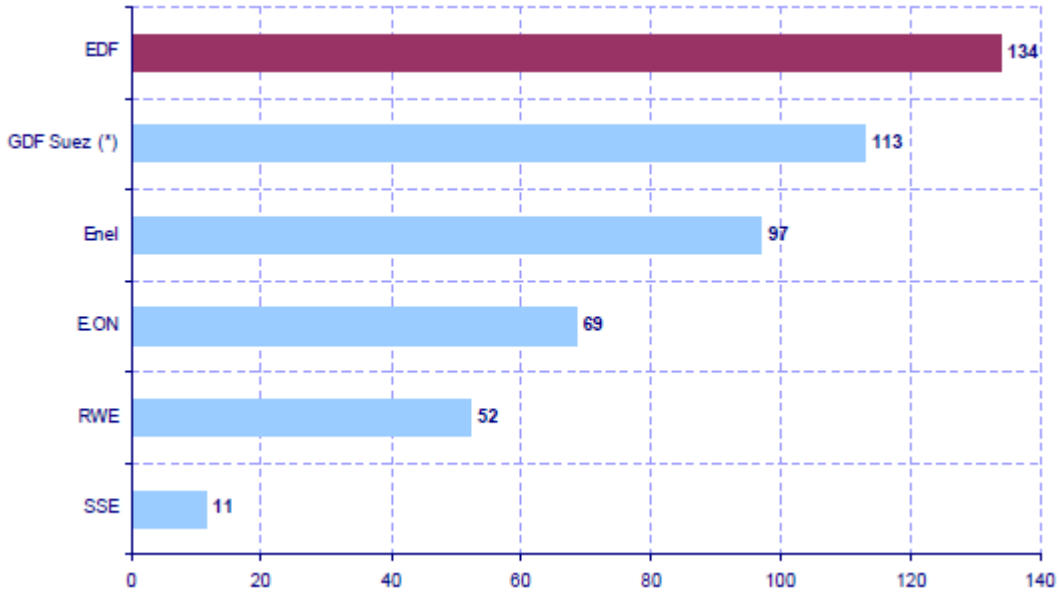
Transmission and distribution are the only regulated activities of EDF. RTE-EDF is in charge of the french transmission network while ERDF (Electricité Réseau Distribution France) is in charge of the distribution network. RTE's main objectives are to maintain and operate the

transmission network, to ensure the functioning of the grid as well as the supply security, to guarantee fair access to the grid, and finally to provide a constant good quality supply to all operators. RTE-EDF has more than 100 000 km of high voltage circuit (between 63kv and 400kv) as well as 46 countries' connexion lines. ERDF is following the same objectives but for the distribution network. It has over 1.3 million km medium and a low voltage circuit and supplies 93 percent of the french districts (Maury, 2011).

3.1.2 EDF, one of the leading electricity companies in Europe

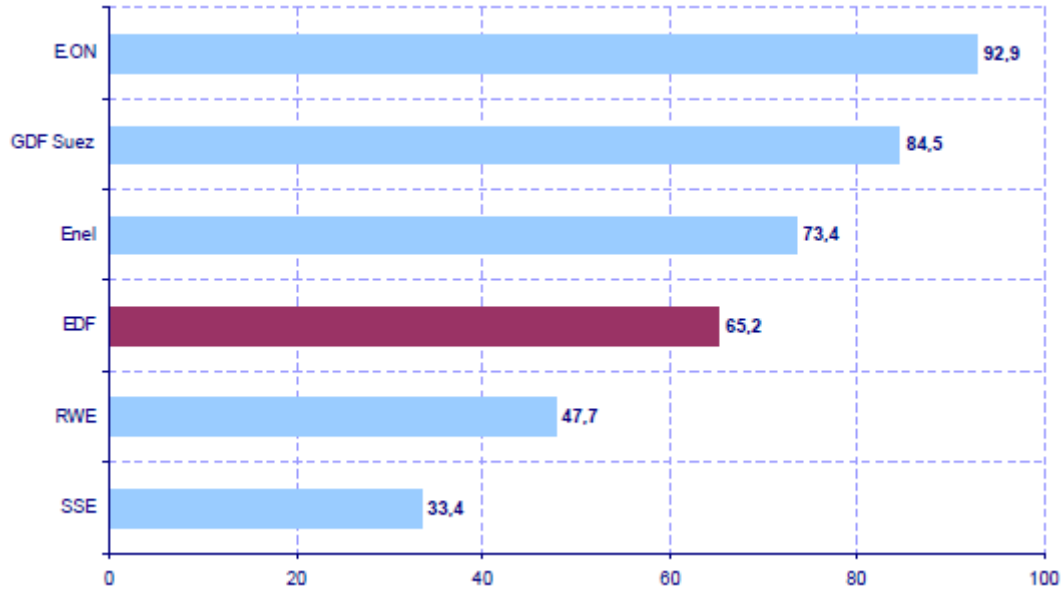
EDF is one of the leading European power companies. In terms of installed capacity, EDF is the first European electricity company with 134 GW. GDF-Suez is the second, since its merger with the British electricity company International Power, with an installed capacity of 113 GW (Figure22). In terms of sales, EDF was at the fourth place in 2010 with annual sales reaching 65,2 billion euros. The top three in terms of sales in 2010 was made by the german company E-ON (92,9 MM€), GDF-Suez (84,5MM€) and the Italian power utility Enel (73,4MM€) (Figure23).It is important to note that EDF is also the fourth largest gas operator in Europe in terms of sales behind E-ON, GDF-Suez and Enel (Bigard, 2012).

Figure22: Ranking of the top European electricity companies in terms of installed capacity (GW)



Source: European Utilities Annual Reports (2010)

Figure23: Ranking of the top European electricity companies in terms of sales (MM€)

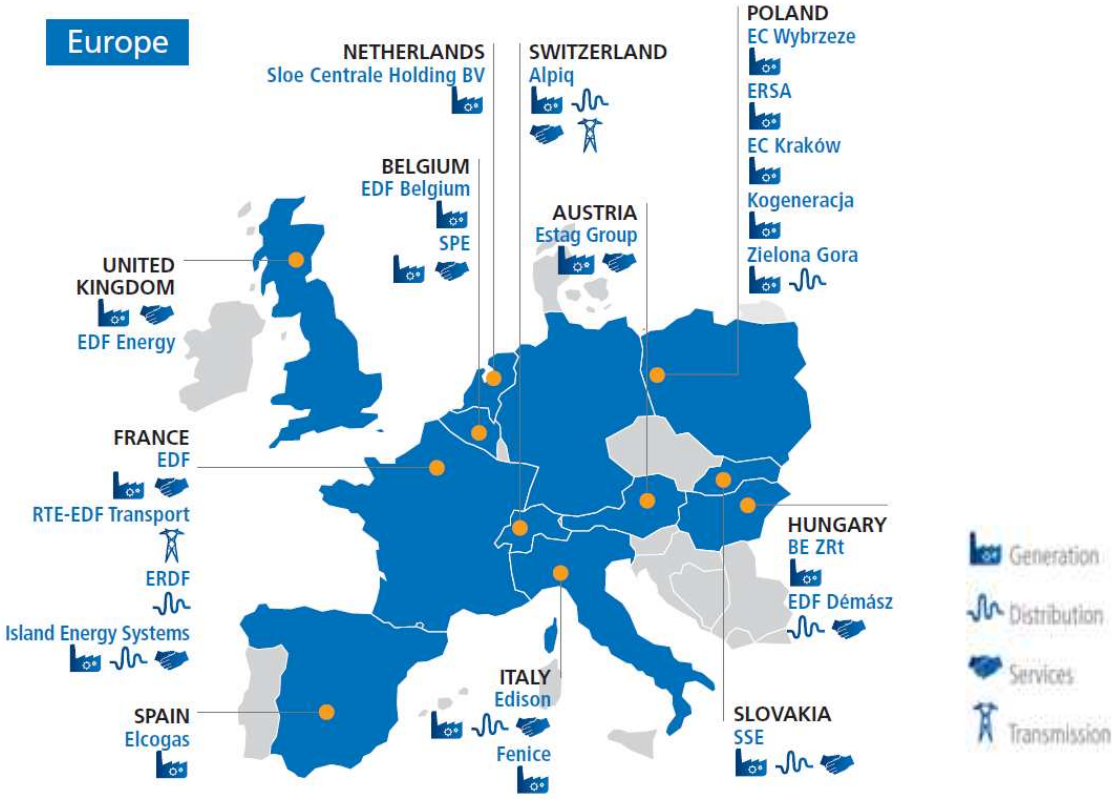


Source: European Utilities Annual Reports (2010)

Europe is EDF's core market, accounting for 90 percent of its annual sales, and the group is currently operating in 11 European countries: France, England, Spain, Italy, Belgium,

Netherlands, Switzerland, Austria, Poland, Hungary and Slovakia. In each of these countries, EDF has generation activities. Distribution activities are limited to 6 countries while so far transmission operations are restricted to France and Switzerland (Figure24).

Figure24: EDF's presence in Europe



Source : EDF (2011)

If France is EDF's main market, the Group has also strong positions in the United Kingdom and Italy. The UK accounted for 16,4 percent of EDF's turnover in 2010 (Figure16). Through its subsidiary EDF Energy, EDF has both generation and commercialization in the UK. EDF Energy has an installed capacity of nearly 13 GW including fifteen nuclear reactors within its eight power plants and its generation in 2010 was 63,7 TWh. Italy accounted for 8,7 percent of EDF' turnover in 2010 (Figure16). The Group is present in the country through its subsidiary Edison which is the second electricity and gas company in the country. Edison had an installed capacity of 12,5 GW in 2010 and its annual generation was 41,8TWh (Bigard, Binet, 2012).

3.1.3 Other International Activities

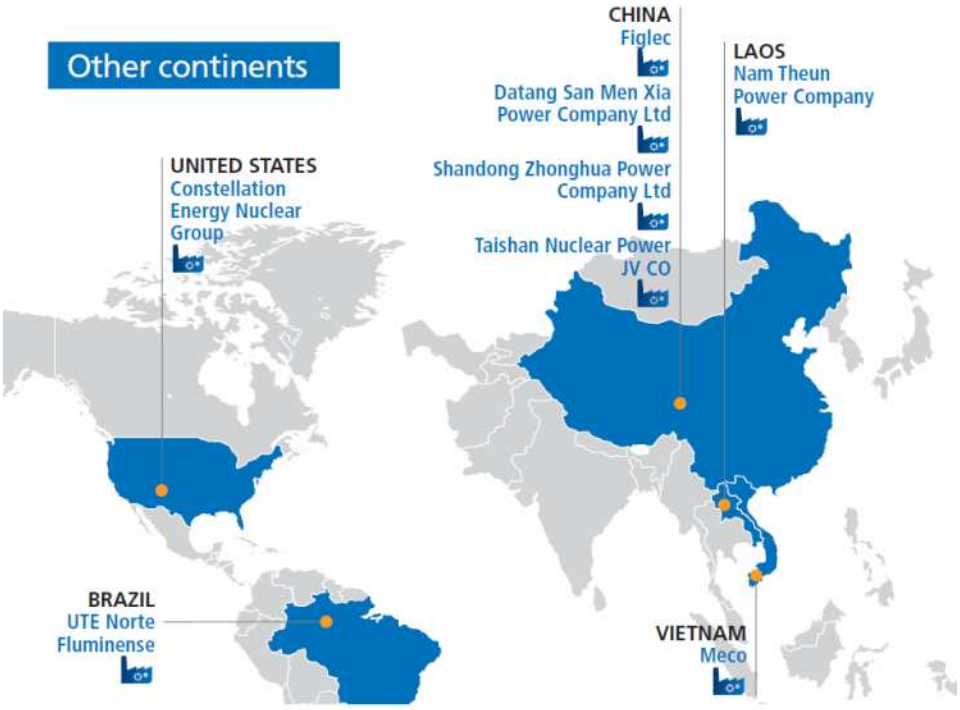
EDF also produces and commercializes electricity outside Europe. Indeed, the Group has subsidiaries in the United States, Latin America and Asia (Figure25).

In the United States, EDF holds 49,99 percent of Constellation Energy Nuclear Group (CENG) capital, an American power utility that owns and operates five nuclear reactors in the country. EDF is also planning to construct several European Pressurized Reactors (EPR) in the coming years with the help of its local subsidiary Unistar Nuclear Energy (EDF, 2010).

EDF has been present in China for more than 20 years and the Group is one of the most important foreign investors in the chinese electricity sector, in both thermal and renewable energies. EDF has started constructing and operating two EPR reactors since 2007 in the region of Taishan. The Group also has had nuclear activities in the Ling Ao and Daya Bay regions for several years. EDF is also present in south Asia, in Laos, Cambodia, Thailand and Vietnam, but on a smaller scale (EDF, 2010).

