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POWER GENERATION POSSIBILITIES IN THE STATE OF SÃO PAULO, BRAZIL



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ABSTRACT

São Paulo is the Brazilian state with the largest economic production, the largest population and the largest industrial park of the country, with a participation in GDP of 36.6% (population: 34 million; area: 248,600 km²; urbane population: 92,8%; illiteracy: 10%; infantile mortality: 26.2/1000). Great part of the industry from São Paulo concentrates in the metropolitan area of São Paulo. Nevertheless, in the interior several cities are becoming important in many industrial sectors. After 1930 São Paulo became the vanguard of the Brazilian modernization. Concurrently with the agricultural expansion the state had an extraordinary industrial development. Channeling the great flows of investments of the American and European multinationals and the great internal migratory currents, São Paulo increased its population vastly, it diversified its social structure and it consolidated its economic power. However, the poverty of a great part of its population is a severe social problem. The State of São Paulo, in 1995, consumed 82.9 TWh of electricity, with the consumption of the industrial sector of 39.6 TWh. In that same year Brazil consumed a total of 249.9 TWh, and of this total value, 118.0 TWh was consumed by the industrial sector. By analyzing the evolution tendencies of energy consumption in São Paulo in the last years, it is possible to identify important aspects of the energetic development of this State, particularly in relation to the perspectives of natural gas utilization in gas turbines for power generation.

1. INTRODUCTION

The objective of this first part is to present some data about the State of São Paulo, and clarify the evaluation of its demands for electricity. The principal economic characteristics of the State, such as industrial production, agriculture and the state's GDP are presented, and several social indicators are included in the second part. Next, the demands for energy and the structure of the State's consumer market for electricity are described in the third part. Finally, the future

possibilities of the State's economy and the demands for electricity are discussed.

São Paulo is a seaboard State, located in the Southeast area of Brazil and it is crossed by the Tropic of Capricorn. The capital, also called São Paulo, it is one of Latin America's most important cities. Sao Paulo is Brazil's largest city and one of the largest metropolitan areas in the world. It is also one of the fastest-growing cities in the world. The city is located in southeastern Brazil, about 400 kilometers southwest of Rio de Janeiro. The climate of the State of São Paulo is between temperate and tropical. Its temperatures vary between minimum averages of 18 and maximum averages of 28°C with a rainy season during the summer and a dry season during the winter.

The State has been occupied since the past century, with the spreading of coffee crops (1870-1920) towards São Paulo interior, creating large cities. The development of the coffee industry led to a significant population increase and to the occupation of new areas. The coffee era led to the development of new cities and industries directed to the internal market.

After 1930 the Brazilian industrialization advanced, and the State of São Paulo became the Brazilian State with the largest economic production, the largest population and the largest industrial park of the country. São Paulo became the vanguard of the industrialization and of the Brazilian modernization. Together with the agricultural expansion (coffee, sugar-cane, soy, corn, bean, wheat, banana, orange), the state had an extraordinary industrial development. The great part of the industry from São Paulo concentrates in the metropolitan area of São Paulo and on important cities as Santos, Campinas, Sorocaba, São José dos Campos, São Carlos, Ribeirão Preto, São José do Rio Preto, Piracicaba, Bauru and Araçatuba.

The transformation industry (steel, cement, machines and components, etc.) and, mainly, the industries of consumption goods (woven, medicines, hygiene and cleaning) and durable goods (automobiles and appliances) developed intensively. Channeling the great flows of investments of the American and European

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multinationals and the great internal migratory currents, São Paulo increased its population vastly, it diversified its social structure and it consolidated its economic force.

Economic activity has been moving away from the traditional industrial centers. This impacted several regions in Brazil, including the interior of the State of São Paulo. Around 1939, the GDP of the State of São Paulo was 31% of Brazilian GDP, and 45% of its gross industrial product. São Paulo City had become a huge urban center. This development also changed the interior of the state with the diversification of agricultural activity, industry and other services. The industrial development after 1930 consolidated São Paulo's economic leadership. Brazil industrialized, mainly by import substitution, and the integration of Brazilian market made possible high levels of growth in São Paulo. In 1970, the State of São Paulo had 19% of Brazilian population, and was responsible for near 40% of GDP. The economy of the State of São Paulo developed important relations between industrial sectors and an intense production integration.