Finally EDF has also been present in Latin America and in particular Brazil since 1996. The Group owns a local generation company in the state of Rio de Janeiro known as UTE Norte Fluminense. It has also kept residual shares of its former brazilian subsidiary, another generation company of the state of Rio de Janeiro known as Light. EDF, through UTE Norte Fluminense, which is operating in the generation, distribution and commercialization sector.

Figure25: EDF International Presence (Europe excluded)



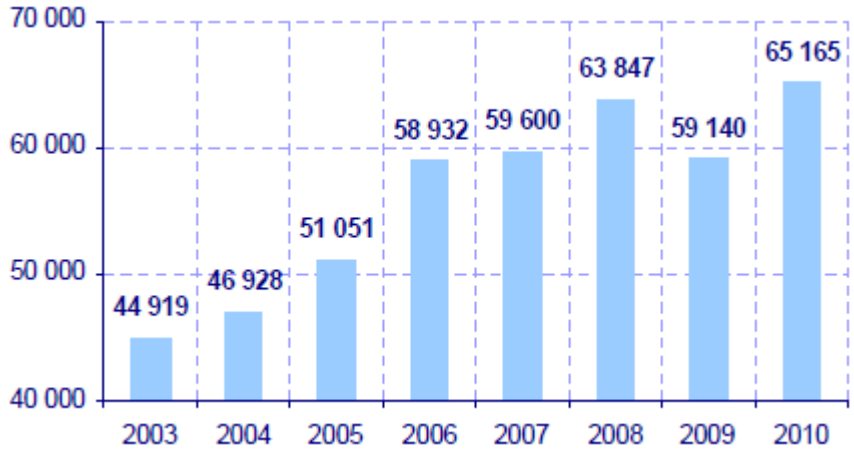
Source : EDF (2011)

3.2 Financial Results and Group Strategy

3.2.1 Financial Results

EDF's revenue increased by 10,2 percent at 65 165 M€ at the end of 2010 (Figure26). After a slow-down in the Group activities in 2009, this growth can be explained for several reasons. First, the current economic situation has led the euro to be under evaluated compared to the British pound or the Brazilian reais. Then, EDF made several external growth operations that boosted its results such as its share increase in both SPE, a Belgium energy utility, and CENG in the United States. Climate conditions also favored EDF's revenue with really low temperatures during winter time and consequently higher electricity demand. Finally EDF directly benefited from an electricity tariff increase for households in August 2010 (Bigart, Bouquet, 2012).

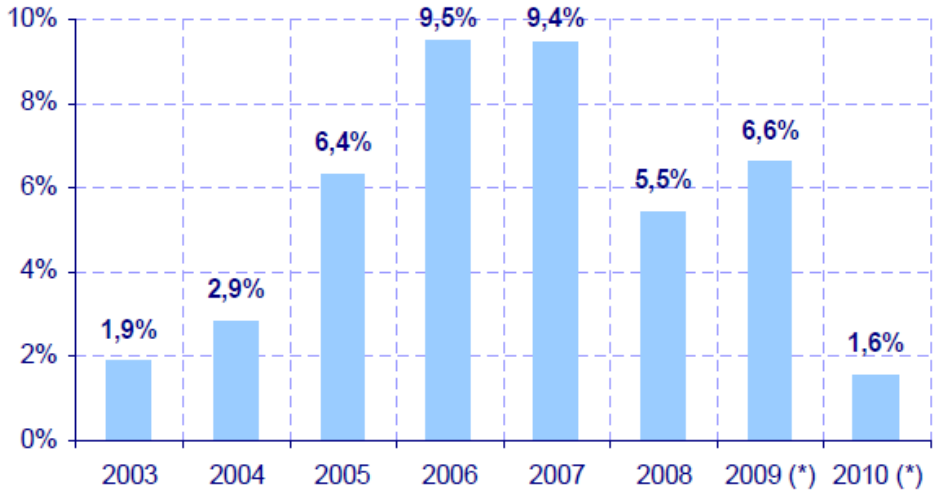
Figure26: EDF Turnover (M€)



Source: EDF (2010)

However, considering only EDF's turnover can be misleading and a good turnover, it symbolized a company's activity growth, does not necessarily mean strong financial results. Indeed, while EDF's turnover increased, its net income fell drastically by 73,9 percent compared to 2009, and the Group net income only showed 1.6 percent of its revenue in 2010 (Figure27). This net income fall was mainly due to the prolongation of regulated electricity tariffs in Europe as well as provisions for risk covering concerning its gas supply in Italy and in the United States.

Figure27: EDF Growth Profit Margin (Net income/Turnover)



Source: EDF (2010)

EDF's expected financial results for 2011, 2012, 2013 should be positive according to a research analysis conducted by the financial company Credit Suisse. Between 2010 and 2011, EDF's revenue should decrease by 0.8 percent but its net income should increase during the same period by 248 percent at 3 549 M€, reaching nearly the same net income the Group had in 2009 (Figure28). However, several factors could change these financial forecasts such as the french nuclear safety audit that EDF still needs to realize after the Fukushima event as well as the investments required to update the nuclear park, the situation with Edison acquisition that needs to be completed and that may require additional investments too, and finally the duration of the European economic downturn (Debs, Gilles, Whitfeld, M. 2012).

Figure28: EDF expected Financial Results

Financial and valuation metrics				
Year	**12/10A**	**12/11E**	**12/12E**	**12/13E**
Revenue (Eu m)	65,165.0	64,617.8	67,824.3	69,876.7
EBITDA (Eu m)	16,189.00	14,741.83	16,575.60	16,673.13
Net Income (Eu m)	1,020.0	3,549.3	4,100.8	4,076.0
CS adj. EPS (Eu)	0.55	1.91	2.20	2.19
Prev. EPS (Eu)	—	—	—	—
ROIC (%)	5.09	7.62	8.94	8.46
P/E (adj., x)	33.05	9.56	8.27	8.32
P/E rel. (%)	367.2	106.9	97.1	107.7
EV/EBITDA	4.9	5.0	4.7	4.7

Source: Debs and Gilles (2012)

3.2.2 Group strategy

EDF's current strategy is based on four main points: internalization, reinforcement of its gas activities, strengthening of its nuclear leader position and diversification of its energy mix. The internalization of its activities is mainly based on M&A activities with generation and gas companies abroad. Investing abroad and especially in fast growing countries such as China and Brazil is supposed to compensate the European poor economic growth The development of its gas activities will be managed by diversifying its portfolio of gas supplier, by increasing its

presence with gas reserves and by investing in adequate gas transport infrastructure. EDF would then be able to profit from a continuing and growing gas demand (Maury, Vottero, 2011)..

Because of tougher regulation in the European energy market and especially on greenhouse gases, EDF decided to diversify its energy mixed by moving forward in the use of renewable energy. Finally, despite the Fukushima event, EDF decided to strengthen its leading position on nuclear energy by continuing the construction of new EPR reactors such as the one in Flamanville, France or by increasing its stakes in international generation companies which use nuclear energy such British Energy in the UK and Constellation Energy Group in the US (EDF, 2011).

4. A WIN-WIN SITUATION

Brazil's energy mix is highly dependent on hydroelectricity which accounted for 78 percent of the country's installed capacity and represented more than 80 percent of the country's generation in 2010 (Enerdata, 2012). If on the one hand, the importance of hydro power in the country's energy mix enables Brazil to lower considerably its GHG emissions, while on the other hand it makes Brazil's electricity supply balance fragile and highly correlated to climate conditions. According to the MME, Brazil will not be well protected against a new power shortage at the end of 2012. In order to tackle that problem, the ANEEL and the EPE are clearly trying to diversify the country's energy mix. EDF, with its unique know-how in nuclear energy but also in all types of electricity generation could contribute to the success of this objective.

4.1 Attractiveness of Brazil for EDF

4.1.1 Nuclear Production

The increasing importance that nuclear energy will have in the Brazilian energy mix cannot be ignored. Given the current hydro predominance in the country and the increasing part of small hydro projects carried out all over the country, the risk of another electric supply imbalance in drought period is rising. Consequently, Brazil needs to diversify its energy mix and therefore needs to increase the share of thermal power plants. However, with the uncertainty concerning gas supply (despite the recent local discoveries) and the bad quality of the country's coal reserves, nuclear energy is a possible solution (World Bank, 2010). Besides, Brazil has important Uranium reserves (the 8th most important world reserves) and has become masters of its production cycle. It is important to note that with the expansion of its nuclear fleet, Brazil would be able to have competitive electricity tariffs not influenced by fossil fuels price and CO2 mitigation would be kept under control. According to the MME and the EPE expansion plans, 4 to 6 additional nuclear reactors should be brought into service before 2030 and according to Electronuclear, the nuclear installed capacity should reach 60 GW before 2050. (EPE, 2010).

EDF, as the world leading nuclear operator, appears to be a serious candidate to support Brazil's nuclear expansion. Indeed, the Group has 58 nuclear reactors and a long experience in operating the french fleet. Furthermore, EDF has a robust business model for generation and engineering and has mastered the entire nuclear chain from design to construction and operation. EDF's unique expertise has been recognized by the Brazilian energy authorities and a five year memorandum of understanding (MoU) has been established between EDF and Eletronuclear in December 2008. The MoU enables cooperation between this two energy entities regarding all areas related to nuclear generation and may lead to common nuclear projects in the near future.

Nevertheless, Brazil has not yet chosen which type of nuclear technology it will use for the expansion of its nuclear fleet. Therefore, nuclear generation in Brazil would be considered as an opportunity for EDF if the local energy authorities decided to choose EDF's reactor technology which is directly competing with the US reactor models and if the brazilian government accepts the foreign power companies' participation in the construction and operation of its nuclear fleet, in cooperation with the local state owned company Eletronuclear (Masvigner, Rougier, 2011).

So far, the french nuclear companies are doing well in Brazil: Areva, a french nuclear utility, is currently in charge of the construction of Angra III and Eletronuclear recently said that it may be interested in a cooperation with EDF in this construction site. Furthermore, Eletronuclear would like to base its nuclear fleet on the french model and is currently working with EDF on that project.

4.1.2 Hydro generation

Despite the previous consideration, hydro generation will keep being at the heart of the brazilian power system and the 2030 energy plan has predicted a hydro installed capacity of 156 GW which means that it will still represent more than 70 percent of the country's installed capacity (Figure1). Brazil needs international power utilities investments and their contribution to build large dams (superior to 1000 MW) such as the Jirau dam project (3 750 MW) or the huge and controversial Belo Monte dam (11 233MW) in order to follow the EPE expansion plans (Energy Market Price, 2010).

EDF is also considered as a valuable candidate for such projects. Indeed, EDF is one of the leading hydropower producer and has a unique know-how and qualified manpower for these kind of projects. EDF has 640 dams in France and operates 68 hydropower plants in Italy (EDF, 2011). The group is also a recognized architect and contractor on international hydro projects

which is why it was commissioned for the construction of a large dam in Laos. EDF has been noticed for its sustainable construction process in Laos and this may be helpful to integrate the Brazilian hydropower sector which is often subject to controversies because of a lack of consideration concerning environmental issues (Meisen and Hubert, 2010).

The success story of GDF-Suez in the hydropower sector shows that this market is open for foreign investments. GDF-Suez, the first private power utility in Brazil known as Tractebel Energia, has done well since its acquisition of Gerasul in 1998. The acquisition by GDF-Suez of the Jirau dam projects through the auction process of 2008 has strengthened the group position in the hydropower generation (GDF Suez, 2008).

4.1.3 Thermal Generation

If thermal plant expansion has been limited in Brazil so far, it is mainly due to the problem of gas availability (Albouy, 2011). Brazil directly depends on Bolivian gas supply even if the recent discoveries of offshore gas by Petrobras may change the situation in the coming years. However, brazilian authorities are still willing to diversify their current energy mix and the share of thermal energy should rise by 57 percent by 2019, from 21 GW in 2010 to 33 GW in 2019 (Figure1).

EDF has a strong position in the fossil fired generation in Europe especially in Italy (86 percent of the energy mix) and in the UK (24 percent of the energy mix). The Group has specialized itself in the construction and the operation of Combined Cycle Gas Turbine Plants (CCGTs), thermal plants that produce less CO2 emissions and that are more efficient than basic thermal plants (Maury, 2011). Since 2002, EDF has been operating a 869 MW CCGT in Brazil through its brazilian subsidiary, UTE Norte Fluminense and has therefore the experience required to operate and construct other thermal plants in Brazil. Furthermore, EDF is currently developing carbon capture and storage technologies as well as supercritical plants which should be the future

of fossil fired generation. These technologies boost energy and environmental efficiency and may be interesting for the future expansion of the Brazilian industry (Mitjaville, Guerand, 2004).

4.1.4 Renewable energies

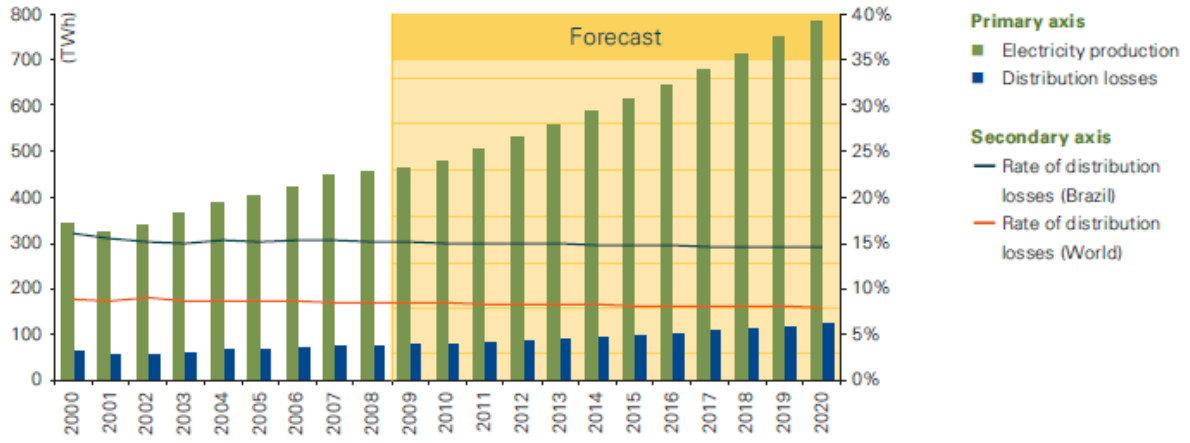
Though renewables are currently the least present energies in the country's energy mix, they will have the fastest growth in the coming years (Meisen, Hubert, 2010). While their installed capacities were about 1 GW in 2010, they are predicted to grow by 600 percent by 2019 and should account for 7 GW at that time (Figure1). EDF with its subsidiary EDF EN is a top of the line power company for renewable projects. If Brazil does not need additional companies for the development of its wind power potential, EDF could be a key asset for the development of solar energy in the country. Indeed, Brazilian photovoltaic potential is considerable but not yet exploited. In 2011, EDF launched the first Brazilian solar plant in cooperation with UTE Norte Fluminense. As a consequence, the Group appeared as a serious possible partner for brazilian power companies willing to develop solar energy (Le Figaro, 2011).

A regulatory framework for this type of energy should be established in the near future and it will probably boost the development of solar energy projects.

4.1.5 Transmission and distribution issue

One of Brazil's main power issues is networks losses because of both the long distances between generation and consumption points. In 2011, the rate of distribution losses in Brazil was about 15 percent of the total country generation, two times higher than the world average (Figure29). In order to tackle that problem, large investment programs are planned in order to upgrade the current transmission grid and private capital has been solicited (Datamonitor, 2011).

Figure29: Electricity production and distribution losses



Source: KPMG (2009)

EDF has a key expertise in the transmission and distribution of electricity that can be valuable for the Brazilian power sector. EDF via its subsidiary RTE-EDF Transport is a key player in the European transmission sector with 100 000 km of lines 2 500 substations and more than 46 cross-border lines (Maury, 2011). The Group has also some experience in emerging markets such as Senegal or Vietnam.

For the distribution sector, EDF has over 1.3 million km medium and low voltage circuits and nearly all french districts via its subsidiary ERDF. ERDF is also testing new business models using the so called “smart grids” which should allow customers to improve their electricity consumption management. This technology is expected to soar in Latin America and especially in Brazil where demand sized management is crucial in order to avoid power shortage (Coronado, E. 2011). Consequently, EDF’s expertise in these fields may be useful for Brazil who needs to upgrade and strengthen its current network and develop its cross borders connections with Paraguay and Peru.

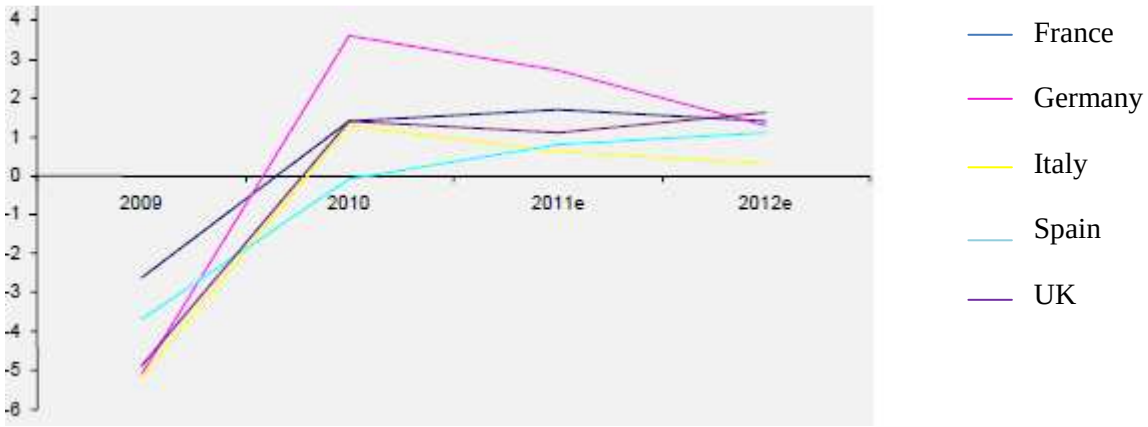
4.2 Attractiveness of EDF for Brazil

While EDF's growth perspectives in Europe seems to be limited for the time being, the Brazilian economy is doing well and is no longer affected by the financial crisis of 2008 or by the current European sovereign debt crisis. As a consequence the Brazilian power market appears as a growth engine for EDF which is facing a downturn in its historical market.

4.2.1 Poor economic situation in Europe, EDF's historical market

The European electricity market is still affected by the financial crisis of 2008 and the current sovereign debt crisis in Europe has not yet allowed recovery on the electricity market. The growth of the European economic activity is low and contributes to a stagnant industrial production despite some improvements in 2010 (Figure30). According to the IMF, Europe's economic growth should reach 1.08 percent in 2012 and the growth perspective should be back to normal in 2014 (IMF, 2012).

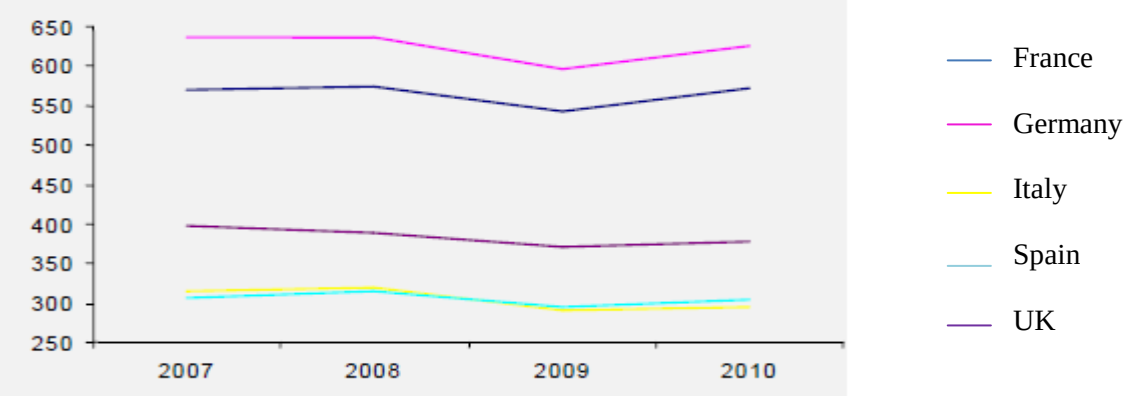
Figure30: Europe's growth perspectives



Source: IMF (2012)

As electricity production is directly linked to the economic activity, the growth perspectives for the european power market are weak. If 2010 was an exception, the electricity production of the five main European economies have not recovered its levels of 2007 level (Figure31). Furthermore, this stagnant demand is creating an overcapacity risk for the generation companies operating on these markets which did not anticipate a continuing economic downturn in Europe. As a consequence, many generation projects are postponed or even stopped. With both a stagnant demand and production, the electricity price is stable. However, if the electricity price remains stable, the price of raw material is increasing which directly penalizes the European generation companies (Bigard, Binet, Bouquet, Brzakowski, Chiappini, Millois and Poyelle, 2012).

Figure31: Europe's Electricity Production



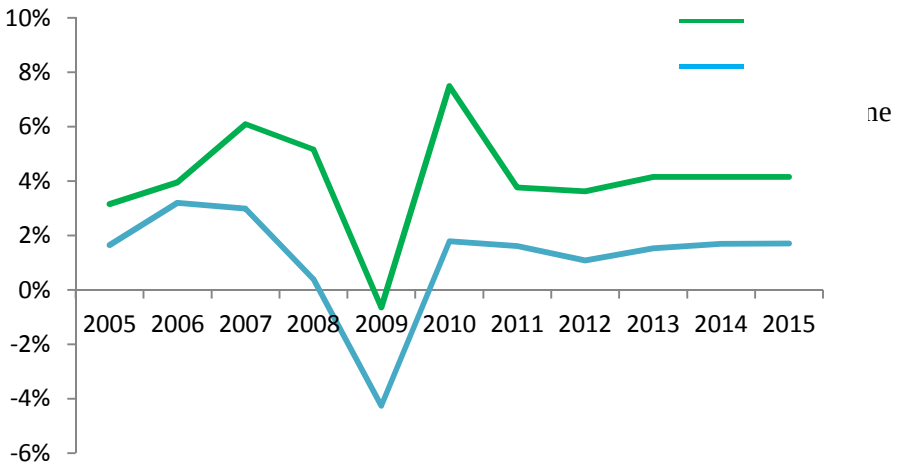
Source: HIS CERA (2011)

Therefore, EDF and other european power utilities in general are looking for growth engines abroad in emerging economies and particularly in the BRICs economies. Brazil, with its expected strong power sector growth, clearly appears as one of these emerging economies and is now highly coveted.

4.2.2 Strong growth perspectives for Brazil

Contrary to the Euro zone, Brazilian authorities have managed to keep the country's strong economic potential at a high level. Indeed, Brazil had an average annual growth rate of 4.3 percent between 2004 and 2010 and its growth domestic product in 2012 is predicted to be 3.6 percent (IMF, 2012). The upcoming events in 2014 (World Cup) and 2016 (Olympic Games) will enable Brazil to keep its dynamic and a strong growth for its economic activities especially in the infrastructure and power sector.

Figure32: Growth Domestic Product, Brazil vs. Euro Zone



Source: IMF (2012)

As electricity consumption is directly linked to economic activities, the power market remains strong. The compound annual growth rate (CAGR) of brazilian power consumption between 2004 and 2008 was equal to 3.9 percent and the CAGR of generation installed capacity between 1999 and 2009 was equal to 4.5 percent (Figure33) (Enerdata, 2011). If the industrial electricity demand has been impacted by the financial crisis, it is now recovering and consumer demand remains strong. For instance during the first half of 2010, residential and commercials demand

increased both by more than 7 percent. This shows that the effects of the 2008 financial crisis are no longer at stake (Lopez, 2012).

Figure33: Generation Installed Capacity in Brazil

Source: ANEEL

To support its long term growth, Brazil will need additional installed capacity. According to the prediction of the MME the CAGR of the generation installed capacity will be 4.5 percent between 2009 and 2016 (Figure33). Therefore, additional power investments will be required to meet these needs and foreign investors such as EDF are now waiting for the next auction process to acquire future energy projects given by the EPE energy expansion plan (Britto, 2011).

5. STRATEGIC ALTERNATIVES FOR EDF IN BRAZIL

This last chapter aims at evaluating the possible solutions for EDF in Brazil. These findings are both the result of the market study we made at EDF, when I worked as business analyst at the Department of Strategy of the Group, and personal researches I carried out to better understand the Brazilian power market in order to present feasible strategies for EDF in Brazil.

From November 2011 to January 2012, I was part of a team of six people in charge of making a strategic plan for Brazil, which had to be presented to EDF executive committee (ExCom) at the beginning of 2012. The team members were the Deputy Director of the strategy division, one business analyst of the International Market Department, and three business analysts of the Strategy Department. As business analysts, our work was to collect and analyze recent market data on the Brazilian power sector in order to update EDF's strategy toward the country. Our main sources of information came from databases focusing on South American power markets such as BNAmericas and Enerdata. In addition, business analysts also had to conduct interviews with experts of the Brazilian power market and attend various conferences related to this topic.

Soon after, our team received feedback from the Executive Board that enabled us to deepen our research. I was then in charge of updating weekly this final strategic plan for EDF in Brazil.

5.1 EDF activities in Brazil

EDF's current presence in Brazil is limited to its stakes in two local generation assets, UTE Norte Fluminense and Ibiritermo via its Italian subsidiary Edison. If Brazil was not considered as one of the Group's top priorities after EDF's failed first attempt to enter the country with Light, Brazil's current power market potential led EDF to reconsider its position toward the country. Considering that the status quo would not allow EDF to take full advantage of future growth in Brazil, various options are currently opened to EDF.