After 1975, a gradual economic decentralization occurred. The participation of the metropolitan area of São Paulo in the country's industrial production is being reduced. This decentralization favored other Brazilian regions and also favored the interior of the State of São Paulo. The decentralization was particularly intense in the 70s because of the high levels of investment which resulted in an increase in industrial installation and a new generation of industrial plants. Nevertheless, it was lower in the 1980s and the beginning of the 1990s, principally because of a fall in investment. The result was that the participation of the metropolitan area of São Paulo in manufacturing was reduced from 43% to only 27% between 1970 and 1995. At the same time, the interior of São Paulo passed from 14.7% to 23.3% with intense growth in regions like Campinas, São José dos Campos, Ribeirão Preto, São Carlos and São José do Rio Preto.

2. ECONOMIC ASPECTS

The transport and communications infrastructure of the State of São Paulo has been developing since the era of coffee expansion. The state highway system extension is 21,000 km. There are also 2,100km of federal highways and near 175,000km of municipal roads. The extension of the railways is 5,500km and there are 1,000 km river transport along the Tieté-Paraná Waterway. There are the ports of Santos and São Sebastião, and 36 commercial airports, including the international airports of Viracopos and Guarulhos. In 1994, the airports of Viracopos and Guarulhos attended more than 167,000 international flights. During the same year the port of Santos moved 34 million tons. Some institutional changes related to the transport system in São Paulo are occurring. The state government wants to concede 5,000 km of paved roads, which will become toll roads, with private industry responsible for the maintenance and expansion. They also plan to restructure the main export corridor of the state's main railway. In 1996 São Paulo had 16 fixed telephone terminals per 100 inhabitants, 50% more than the Brazilian average. It has been introduced digital technology, fiber optics and the system is using increasingly satellites and wireless communication.

The growth of the interior of the State of São Paulo is one of the most important components in the process of decentralization of Brazilian industry. The interior of the State of São Paulo increased its participation in manufacturing industry in the state, and it became the second largest industrial concentration in the country, after the metropolitan area of São Paulo. Several factors contributed to this evolution: exports subsidies, the national alcohol program, the state

investment in oil refining and steel production, the development of universities in the interior of the State of São Paulo. The State developed policies of moving industries to the interior and policies of environmental restrictions also influenced.

According to SEADE (1997) the evolution of real production was affected by fluctuations in industrial activity during various periods: the recession between 1981 and 83, the recovery from 1984 to 1986, low growth between 1987 and 1989, a new recession along 1990-1992 and recovery after 1993. Until 1993 the best average performance was seen in intermediate goods, stimulated by the growth in exports. The evolution of the non-durable goods sector followed the fluctuation of wages. But there was growth with the increase of the urban population, which was able to spend a little more after the stabilization plan in 1994. Up to this date the goods which performed better were those where demand was more flexible in relation to income. The production of durable consumer goods fluctuated, expanding only in the few short periods of stability and improving after 1993. Even during the period of low industrial growth, in the 1980s, the economy in the interior of São Paulo continued to perform well, as industry in the metropolitan area of the city of São Paulo began to decentralize.

The slowdown of the National Alcohol Program, at the end of the 1980s, affected negatively the performance of industrial production in the State. Despite that, the increase in international sugar prices in the 1990s helped to decrease the impact of reduction in alcohol demand.

The interior of the State of São Paulo has not only become the main destination for new investment in the metal-mechanic and chemical sectors but has also benefited from an important growth rate in industry related to agriculture. Between 1930 and 1950 the modernization of São Paulo's cattle industry and the gradual substitution of coffee for cotton and of various crops by sugar cane, implied a transference to other regions of the country of activities with lower returns. At the same time the mechanization and intensive use of fertilizers and other chemical products created the basis for the installation in the State the main body of the industry of machinery and input materials.

The production of sugar cane had already been important at various times in the economic history of São Paulo. But it became more significant with the implementation of the National Alcohol Program at the end of the 1970s intended for oil import substitution. With this program, São Paulo's production went from over 1.1 billion liters to more than 8.6 billion between 1976-78 and 1993-94 with the State of São Paulo producing more than two-thirds of national production.

Another sector which has performed very well in São Paulo's agriculture is the production of citric fruits, stimulated by the increase in the volume of exports of concentrated orange juice during the 1980s. Brazilian production is based almost entirely in São Paulo, which possesses 90% of the country's fruit-pressing capacity. The production of oranges in São Paulo is responsible for more than 20% of world production. Other important products are coffee, corn and soy. The tendency in agriculture in the State of São Paulo is crop diversification.

The figures for regional GDP, presented in Table 1, show the development of the economy in the State of São Paulo. Although the service sector has been becoming more significant, industry, agriculture and cattle-ranching continue to have a large weight in the overall production value.

The interior of the State of São Paulo is an industrialized region which is integrated with the national and international market. It contains a varied production base with a predominance of large

Table 1 - GDP in the main sectors for São Paulo and Brazil -1995.

Composition	Agriculture/ cattle (%)	Industry (%)	Building and Public Serv. (%)	Commerce (%)	Other Services (%)	GDP (%)	GDP (US\$ millions)
State of São Paulo	7.3	31.6	3.6	5.3	52.2	100.0	240
Brazil	11.4	21.6	9.9	6.3	50.9	100.0	655
Relative Participation in nation GDP:							
State of São Paulo	23.6	53.7	13.2	30.6	37.6	36.6	
Brazil	100.0	100.0	100.0	100.0	100.0	100.0	

Sources: IBGE, IPEA, and SEADE.

industrial and business enterprises linked to a solid agro-industrial base. Among the big industrial enterprises installed in the region - all energy consumers - can be found some of the most important national and foreign groups. In any of the above cases the companies are not only supplying the Brazilian market but are also dedicating part of their production to export, to MERCOSUL countries and other external markets.

3. SOCIAL ASPECTS

From the 1960s on, when favorable local conditions began to attract industrial investment, the interior region began once again to receive migrants from other Brazilian regions and, more recently, migrants from the metropolitan region of São Paulo. In Table 2 are presented data comparing the population growth of the State of São Paulo with the corresponding data for the country as a whole. During 1980-1995, the cumulative population growth rate for State of São Paulo was of 35%, whereas the corresponding figure was 30% for Brazil. The growth of the metropolis, which had always been fed by migration has declined over the last decade (IBGE, 1997). The decline in the growth rate of the metropolitan area of São Paulo was more or

Table 2 - Area and Population - State of São Paulo and Brazil (1970 and 1995).

	State of São Paulo	Brazil
Area (km ²) (1)	248,600	8,513,844
Population 1970 (1)	17,771,948	93,131,132
Population 1995 (1)	33,699,614	155,822,440
Average Annual Growth (%) (1)		
1970-1980	3.4	2.4
1980-1991	2.1	1.9
1991-1995	1.6	1.5
Urban Population (%) (1)		
1970	80.3	55.9
1980	88.6	67.6
1991	92.8	75.6
Economically Active Population (million of persons) (1)	13.1	55.3
Employment - 1995 (2)		
industry and building (%)	34.9	25.3
commerce (%)	14.9	12.2
services (%)	47.1	46.7
agriculture and cattle (%)	2.7	2.1
Total Absolute values (million of persons)	6.98	23.03

(1)IBGE; (2) Ministério do Trabalho.

less balanced out by the increase in the growth rate of cities and urban concentrations in the interior of the state. The interior began to have an industrial function which before had been concentrated in the metropolis, and also started developing its own service sector.

The job market in Brazil shows the coexistence of informal and formal work. Large part of the jobs described above are made up of people working independently, or informal jobs where formal legal requirements are ignored.

Social conditions and the quality of life in State of São Paulo are better than those in Brazil as a whole, as can be seen in Table 3. A relatively high income per capita in State of São Paulo created a better standard of consumption for the local population than that verified in the rest of Brazil and in some Latin American countries. This standard can be compared with the possession of durable goods which require a good income, reasonable living conditions and access to electricity. In recent years a rapid expansion occurred in the production of durable consumer goods, which increased by 59% between 1991 and 1996, which in part explains the recent increase in average residential consumption of electrical energy.

The social problems in the metropolitan area are intense. To some extent, because the economic growth of the São Paulo metropolitan area, has been smaller in the last three decades, with many investors looking for more profitable opportunities in another areas of the State.

Table 3 - Family Income, Household Characteristics and Some Social Indicators for São Paulo and Brazil

	State of São Paulo	Brazil
Family income total (US\$ Dec./1995) (1)	12,806.26	8,328.20
Family income per capita (US\$ Dec./1995) (1)	3,476.97	2,105.95
Persons per home (1)	3.89	4.19
Houses with (%) (1)		
Water	91.1	70.7
Drains (network or septic tank)	83.2	52.5
Rubbish collection	91.0	63.9
Electricity	99.1	86.9
Car	37.1	23.1
Refrigerator	89.6	68.8
Color TV	66.0	43.4
Washing Machine	46.7	26.0
Telephone	28.2	18.6
Years of instruction (2)	5.1	4.1
Infant mortality (3)	26.2	57.0

(1) IBGE 1991 Demographic Census; (2) SEADE for 1993;

(3) SEADE for 1994.