5.1.1 Context

After having assisted technically in both the brazilian holding Eletrobras between the seventies and the eighties and Furnas in the nineties with the construction of the nuclear power plant Angra I, EDF took advantage of the national privatization plan to enter in the capital of Light in 1996, a local distribution utility based in Rio de Janeiro. However, EDF's activities in Brazil got severely affected by both the power shortage that occurred in 2001 and the strong reais devaluation. Consequently, EDF decided to almost exit the market by selling 80 percent of its stakes of Light in 2006 and another 10 percent in 2009 (Rougier and Puech, 2011).

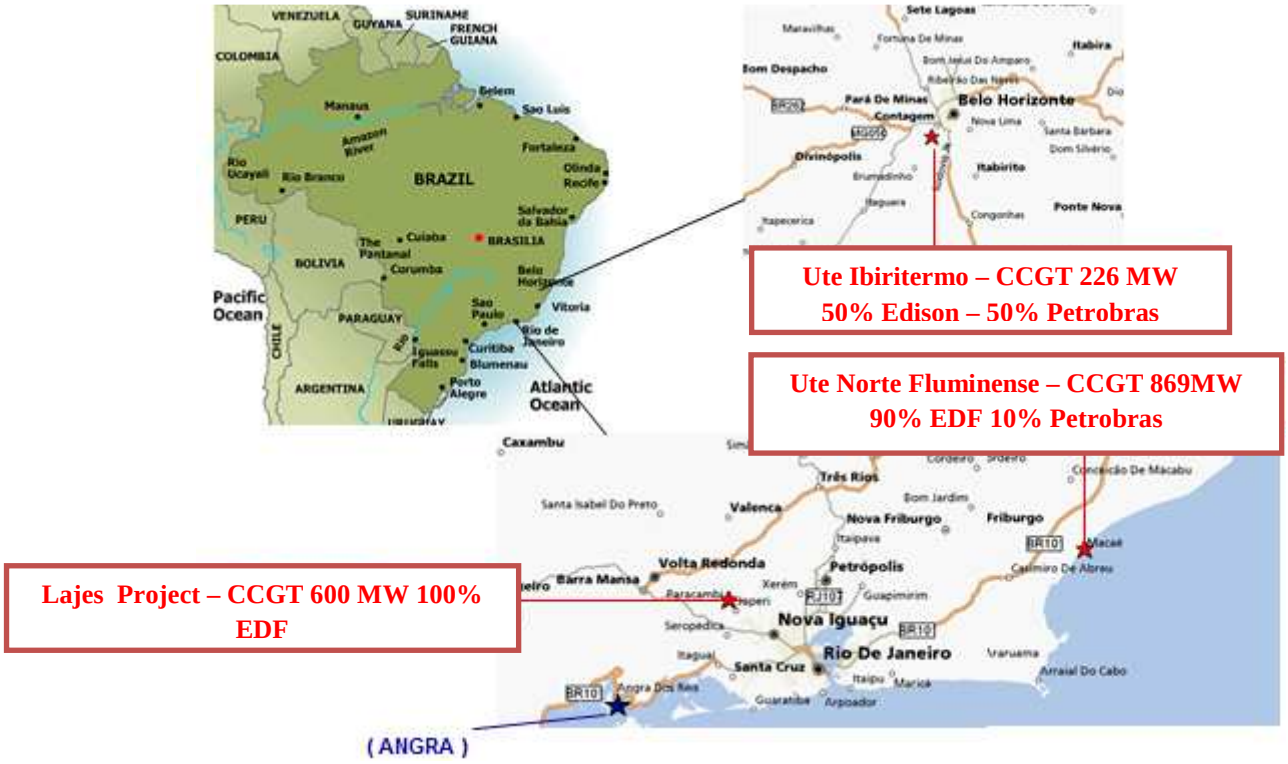
Nevertheless, the Group decided to take part in the construction project of UTE Norte Fluminense in 2002, a 860 MW CCGT which now responds to 25 percent of Rio de Janeiro's electricity demand. It is important to note that, in addition to UTE Norte Fluminense, EDF has another 230 MW CCGT known as Ibiritermo via its Italian subsidiary Edison.

At the same time EDF EN, EDF's subsidiary in charge of renewable energies, tried to enter the brazilian renewable energy sector with two local subsidiaries SIIFELEC (wind energy) and SIIFLUX (small hydro). Under the PROINFA program, SIIFELEC developed five wind projects for an installed capacity of 342 MW and SIIFLUX developed a small hydro project of 30 MW known as Santa Rosa. Facing too much competition, EDF EN finally decided to fully exit the market, selling its stakes in 2005 and 2008 (Rougier, 2011).

In December 2008, EDF made a five year MoU (Memorandum of Understanding) with the two major actors of the brazilian energy sector, Eletrobras and Petrobras, so that these three utilities could cooperate on hydropower as well as nuclear power. In July 2011, EDF made another attempt to consolidate its position in Brazil. The group took part in the A-3 auction process of 2011 with its Lajes Project, a 600 MW CCGT which was supposed to be constructed in the state of Rio de Janeiro. However, the competition was so tough that EDF's project has not been selected for this bidding process. As a consequence, EDF's position in Brazil remains limited

(Figure34), in comparison to the other international utilities such as GDF-Suez or AES Corporation (Picon, 2011).

Figure 34: EDF Positions in Brazil



Source: EDF (2011)

5.1.2 The Light Case

Light is a Brazilian distribution power utility based in Rio de Janeiro, which was created in 1904 and started operating in 1905. The company is now supplying electricity to 4 million customers in the state of Rio de Janeiro and has an installed capacity of 885 MW (Light, company filings, 2012). In 1996, EDF decided to strengthen its presence in the Brazilian power market through the acquisition of Light. Between 1996 and 2001, EDF spent 2 billion euros for Light and spent an additional 1 billion euros during the supply crisis of 2001-2002 in order to avoid bankruptcy.

To strengthen Light, EDF also lent it 300 million euros to the company. However, after being profitable for a short period of time, between 1996 and 1998, Light started losing money after 1999 (Silvain, 2010).

For instance, between 2001 and 2003, Light's net profits decreased by 90 percent annually, from -276 M € to -994 M € while its revenue grew by 2,6 percent annually (Figure35). Despite the additional investments EDF realized in order to boost Light's activities and financial results, the Group finally decided to sell the local distribution company in 2006 and 2009.

Figure 35: Light Financial Results

Million €	2001	2002	2003	CAGR 2001-2003
Revenue	1028	1301	1081	+2,6%
Net Profit	-276	-715	-944	-90%

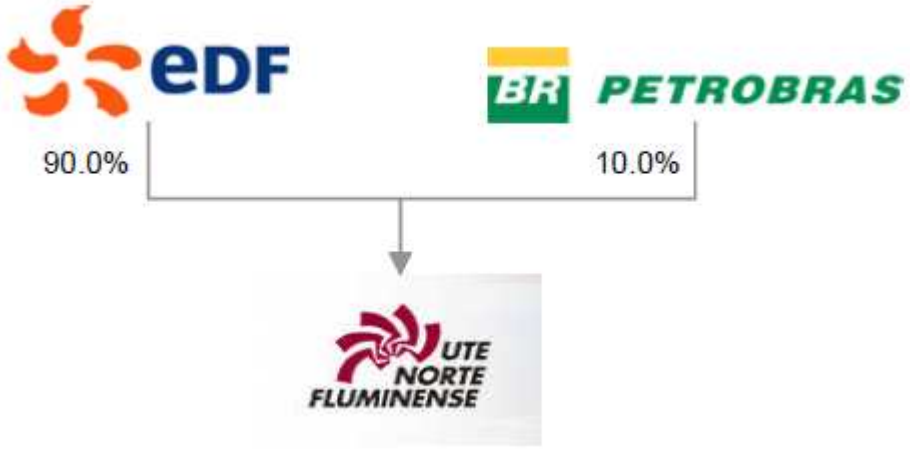
Source: Mitjaville and Guerand (2004)

The poor results of Light at that time can be explained by various reasons (Mitjaville and Guerand, 2004). First, the company was strongly indebted (1 280 million euros) though it did not have the financial capacity to do so. Indeed, in 1998, EDF, through Light, decided to enter the capital of Eletropaulo, a Brazilian generation company. Despite the low treasury of Light at that time, EDF purchased stakes of Eletropaulo for 2 billion euros without the help of its shareholders. In 2001, because of Light's unstable financial situation, these stakes were sold back but at 30 percent of the acquisition price (EDF, 2011). In addition to the debt's interests that Light had to pay, the brazilian interest rates were considerably high at that time (from 10 to 25 percent) which did not ease the company's financial stabilization. The high level of the interest rates could be explained by the willingness of the authorities to mitigate a growing inflation and avoid an economic crisis at that time. Combined with that, the power crisis of 2001 and 2002 and the rationing imposed by the government reduced by 20 percent Light's global revenues. Despite many efforts, Light was not able to recover financially and EDF went out of the company's capital which was then acquired by a local state owned company, CEMIG.

5.1.3 UTE Norte Fluminense

The UTE Norte Fluminense project started in 1999 and EDF decided to acquire 90 percent of its capital from the Brazilian electricity distribution company Light. The last 10 percent are held by the state owned company Petrobras, which is also a UTE gas supplier (Figure36). UTE Norte Fluminense started operations in 2004 and is now operating a 869 MW CCGT, located in Macaé, about 150 miles from Rio de Janeiro. The company supplies 20 percent of Rio de Janeiro's electricity demand and also supplies the state of Espirito Santo. Its annual power generation per year is about 6 350 GWh UTE Norte Fluminense has contracted a 20 years power purchase agreement (PPA) with Light and is selling its electricity surplus on the free contracting market (UTE Norte Fluminense, 2011).

Figure 36: UTE Norte Fluminense – Ownership Structure



Source: EDF

Contrary to what EDF experienced with Light, UTE Norte Fluminense is financially solid and the company is ranked among the top of the line energy utilities in Brazil. Between 2005 and 2013, the compound annual growth rate of both its revenue and its net income should respectively rise by 5,8 percent and 1,6 percent (Figure37). 2010 was a really good year for the company: its EBITDA reached 164 M€ for the first time and its total sales reaches 6 510 MWh

(25€/MWh). These good results are due to an excellent industrial performance (availability of the CCGT at about 98 percent and zero accidents since 2005), an efficient demand-size management and a production surplus which is sold on the free market (Picon, P. 2011). With Petrobras as the second shareholder of the utility, UTE has a competitive access to gas supply and this situation is also one of the main reasons of such a good performance. Furthermore, thanks to a positive combination of factors including strong rains which kept reservoir levels high and therefore spot price low, a freezing winter in Argentina and a nearly full availability of its CCGT, UTE Norte Fluminense's export revenues reached 55M€ in 2010 (UTE, 2010).

Figure 37: UTE Norte Fluminense Financial Results

M€	2005	2006	2007	2008	2009	2010	*2011*	*2012*	*2013*	CAGR 2005-2013
Revenue	289	283	301	301	343	373	*422*	*431*	*453*	+5,8%
EBITDA	123	119	116	111	145	162	*164*	*167*	*169*	+4,1%
Net Income	75	53	54	41	73	79	*71*	*80*	*85*	+1,6%

Source: UTE Norte Fluminense (2010)

UTE Norte Fluminense has been operating for nearly 8 years now and, as every power plant must, the UTE's CCGT will need to go through a performance evaluation and will need to be upgraded. This will require additional substantial investments for EDF which has already invested more than 515 M€ in UTE Norte Fluminense since the beginning of its operations in the brazilian power sector. Furthermore, UTE Norte Fluminense will have to contract new PPAs with local distribution companies in order to ensure the sale of its production in the near future. Competition becoming tougher and tougher between generation companies during the energy auction processes, UTE Norte Fluminense will have to consolidate its cooperation with Light (which is currently purchasing 90 percent of its electricity generation) but will also have to be able to offer competitive electricity prices. This may be achieved by extending its production

through the acquisition of emerging power producers in the State of Rio de Janeiro or the construction of an additional CCGT in order to create synergies and economies of scales (UTE Norte Fluminense, 2011).

The international coming events (World Cup in 2014 and Olympics in 2016) are also fostering the rivalry between the energy actors of the state of Rio de Janeiro which all want to profit from the revenue these events will generate. However, EDF and UTE Norte Fluminense are doing well so far. In June 2011, both companies were inaugurating Brazil's first solar power plant in the state of Rio de Janeiro. With a 320 KW capacity when the sun radiation is at its climax, the solar plant supplies 300 houses in Rio. With this successful project, UTE Norte Fluminense has already been sought for other solar projects in the coming years such as the construction of **a** solar roof for the Maracanã stadium in Rio de Janeiro. As a consequence, if UTE Norte Fluminense keeps its excellent operational performances thanks to technical upgrades and continues diversifying its activities (generation, solar roofs, sustainable construction), the company will stay among the leading utilities in the state of Rio de Janeiro as well as a valuable asset for EDF (Rougier and Puech, 2011).

5.2 Strategic Alternatives for Brazil

EDF will have to soon face strategic choices concerning its presence in Brazil, depending on what the company is willing to do to stay on the Brazilian power market. There are four possible strategic alternatives for EDF concerning Brazil: exit strategy, status quo, EDF alone and local partnership. Before drawing the possible strategies of EDF, it is important to understand the market forces at work in the Brazilian power sector.

Then, in order to identify the potential partners of EDF or potential buyers of EDF's stakes in UTE Norte Fluminense, it is important to analyze the position and strategy of the main electricity producers in the market first and finally evaluate the different strategic options.

5.2.1 Brazil Power Sector: PESTEL Analysis

The Brazilian power sector is a complex environment and a correct assessment of this environment is necessary for organizations operating in it, in order to identify the opportunities and threats of the sector. The PESTEL framework provides a relevant structure to assess the Brazilian power sector environment for a utility like EDF. PESTEL enables to focus on the following factors, which cannot be underestimated when operating on a market: political, economic, social, technology, environmental and legal.

The political aspect should not face major changes under President Dilma administration. Energy is still considered as a top priority by the government which tries to foster the use of renewable sources for power generation in order to continue the process of energy mix diversification.

The economic aspect is still traduced by a strong need for additional power generation. According to the EPE, the country needs to raise its production capacity by 5% per year by 2020 in order to cope with the forecasted demand. In addition to this, Dilma's administration will have to face two new due dates: the organization of the next World Cup in 2014 as well as the next Olympics in 2016. These two events directly affect the Brazilian power sector environment. According to some analysts of the MME, the country will have to invest US$ 2.7 Bn. in electricity infrastructure to avoid power outage in the World Cup host cities. So far, it is quite clear that Brazil will not be able to cope with the future power needs if substantial investments are not realized in electricity infrastructure and especially in transmission and distribution systems. It is foreseen that the government will foster private initiatives to upgrade its power

sector in order to cope with this due dates, offering real growth opportunities for local and foreign private utilities.

The social aspect in the local power market environment is improving rapidly since the launch of the “Luz para Todos” governmental program in 2003, which aims at providing universal access to electricity to the 12 million of Brazilians that lived without it. Since the implementation of the Luz para Todos program, 11 million of Brazilian gained access to electricity. Reaching the remaining 1 million people will be a challenging task for the current government. This last section of population lives in Amazonia, where power network is still at its beginnings. Brazil will have to find innovative ways of bringing electricity in this region if it wants to achieve electricity universal access. The social programs implemented by the Lula administration also allowed the insertion of million people in a larger middle class. The side effect of this social improvement is the increasing electricity demand coming from this growing middle class.

Technological improvements are constant in the local power environment. Through the enhancement of the power generation technologies, power plants are becoming more and more efficient. The creation of a new energy trading platform in 2011, known as Brix, may be the most interesting technological development since a year. Brix was created to provide transparency and increase competitiveness in the Brazilian power market, giving a new electronic marketplace for open to all power market participants. This innovation directly contributes to the evolution of the local electricity trading environment.

Environmental considerations are becoming stronger in the power sector environment. The expansion of the installed capacity needs now to respect a “sustainable process” and authorities are becoming more demanding on this aspect. The controversy that has implied the Belo Monte project is a clear example of the importance that is given to the sustainable development of the country installed capacity.

The legal aspect is currently in the limelight with the announcement of a plan to cut and simplify taxes for electricity producers and distributors, in order to stimulate the local economy. Brazil has the third highest power costs in the world, after Italy and Slovakia. This situation is penalizing the industry sector and contributes to its poor performance these last years. High electricity prices have contributed to stagnant production and investment in energy intensive industries according to the Getulio Vargas Foundation. If the government initiative of reducing taxes is successful, this could help restoring competitiveness in the economy.

5.2.2 Brazil Power Sector: Porter Forces

The Porter analysis is crucial for EDF in order to understand which market forces are at work in the brazilian power sector. According to the Porter theory, before entering or taking strategic decisions in a specific market, it is important to analyze the buyers and the supplier negotiating powers, the risk of product substitution and new entrants, and finally the rivalry between existing firms (Figure38).

In the Brazilian power sector, the buyer's power can be considered as weak for "captive consumers" (residential consumers) that do not decide about how the electricity tariffs are set up. Indeed, the electricity price for residential end-users is established by the ANEEL whose main objective is to protect these captive consumers from price volatility. However, this situation only concerns the regulated market. On the free market, large scale industrial producers are free to choose their power providers through long term contracts also known as PPAs. In that case, the buyer's power is strong.

For generation companies, primary energies are key inputs especially for companies using thermal power plants. One of the weaknesses of Brazil is its dependence on the Bolivian gas supply. Furthermore, the major primary energy supplier in Brazil is the public company

Petrobras. As long as Petrobras will keep this monopolistic position for primary energy supply, the supplier power will stay strong as the majority of generation companies will keep having for unique interlocutor a public entity. Nevertheless, in the case of hydroelectricity, facilities are managing their own water supply that depends on climate conditions. Therefore, supplier power could be considered as weak as there are no proper suppliers. However, if weather conditions are considered as a "supplier", the supplier power remains strong. Indeed, during the dry season, large dams' electricity generation is reduced for real. Considering, weather as a supplier, supplier can be considered as strong.

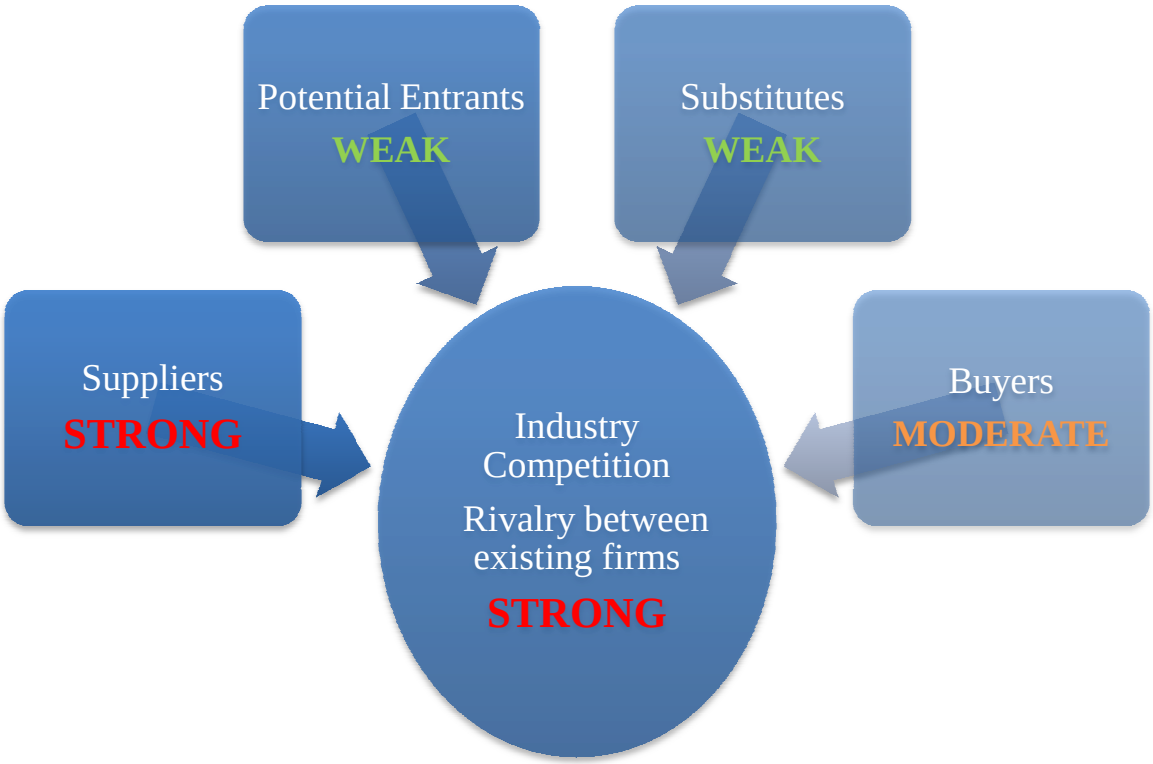
Although the Brazilian power sector has been liberalized, the threat of new entrants remains weak. A vast majority of current power companies operating in Brazil, public and private, are vertically integrated from generation to commercialization and their important market size does not ease the entrance of new electricity companies. Besides, the existing Brazilian power market is extremely competitive and it can be difficult for electricity start-ups, that do not have strong initial funds, to face competition. (Datamonitor, 2011).

The threat of substitute is weak in the Brazilian power sector. Auto generation would be the main threat for generation companies. In other words, customers would start installing their own generation plants. Even if it did start with the arrival of renewable energies on the power market (solar roofs, wind power for businesses installed near the coast), the current cost of using these new technologies make them exclusive to the majority of the population at the moment. However, long term, renewable technology costs should go down enabling the population to have a growing access to these technologies. This issue is important notably for outlying populations which are difficult to reach and are widespread in all Brazil ((Datamonitor, 2011).

Though a little number of companies (Eletrobras, CEMIG, CESP and Tractebel) is currently dominating the Brazilian electricity market, rivalry in the Brazilian power sector remains strong. Indeed, in every energy auction process for the expansion of Brazil's installed capacity, every

power utility, public or private, has the right to compete in order to acquire new power projects. The actual power market rules were established so that public companies were not favored in order to attract foreign investments. As a result, competition is tough and leads to fair electricity tariffs for the residential end-user (Britto and Kogake, 2011).

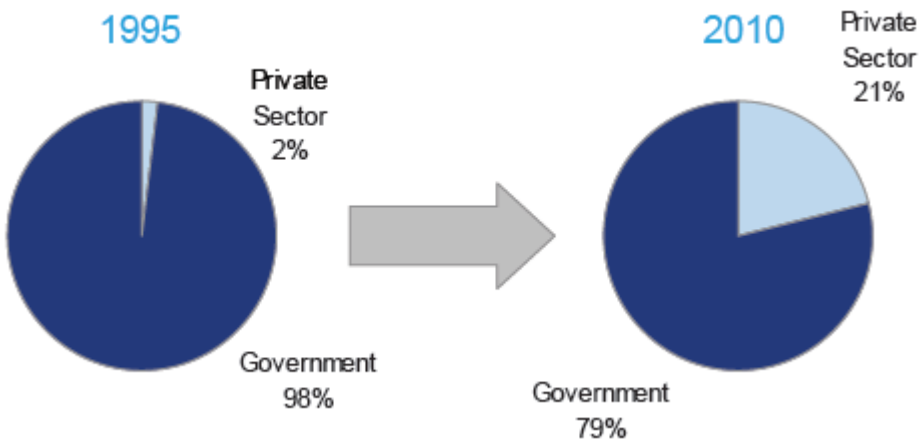
Figure 38: Brazilian Power Sector Porter Forces



5.2.3 Positioning and strategy of the generation key players

Though the power market liberalization attracted a lot of foreign energy investors, the generation sector remains strongly dominated by state-owned companies. Between 1995 and 2010, the private sector's share in power generation increased from 2 to 21 percent while the government's share decreased from 98 to 79 percent (Figure39).

Figure 39: Evolution of Private Sector Participation

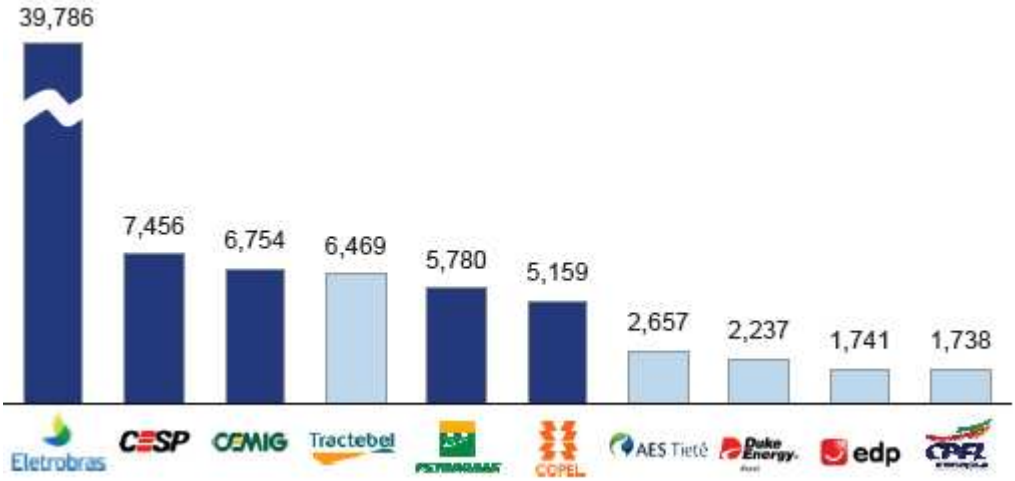


Source: ANEEL

In terms of installed capacity the top three generation companies are all public. The most important power utility in Brazil, which is also the most important power utility in Latin America, is Eletrobras. The Brazilian government owns the majority of the company's voting shares but the remaining shares are openly traded. The public group through its six subsidiaries and six distribution companies is responsible for the generation, transmission and distribution of 60 percent of Brazil's electricity (EnergyMarketPrice, 2011). In 2010, Eletrobras had 40 percent of Brazil's installed capacity with a generation capacity of 39,8 GW (Figure 39). Then comes CESP and CEMIG, two state owned companies, which respectively owned 8 and 7 percent of Brazil's installed capacity in 2010. CESP is owned by the state of São Paulo and had an installed capacity of 7,5 GW in 2010.