Table 4 - Consumption, Number of Consumers and Consumption per capita of Electricity Indicators (1985=100.0) and Absolute Values (1995) for the State of São Paulo and Brazil.

Total Consumption	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1995 (TWh)
State of São Paulo	111.9	112.8	119.2	124.4	123.0	126.9	127.7	133.4	138.5	144.9	82.9
Brazil	108.2	111.1	117.7	123	125.3	130.9	133.3	138.7	143.8	152.5	249.9
Consumers (1000)											
State of São Paulo	104.9	108.8	112.9	117.7	122.1	126.9	132.3	138.4	144.1	148.2	9,972

Source: CPFL.

Partly because the available urban and industrial infrastructure is insufficient to assist to the social demands of transport, health, dwelling and education. With that, São Paulo shows off today, beside the wealth of vast areas of the interior, a relative impoverishment of its metropolitan area.

4. ELECTRICITY DEMAND

The electric section in Brazil is constituted by companies of generation, transmission and distribution of electric energy, which are, still in its great majority controlled by the Brazilian Government and by the State Governments. Based on Llagostera (1990) it is presented here a short summary of the evolution of the Brazilian electric section. The companies that began to act in the electric sector in Brazil at the end of the 19th century and beginning of the 20th century were "São Paulo Railway, Light and Power", in 1889; the "The Rio de Janeiro Tramway, Light and Power", in 1905; and to São Paulo Electric, in 1911. In 1912 it was constituted in Canada the "Brazilian Traction, Light and Power" (Broder, 1988), company that controlled that three companies. In 1927 the "American & Foreign Power Company (AMFORP)", company of the North American group "Electric Bond & Share Corporation (EBASCO)" began to act in Brazil, with the creation of the "Empresas Elétricas Brasileiras", future "CAEEB (Companhia Auxiliar de Empresas Elétricas Brasileiras)". Between 1927 and 1930 AMFORP incorporated many Brazilian companies that had been created by Brazilian capitalists, including the largest four groups that acted in the interior of the State of São Paulo, and several other companies, in another Brazilian states (CPFL, 1982).

The intense movement of concentration accomplished by Light and by Amforp determined important alterations in the Brazilian electric sector. In 1930, practically all the developed areas of the country, as well as the ones with greatest potential, passed to the control of those two companies. This process defined a new profile,

characterized by the massive presence of the foreign capital, that stayed unaffected approximately until the 1950s. The power installed in 1930 was 780 MW.

In the beginning of the years 1940s, with the industrial development, it was already realized the tendency of electric energy shortage and the Brazilian Government started to create electric companies and to invest in the generation of electric energy (Calabi et al., 1983). "CHESF (Companhia Hidrelétrica do São Francisco)" was created in 1945, and "Eletrobrás (Centrais Elétricas Brasileiras)" in 1954-1962. In the period from 1945 to 1962, it was enrolled a great increase of the installed capacity of electric energy in Brazil (from 1,340 MW to 5,730 MW), basically promoted by the state owned companies. After the creation of Eletrobrás the foreign companies left Brazil and the Government promoted the organization of the electric sector with the aspect that until now possesses (CEMB, 1988). The installed capacity of 5,730 MW in 1962 increased to 49,870 MW in 1989. The State, by means of the companies of the group Eletrobrás and of the state public companies, constituted the main agent of that process of amplification of the activities of electric energy. In the State of São Paulo the existent state public companies now are "CESP (Companhia Energética de São Paulo)", "Eletropaulo (Eleticidade de São Paulo)", and "CPFL (Companhia Paulista de Força e Luz)". The last one, owned by Amforp until 1965, was privatized in November 1997, when it was bought by a joint venture of important Brazilian companies (Votorantim, Bradesco and Camargo Corrêa).

After this introduction, the characteristics of the electricity demand in the State of São Paulo will be discussed. In Table 4 are presented data about the recent evolution of the total consumption of electricity in Brazil and in the State of São Paulo. The class breakdown of electricity consumers in the State of São Paulo, shown in Tables 5 to 7, is clearly the result of the economic characteristics of the region (SEE, 1997a). Around 42.6% of energy sold is directed towards the industrial sector. The industrial development of the

Table 5 - Household Consumption, number of Consumers and Average Consumption of Electrical Energy, Indices (1985=100) and Absolute Values (1995), for the State of São Paulo and Brazil.