CEMIG is owned by the state of Minas Gerais and had an installed capacity of 6,8 GW in 2010. The first foreign investor is in fourth place and is called Tractebel Energia, which is a subsidiary of a french power company, GDF-Suez. In 2010, Tractebel Energia accounted for 7 percent of Brazil's generation capacity and had an installed capacity of 6,4 GW. The position of the next foreign investors like AES Corporation, Duke Energy and EDP in terms of installed capacity are way less important, with installed capacities reaching no more than 2,6 GW (Business News Americas, 2011).

Figure 40: Installed capacity in Brazil in 2010 (MW)



Source: Business News Americas (2011)

As a result, the leading generation companies in Brazil can be categorized into three subgroups: the indisputable leader Eletrobras (more than 30GW of installed capacity), the other market leaders which have an installed capacity between 5GW to 8GW (CESP, CEMIG, Tractebel, Petrobras and Copel) and the challengers with an installed capacity between 3GW to 1GW (AES, Duke Energy, EDP, CPFL, Light, Neoenergia, Endesa) and where many foreign investors are present (Business News Americas, 2011).

In terms of strategy, the key generation players can be categorized in five subgroups: emerging players, new entrants, consolidators, status quo and exit (Britto, 2011). The consolidators characterize generation companies that have already strong positions in the Brazilian power market and want to be among the leading energy companies in Brazil in terms of installed capacity. These companies are generally already market leaders or strong challengers with installed capacities between 7GW and 1GW like Tractebel Energia, CEMIG, EDP, Light, Neoenergia and CPFL Energia. These key players are strengthening their market position mainly through the energy auction process. Indeed, their market size enables them to make extremely competitive offers in terms of electricity tariffs during the various auction processes compared to smaller generation companies which struggle to make competitive offers and to be selected for the expansion plans.

Power companies that choose the status quo strategy are generally important market players with an installed capacity above 1 GW. However, these companies, contrary to the consolidators are not willing to expand their generation activities as their current business is already profitable enough. Both private and public companies are using the status quo strategy such as Copel for the public companies and Endesa or Duke Energy among the private investors.

The so call “new entrants” are generally holding companies that decided to enter the brazilian power sector to create synergies with their other activities like the norwegian SN Power and MPX a subsidiary of the EBX group, or to diversify their portfolio such as the brazilian holding Odebrecht. The new entrants generally have a lot of cash flow which can ease their power project acquisitions.

Emerging players are smaller companies that often uniquely focus on the power sector. As they do not have the cash flow or the market size of the “new entrants” they specialize in specific power projects, mainly concerning renewables energies. As they are not big enough to compete with the market leaders or the “new entrants”, these power companies focus on smaller projects (inferior to 500 MW) but which need specific expertise that they do have and that bigger companies may not have. This is the case with local companies such as SIIF Energia, Omega Energia, Hidrotérmica and also foreign investors such as the Canadian asset management group Brookfield Renewable Power.

Finally, various power companies decided to exit the Brazilian power market for various reasons such as debt (NRG Energy), a lack of profitability and a competition which is becoming stronger and stronger (Elpaso) or a strategy refocusing (Rede Energia) (Britto and Kogake, 2011).

5.2.4 Strategic options for EDF

Taking into account the positions of key generation players on the Brazilian power market, and considering the experience EDF acquired through Light and UTE Norte Fluminense, the Group now needs to adopt a clear strategy toward Brazil in order to fully profit from the growth potential of this market.

a) Exit Strategy

An exit strategy for EDF will be characterized by a full sale of EDF's stakes in UTE Norte Fluminense and the end of its partnership with local utilities such as Eletronuclear or Light. This will conclude the market exit that EDF initiated in 2006 with the sale of Light. For EDF, it would be the opportunity to fully exit Latin America, and refocus its international strategy on other fast growing regions such as Asia, where the Group already has strong positions.

As UTE Norte Fluminense's financial results are excellent, and as there is currently a strong demand for generation assets in Brazil, it may be the right moment to process to the sale of UTE in order to receive important funds and improve the financial situation of EDF. The Fukushima events urged the upgrade of EDF's nuclear fleet imposed by the french nuclear watchdog, the ASN, and this will be extremely costly for the company. Therefore, EDF is seeking additional funds and the sale of UTE could be a solution to that problem. The possible purchasers of UTE Norte Fluminense could be the "consolidators" like Tractebel or the "new entrants" like MPX. On the other hand, exiting the market will not lead EDF to profit from Brazil's power market potential which is substantial: electricity demand annual growth of 4,9 percent between 2011 and 2020 and an installed capacity increase of 61 percent between 2010 and 2019 (MME, 2010). Furthermore, a re-entering the Brazilian power market later on would be both time consuming and expensive. Consequently, if EDF decides to leave the Brazilian power market for real, a market exit at that time is attractive. However, EDF's strategy has to be clear on one point: if the group leaves Brazil now, it leaves it for good (Masvigner and Rougier, 2011).

It is also important to stress the fact that a country exit strategy would be a turning point for EDF international strategy. Indeed, EDF's current presence in Latin America is limited to its Brazilian assets UTE and Ibiritermo via its subsidiary Edison. Brazil is still considered by the Group as the starting point for a further expansion in Latin America. If EDF decided to exit Brazil, the most important power market in South America, neighboring countries like Chili, Colombia and Peru my no longer be considered as strategic. Given up these markets may not be a relevant choice considering the growth opportunities offered by those countries. According to the Strategy Division of EDF, Colombia, Chili and Peru should all have an economic growth rate superior two 4,5% by 2016. By 2020, Peru will have to construct more than 9 GW in terms of installed capacity, Chili 8 GW, and Colombia 5 GW (EDF, 2012). Few countries have such power market growth potentials. Hence, it is important to evaluate the long term cost of a market exit in Brazil, and figure out if focusing only on the Asiatic region would be enough to compensate the loss of the South American markets.

b) Status Quo

If EDF chooses the status quo, no immediate action would be taken. The Group would keep profiting from the excellent financial results of its Brazilian subsidiary UTE Norte Fluminense and would maintain its presence in Brazil. Indeed, EDF could simply wait for new local market opportunities while enjoying high returns, without additional substantial investments.

A status quo strategy can be relevant in a power market that is already mature and above all when the entity has reached a "critical size", so that competitors can hardly challenge its market shares. That is not the case of EDF in the Brazilian power sector. Indeed, EDF does not have yet a sufficient size that would enable the company to defend efficiently its current market shares. Furthermore, as competition is increasing, the competitors size is also growing, which results in reducing EDF's market power in the local electricity sector (Oliveira, 2005). As a consequence,

if on the one hand the market is consolidating, and on the other hand EDF decides not to go big, the Group will face great difficulties to maintain its current market shares in the near future. Last but not least, the Brazilian market is not mature yet and is constantly undergoing changes. Therefore, a pro-active strategy has to be adopted, rather than a status quo position.

As a consequence, if EDF is not proactive, it may miss growth opportunities that other utilities are eager to get. EDF's strategy towards Brazil would then remain unclear and the Group could be seen as a "freeriding" utility that only wants to profit from Brazil power sector growth and which does not participate to the improvement of the local electricity sector.

In other words, a status quo strategy would simply postpone the problem of EDF, though immediate decisions need to be taken if the Group wants to profit fully from future growth prospects in Brazil. Consequently, the status quo may be the least attractive strategy for EDF.

c) EDF Alone

EDF could also decide to grow alone in Brazil. Organic growth would be possible through the enhancement of UTE Norte Fluminense sales and greenfield investment projects. As a consequence, EDF would follow the strategy of some power utilities such as Duke Energy Brazil, a subsidiary of the US holding Duke Energy. Duke Energy grows through acquisitions of power projects that it then operates on its own. Using the same strategy, EDF would keep looking for growth opportunities in the local power market and maintain total control of its activities in Brazil.

The main advantage of this option is that the Group would finally have a clear strategy and planning to profit from the expected market growth. EDF will be able to pilot alone its decisions. While a Joint Venture (JV) generally implies mutual agreements between partners before taking

any action, by playing alone, EDF would save precious time and energy. Time management is one of the key success factors in any fast growing market.

However, such a strategy is costly and EDF does not have sufficient cash flows at the moment for two main reasons. First, the company has to upgrade its nuclear fleet in France and this will costs billions of euros to EDF in the coming years. Since the Fukushima event, the French Nuclear Safety Authority urged EDF to conduct the necessary investments to upgrade its nuclear park in terms of security. These investments are estimated at 10 billion euros in the next 8 years, which equal 1.25 billion euros per year until 2020 (Debs and Gilles, 2012). Second, the expected financial results of EDF are weak because of the current economic slowdown in Europe, reducing available cash flows for greenfield investments. Finally, though M&A activities in the Brazilian power sector are growing, few opportunities are available and the generation asset prices in Brazil keep skyrocketing (Tabbush and Oliveira, 2011). EDF is definitely not the only company which is eager to acquire local entities, and if an opportunity was available, power companies will be prepared to invest billions. Considering EDF's current financial situation and the future investments the company will already have to face, this strategy is not interesting at the moment.

d) Local Partnership

The last solution for EDF is to find a local partner. Though EDF's experience was not great with Light in 2006, it seems to be the most appropriate strategy for several reasons. First, making a partnership with a local Brazilian actor would enable EDF to gain additional knowledge about the local power sector and would foster its relationships with local entities. By doing so, EDF could then get rid of the bad image it has because of the hasty sale of Light. Furthermore, by growing its business with the support of a local partner, EDF would be able to profit from growth prospects without investing substantially (compared to a greenfield strategy). Indeed, the

investment would be shared between both entities and EDF could stay and grow in Brazil without jeopardizing its market positions in Europe.

However, there are two prerequisites for a correct functioning of this type of strategy. First, EDF needs to find the right partner and that is not an easy task. Many local power utilities are solicited by foreign investors to create a partnership and demand is higher than the offer. As a consequence, Brazilian local utilities are in a position of strength and set their own conditions with foreign investors who often need to pay a high price if they do want to find a local partner. This leads to the second issue which is the question of corporate governance and control. Indeed, as local entities are generally in a position of strength, they are quite demanding concerning the governance of a possible joint venture. As a result, if EDF wants to find a local partner to strengthen its position in the Brazilian power sector, it must be ready to fairly share the corporate governance of the joint venture. In that case, EDF would no longer be able to solely decide the strategic decisions of the new power entity and would have to deal with the expectations of its local partner.

Although a local partnership implies that EDF's strategic decisions are no longer the result of its own market evaluation and it would have to share the benefits of the future power sector growth opportunities, this strategy seems to be the most interesting one considering both EDF's position in Brazil and its current constraints coming from Europe.

5.3 Partnership with EBX, a deeper example

Considering that finding a local partner could be the best strategy for EDF in Brazil, it is crucial for the Group to find the right partner. The Brazilian power market is still in its consolidation phase and several local players are eager to reach a critical size in order to fully profit from market opportunities instead of becoming prey to the current leading power utilities. To do so, some of them may be willing to make a partnership with a foreign investor which would help them to grow fast and reach this critical size. Among them, the Brazilian company EBX, via its power subsidiary MPX, has already showed interests in finding a potential foreign partner. This last part analyzed a potential partnership between EDF and MPX which could be a highly attractive strategic choice for both entities.

5.3.1 EBX Group Overview

EBX is a Brazilian private holding company that manages a wide portfolio of business activities such as mining, power generation, logistics, oil and gas, real estate and entertainment. So far EBX holds major ownership stakes in 5 listed companies and 6 private companies (figure41). Since its creation in 1983, EBX has tried to identify business opportunities in various areas of expertise, raising funds through partnerships and strategic alliances with private investors. Until 1998, the company was only focused on mining activities especially on gold, nickel, zinc and silver businesses, in Brazil as well as abroad. EBX then decided to diversify its portfolio and started entering other businesses such as power generation and oil exploration in order to create synergies with its previous core business. The company also decided to enter totally different markets like real estate and entertainment (EBX, 2012).

So far EBX has a production capacity of 10.8Mt/y iron, 29 oil and gas exploration blocks, two ports in southern Brazil and electric power projects expected to generate 2,6 GW in 2012 (Business News Americas, 2012). EBX is currently owned by the one of the richest men in Brazil as well as one of the most successful entrepreneurs of the country, Eike Batista.

Figure 41: EBX Portfolio Companies

Company	Sector	Market Cap. (US$ in millions)	EBX Stake (%)
Listed Companies			
OGX	Oil Exploration	$37,354	62%
LLX	Logistics	1,780	54%
OSX	Shipyard	3,455	24%
MMX	Mining	3,042	40%
MPX	Power Generation	2,207	76%
Private Companies			
REX MLX	Real Estate	NA	NA
Pink Floyd GLORIA PALACE MIAM	Entertainment	NA	NA

Sources: EBX (2012)

5.3.2 MPX Company Overview

MPX, a subsidiary of the EBX group, is engaged in power generation and trade as well as the exploration of natural resources, especially coal and gas (MPX, 2012). The company is also showing a growing interest in renewable energy activities. MPX was created in 2001 and started its activities with a 220 MW thermal power plant in partnership with MDU Resources Group, a US energy holding company. In 2005, this plant was sold, generating a profit of 78 M€. MPX decided to open its capital in 2007 in order to gather additional funds for future investments. This operation enabled the generation company to raise 822 M€. EBX currently owns 76 percent of the company's stakes while the 24 percent remaining stakes are in free float (Figure41).

Figure 42: Ownership Structure

Sources: MPX (2012)

At the moment MPX is operating an installed capacity of 1 080 MW with three thermal power plants that are nearing completion and that already have PPAs of fifteen years each on the regulated market. Among these contracted power projects Pecém I is a 720 MW thermal plant operated in partnership with Energias do Brasil, Pecém II is a fully owned 360 MW thermal plant, and Itaqui is another 360 MW power plant also developed by MPX. Serra do Navio is the only MPX power plant that is currently operating at its maximum capacity, 23 MW. Serra do Navio is owned by both MPX and Eletronorte (MPX, 2012)

Furthermore, MPX has an additional 9 996 MW greenfield projects under development and which are planned to be built in the coming decades though they have yet to obtain any PPAs (Figure43). In other words, between 2012 and 2016, MPX's installed capacity should increase from 1 080 MW to 2 480 MW at a compound annual growth rate of 23 percent (Debs and Gilles, 2012).

Figure43: MPX Greenfield Projects

Project	Capacity (MW)	MPX's stake	Fuel Source
Açu I	**2 100**	**100%**	**Coal**
Açu II	**3 300**	**100%**	**Natural Gas**
MPX Chile (Castilla)	**2 100**	**100%**	**Coal**
Sul	**600**	**100%**	**Coal**
Parnaiba	**1 863**	**70%**	**Natural Gas**
Paracuru	**32**	**100%**	**Wind**
Taua	**1**	**100%**	**Solar**
Total	**9 996**		

Source: MPX (2012)

5.3.3 Feasibility of Partnership Between MPX and EDF

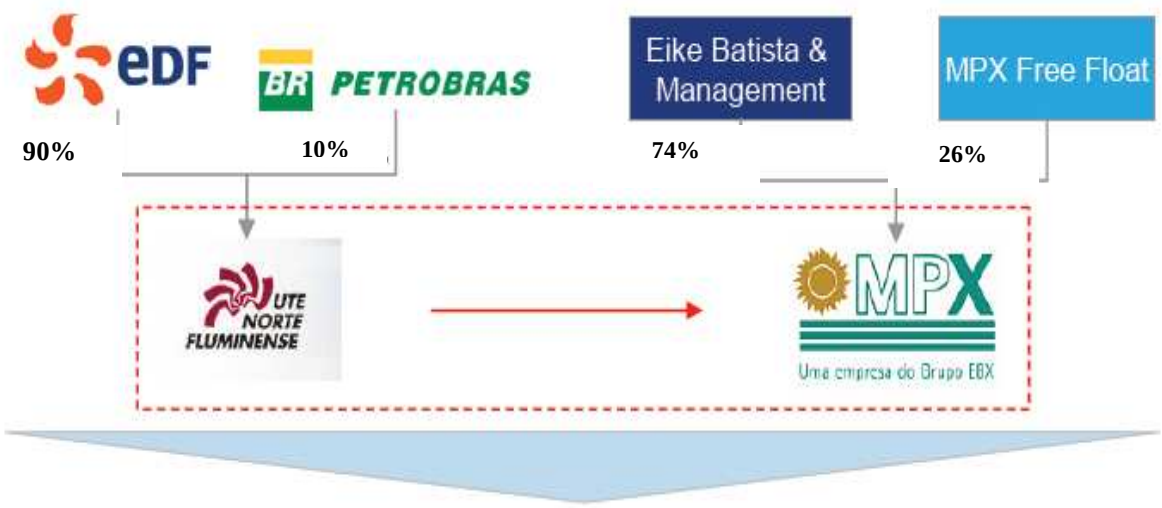
MPX installed capacity expansion plan for the coming decades is ambitious. Though the EBX group is often compared to a cash machine, it will not be able to finance all the greenfield projects of its power subsidiary. As a consequence, MPX needs to find various partners, public or private, that could help in the achievement of the expansion of its power plant fleet and bring the necessary additional cash flows for MPX's future investments. For a couple of years, the firm has been in discussion with various private investors and MPX's willingness to make strategic alliances with other private investors is growing. EDF could be a serious candidate for a joint venture with MPX because of its historical expertise in generation, its extremely attractive Brazilian generation asset, UTE Norte Fluminense, and because of its international market size (Rougier and Puech, 2011).

Therefore it is interesting to evaluate how a joint-venture between EDF and MPX could be operated (Figure44). The most feasible scenario would be the sale of EDF's stakes in UTE Norte Fluminense to MPX in exchange of some MPX shares. In an operation like this one, the first thing to do is to assume a firm value for both UTE Norte Fluminense and MPX. Through

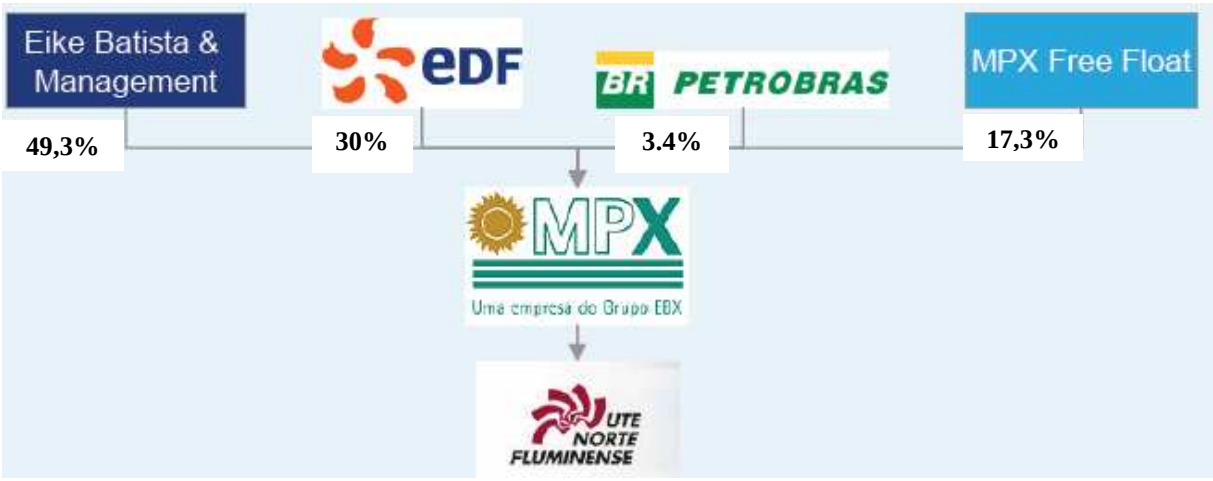
complex calculus and stochastic models the right firm value could be found. In order to ease this demonstration it is supposed that UTE Norte Fluminense's firm value is 1 000 M€ and that MPX's firm value is 2 000 M€. EDF owns 90 percent of UTE (900M€ in terms of firm value) while Petrobras the least 10 percent (100M€). In the case of MPX, EBX owns 74 percent of the firm (1 480M€) while the least 26 percent (520M€) are considered as openly traded. In the case of a sale of UTE Norte Fluminense to MPX, the new joint-venture of MPX would now have a firm value of 3 000M€ (2000+1000). What would be the transaction results?

First of all, UTE Norte Fluminense would become a subsidiary of MPX. Then, the former shareholders of Norte Fluminense would become minority shareholders of MPX while EBX would stay the main shareholder of the firm. As EDF held a 900M€ firm value in Norte Fluminense, it would now own 900/(2000+1000) which is equal to 30 percent of the new joint-venture (MPX after the transaction). The same calculation can be made for Petrobras (100/3000) which would own 3,4 percent of MPX. EBX after the transaction would stay the major shareholder with 49,3 percent of MPX (1480/3000) while MPX's free float would now represent 17.3 percent.

Figure44: EDF & MPX Joint-Venture



TRANSACTION RESULTS



To summarize, if EDF decides to sell UTE Norte Fluminense to MPX, Norte Fluminense would then become a subsidiary of MPX. EDF and Petrobras would become shareholders of MPX. However, as the firm value of MPX is considered as higher than the one of UTE Norte Fluminense, EBX, major shareholder of MPX before the joint-venture, would still own the majority of MPX's capital. EDF and Petrobras would finally retain an indirect ownership of Norte Fluminense through MPX.

5.3.4 Transactions Results for EDF

Such an operation would be highly attractive for a foreign investor like EDF in terms of strategy, finance, and market perspective.

In terms of strategy, thanks to this transaction EDF would finally become a relevant player in the Brazilian power sector through a minority ownership in MPX. Indeed, if MPX follows its expansion plan, the company could soon become one of the leading generation companies in Brazil. A partnership with MPX, a strong and well established local player, will enable EDF to profit fully from the highly attractive growth opportunities that are offered by the current brazilian power sector. Besides, in the longer term, EDF could become a relevant shareholder of MPX. Indeed, EBX might eventually exit MPX in order to refocus on its other business units and that would create a fantastic acquisition opportunity for EDF which could become the major shareholder of MPX.

This transaction would also be financially attractive for EDF. First, EDF could take advantage of the high market valuation of its unique generation asset in Brazil, UTE Norte Fluminense, and the relatively low market valuation of MPX at the moment, in order to obtain interesting transaction conditions. Then, this operation would have no cash impact for EDF as companies are just exchanging shares. Furthermore, in the case that EDF would like to exit from MPX, it would be easy because of the liquidity of MPX shares. In addition to that, EDF could make a lot of money as the MPX's market valuation is expected to skyrocket if the firm manages to realize its installed capacity expansion ambition (Severine, M. 2011).

Finally, this transaction would enable EDF to fully profit from the Brazilian power market perspectives. Brazil's power generation market is offering attractive future growth opportunities and the market is finalizing its consolidation which will limit options for new entrants in the near future. As a consequence, it is the right momentum to make this kind of deal for EDF.

Last but not least, even if nuclear power market remains the exclusive territory of the government at the moment, EDF would be already well positioned to catch the future growth potential of this market as soon as the private sector will have the right to operate in that market.

6. CONCLUSION

Europe, EDF's core market, is currently undergoing economic slowdown. The recovery of the European market will take time. Growth prospects are thus limited for the coming years in Europe and EDF needs to develop its activities in fast growing countries. Brazil is part of the countries that best resisted to the last financial crisis and will continue to have high economic growth rates in the coming years. Furthermore, the Brazilian power market is currently soaring and its potential is still underexploited. Thanks to its generation asset UTE Norte Fluminense, EDF is already operating in the country. Besides, the company is present in Brazil since 1996 and thus already familiar with the local power sector. Consequently, Brazil could become a priority for EDF. However, the strategy of the Group for Brazil is still unclear. This paper intended to evaluate the strategic options of EDF in the Brazilian power sector.

Four possible strategies could be followed.

- The first one consists in fully exiting the market. By doing so, EDF will profits from the current high valuation of generation assets in Brazil and get sufficient cash flows to invest in other fast growing countries where the group is already present, such as Vietnam for instance. By doing so, however, the group would not profit from Brazil's power market opportunities and re-entering the market would be difficult.
- The second option for EDF is the status-quo which consists in holding its current position. Even if UTE Norte Fluminense is highly profitable, a status quo position may

not be sustainable in the long run, as the local power market is moving fast with increased competition.

- The third position consists in operating alone on the brazilian power market. It is both risky and costly. Considering the current financial situation of EDF and its core market poor expected performance, operating alone does not appear as a good solution for the time being.
- The fourth and final option studied in this paper consists in making a partnership with a local energy player. Going ahead with a local player would bring both local expertise and synergies to EDF. Fusion or acquisition could even enable the Group to reach critical size and start claiming for a relevant market share. Consequently, a local partnership seems to be the most relevant option for EDF in Brazil.

If the Brazilian power sector can be a real growth engine for EDF, this paper showed that seizing the opportunities of this market is a complex task. If the company decides to stay in Brazil, the Group will to reach the critical size of thousands of MW in order to be part of the leading local energy players who are able to defend their market positions. If EDF keeps acting on a small scale, it will not manage to fully profit from future growth and opportunities in the Brazilian power sector. Furthermore, by not taking immediate action, EDF lets its direct competitors, like GDF-Suez, take strong positions in Brazil, win market shares and lock even more the market. For these reasons, the status quo strategy does not make sense. Then, considering that EDF decides to stay in Brazil, which is the most probable case, the company only has two strategic options: prepare itself for the next auction process with a competitive offer to be able to implement a greenfield energy project, and/or enter the capital of a local power utility through M&A operations.

If EDF decides to stay alone in the Brazilian electricity market and develop its activities through greenfield investments, hydropower projects remain the most attractive activity. Nuclear and gas

will become attractive in the long run, once gas supply management is no longer be a problem, and when the government decides to allow private companies to operate in the nuclear power market. However, each year, competition during the energy auction processes becomes stronger and stronger. EDF needs to be ready to make compromises, especially on its price offering if it wants to win energy projects at the next bidding process. The failure of its CCGT project Lajes during the last auction process in 2011 reminded EDF that operating on the brazilian power sector is a difficult task.

Therefore, a partnership with a well-established power utility seems to be the best strategic choice for EDF in regards to the difficulties of winning energy projects during the bidding processes. Thanks to a local partnership, EDF would acquire both the necessary market size and the local expertise that are required to profit from the Brazilian power sector growth. Even if MPX appears to be a good option, there are also other serious candidates for a partnership. The key success factor for EDF, in an operation like this one, would be to show that it can bring a real added value to its local partner. Electricity and nuclear expertise are among the main strengths of the Group to be used to attract local energy players

EDF strategy in Brazil also needs to be thought in terms of time frame. In the short term, EDF, through its current Brazilian generation assets (UTE Norte Fluminense and Ibiritermo via Edison) should consolidate its presence in the brazilian power market and prepare itself for the next energy auction process. In the long term, the Group should be prepared for the opening of the nuclear market and ready to strengthen its agreement with Eletronuclear in this regard. Parallel to these operations, EDF needs to be actively engaged in discussions with local power utilities such as MPX, in order to be ready for a potential partnership.

If this paper does present different strategic alternatives for EDF in Brazil, it should be considered as a basis for further analyses so as to implement the best strategy in Brazil. For instance, it is important to evaluate the cost of each strategic option. If some of the options can

be more costly and time consuming in the short term (local partnership, EDF alone), they could become more interesting financially and strategically in the long term. To do so, a close collaboration with both the financial and M&A divisions of the Group would be necessary. Then, if making a partnership seems to be one of the most relevant options for EDF, further studies could be conducted such as a benchmark of all potential local partners who would be willing to associate with EDF. This could be realized by making a financial analysis of each company, by evaluating what potential synergies could be created between both entities and by meeting directly with the interested local player in order to understand their needs and expectations concerning this kind of partnership. Finally, it would also be wise to see which kind of partnerships would be more relevant in this sector (MoU, JV, merger or acquisition), each of them having their own pros and cons.

7. BIBLIOGRAPHY

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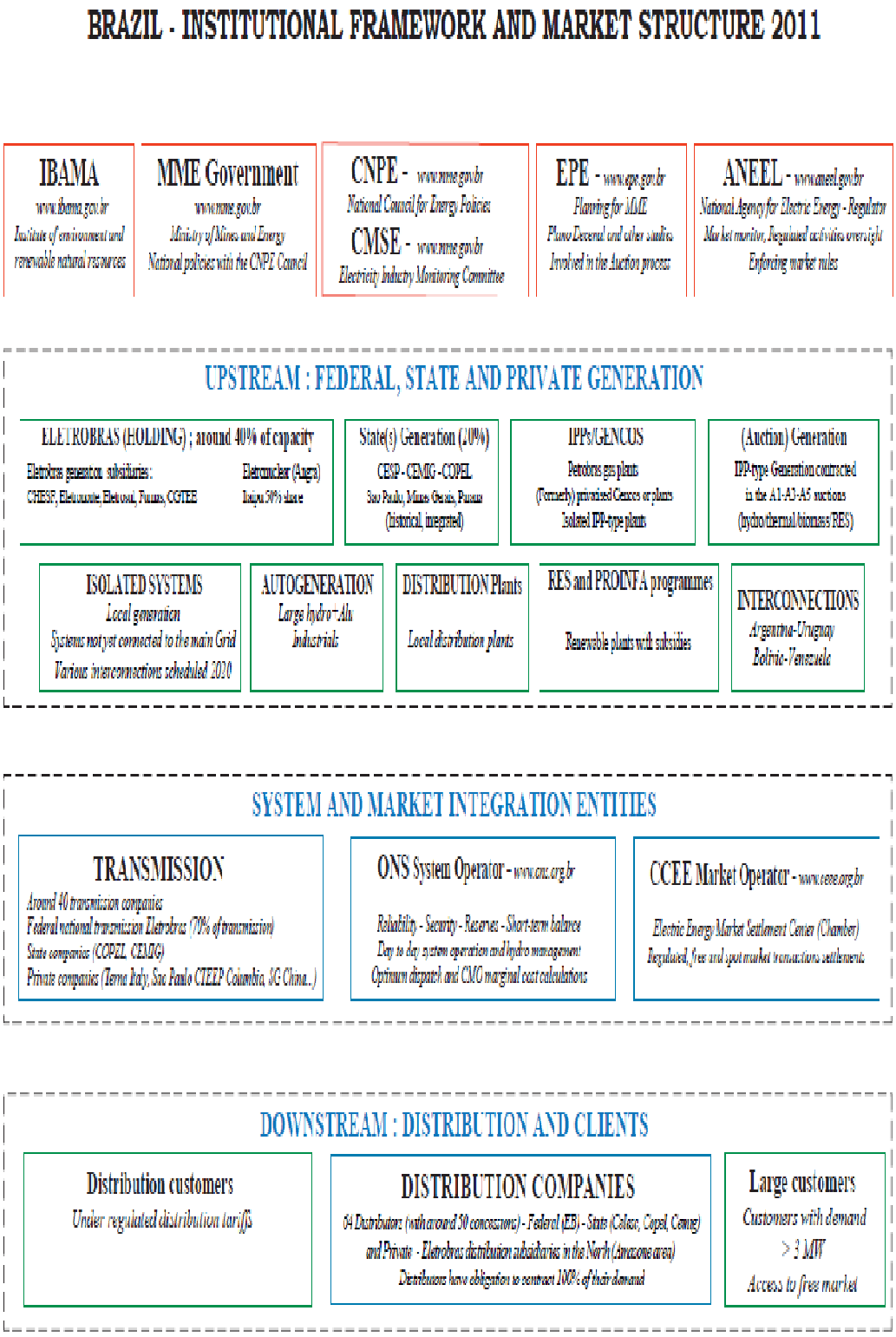
8. **ANNEX: Brazil – Institutional Framework And Market Structure 2011**



9. ANNEX: Energy Legislation: The Federal Laws

The **fundamental legislation of the electrical sector** was instituted over approximately 70 years of history. It includes articles of the Constitution, decrees, complementary and ordinary laws, inter-ministerial ordinances, ordinances of the Ministry of Mines and Energy and of the previous National Department of Water and Electric Power (DNAEE), ANEEL and CONAMA resolutions. The Concessions of Public Services Law of February 1995 and 9427/1996 Law , which provide for the foundation of ANEEL, are objectives for the modernization of the sector, the government leaving the role of investor.

The Federal Law n. 8,987/95 - institutes criteria and definitions concerning public concession and public permission regimes as established in article 175 of Brazilian Constitution, plus other definite provisions.

The Federal Law n. 9,074 - July 7, 1995 - brought a sequence of structural changes for the Electric Sector, set up rules for Electric Power Concessionaries, acknowledged the role of the Independent Power Producer (IPP), freed Large-Scale Consumers from the commercial monopoly of the utility and ensured access to the transmission and distribution systems, with the clear goal of establishing a competitive environment, where the price is the instrument of the agents' orientation.

The Federal Law n. 9,427 - December 26, 1996 - created ANEEL, the Brazilian Electricity Regulatory Agency, the Electricity Sector regulator, with operational and financial autonomy, and the legal power to control and focalize the electric energy generation, transmission, distribution and commercialization in line with the policies and directives fixed by the Federal Government, and to carry out public utilities tendering for the employing public utility concessionaires for electric energy production, transmission and distribution, as well as the granting of concessions for the utilization of hydraulic potentials;
This Law introduced competition in the generation and supply sectors taking into consideration the outstanding character of the Brazilian hydraulic production park.

Federal Law n. 9,648 - May 28, 1998 - revises some dispositions of Law n. 9,074 referring to the free consumers. The Free Consumers, starting 1998, will be able to have the alternative to buy energy from any distribution company, generation or energy agent. A new niche for the Electricity Market in Brazil is as well created. This Law ensured the free access to the transport networks, which establishes the obligatory condition that approval to spread blocks of energy traded by the Agents be issue to the payment of due charges for the utilization of the electricity network.
This Law creates the Wholesale Electricity Market – MAE, with the purpose of intermediating all electricity sale and procurement transactions in each of the interconnected electricity systems.
This Law also created the National System Operator (Operador Nacional do Sistema - ONS), and approved the commercialization of electric energy by traders.

The Federal Law 10.433/02 - authorizes the institution of the Wholesale Electricity Market (MAE - Mercado Atacadista de Energia Elétrica) as a ordinary law legal entity.

The Federal Law 10.438/02 – sets up rules and criteria for the addition of electricity supply in crisis situations, as well as for unexpected tariff recovery; creates the Alternative Electricity Sources Incentive Program (PROINFA - Programa de Incentivo às Fontes Alternativas de Energia Elétrica), the Energy Development Account (CDE - Conta de Desenvolvimento Energético); establishes rules and criteria to offer total access to electricity.

The Federal Law 10.604/02 - institutes rules and criteria referring to the resources to be used to support financially low income consumers of electricity.

The Federal Law 10.637/02 – sets up provisions concerning non-accrual payment of contributions to the Social Integration Programs (PIS) and for the Public Servants Patrimony Buildup Program (PASEP) in particular cases; as well as provisions as regards the payment and parceling of federal tax debts, the offsetting of tax credits, customs laws.

The Federal Law 10.762/03 - creates the Electricity Distribution Companies Emergency and Special Support Program.

The Federal Law 10.847/04 - permits the foundation of the Energy Research Company (Empresa de Pesquisa Energética - EPE).

The Federal Law n. 10,848 - March 15, 2004 – institutes provisions concerning the commercialization of electricity.
This Law introduced the new regulatory agenda for the Electricity Sector in Brazil after changes in Government in 2003. It created two environments for electricity agents to complete electricity acquisition and sale transactions: *The Regulated Contracting Environment – ACR* and *the Free Contracting Environment – ACL*. In the ACL, all electricity negotiator, excepting the distributors, would be permitted to freely negotiate power purchase agreements - PPAs. In the ACR, the distribution concessionaries would acquire, at public auctions, the totality of the electricity that they have to buy so as to meet the consumers' needs.

10. ANNEX: Evolution Of The Brazilian Electricity Model

Former Model (until 1995)	Free Market Model (1995 to 2003)	New Model (2004)
Financing using public funds	Financing using public and private funds	Financing using private and public funds
Vertical Companies	Companies classified by activity: generation, transmission, distribution and commercialization	Companies classified by activity: generation, transmission, distribution, commercialization, imports and exports
Predominantly State-controlled companies	Opening up of the market and emphasis on the privatization of the Companies.	Coexistence between State-controlled and Private Companies
Monopolies – No competition	Competition in generation and commercialization.	Competition in generation and commercialization
Captive Consumers	Both Free and Captive Consumers	Both Free and Captive Consumers
Tariffs regulated throughout all sectors	Prices are freely negotiated for the generation and commercialization.	In a free environment: Prices are freely negotiated for the generation and commercialization. In a regulated environment: auctions and bids for the least tariffs
Regulated Market	Free Market	Coexistence between Free and Regulated Markets
Determinative Planning – Coordinator Group for the Planning of Eclectic Systems (GCPS)	Indicative Planning accomplished by the National Council for Energy Policy (CNPE)	Planning accomplished by the Energy Research Company (EPE)
Contracting obligation: 100%	Contracting obligation: 85%(until Aug/2003) and 95% (from Sep/2003 to Dec/2004)	Contracting obligation: 100%