Household Consumption	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1995 (TWh)
State of São Paulo	107.9	115.9	121.6	128.8	138.7	148.1	151.0	156.4	163.6	183.1	21.8
Brazil	109.5	117.5	124.1	133.8	147.0	156.4	158.7	164.1	171.2	194.4	63.5
Consumers (1000)											
State of São Paulo	104.4	108.2	112.4	117.2	121.5	126.2	131.8	138.1	143.8	147.7	8.7
Brazil	106.3	111.4	116.4	122.6	127.6	133.0	138.5	145.7	152.4	157.4	32.5
Average Consumption (kWh/house)											
São Paulo	103.4	107.2	108.1	109.9	114.1	117.3	114.6	113.3	113.8	123.9	2502
Brazil	103.0	105.5	106.6	109.1	115.2	117.6	114.6	112.6	112.3	123.5	1954

Source: CPFL.

Table 6 - Commercial Consumption, number of Consumers and Average Consumption of Electricity, Indicators (1985=100) and Absolute Values (1995), for the State of São Paulo and Brazil.

Commercial Consumption	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1995 (TWh)
State of São Paulo	106.6	111.0	116.1	121.7	129.8	135.9	143.8	152.8	161.3	180.3	11.2
Consumers (1000)											
State of São Paulo	105.9	109.4	111.9	117.4	122.4	129.4	134.1	140.5	147.2	152.7	836.5
Average Consumption (MWh)											
State of São Paulo	100.7	101.4	103.8	103.7	106.0	105.0	107.2	108.7	109.6	118.1	13.33

Source: CPFL.

interior of the State of São Paulo led the manufacturing industry to become the largest market segment, even though this activity has recently lost some weight, given the higher dynamism in the demand of other consumption classes. Both the average in the State of São Paulo and in Brazil, industry is responsible for 50% of the consumption of electrical energy.

The accumulated growth along 1986-1995 for the State of São Paulo was 44.9%, and the average for Brazil was 52.5%. Between 1989 and 1995 the expansion of demand was of 24.0% for the country as a whole and in the State of São Paulo the rate was 25.9%.

The evolution of the rates of consumption shows exactly the extraordinary growth in total electricity demand and more specially, in residential and commercial consumption, as well as the energy demands in the public sector (street lighting, traction and supply of water). For a period which covers a deep recession, the growth in industrial demand remains surprising.

The main reason for the increase in consumption per capita is that the increase in average income has expanded the consumption of electrical-electronic goods and domestic appliances. This effect has overridden a reduction of the average number of persons per household. At the same time the figures enclose a small expansion in consumption at the end of 1989 which gained some momentum at the beginning of 1990, with the opening up of trade and with the restocking process of durable and semi-durable goods due to the freeing up of imports.

The expansion of commercial consumption shows a certain sensitivity to changing levels of activity and to the cycles of expansion of consumption. The lowest annual variation of the rate of commercial consumption occurred in 1992. The total commercial consumption in 1995 was 11.2 TWh in the State of São Paulo.

The Table 7 presents the rate of consumption, number of consumers and consumption per capita in the industrial sector. Industrial consumption draws attention in particular with growth of 23.7% between 85-95, especially when one recalls that this was a time of recession where energy demand was stagnating between 1989 and 1992. Including the growth in demand registered in 1996, is obtained an accumulated growth rate higher than 27% between 1985 and 1996,

which is relevant. The figures for industrial demand shows a considerable growth in the number of consumers. These increased 57.9% between 1985 and 1995. After 1993, it is surprising to find levels of growth almost every year. The level of growth corresponds to the influence of new factors in the economy, such as the opening of new small companies and the movement in the direction of new service sectors and the emergence of new suppliers.

The way development went into the interior of São Paulo has given the region an intense dynamism which attenuates the consequences of recessions and which makes possible for the local economy grow to higher levels during the years of recuperation.

5. POSSIBILITIES OF POWER GENERATION

The economic perspectives of State of São Paulo depend on the success of the Brazilian economy. The area's industrial character makes it dependent on conditions in the economy as a whole principally because the target markets of the companies in the area are increasingly in the rest of the country and abroad. Therefore the short and medium term horizon is dependent on the direction taken by the federal government's economic policy. This in turn depends on how the balance of payments is financed and on exchange rate policy. In the short term, the world economy is favorable for Brazil. There is relatively good availability of external finance and an increase in international trade. However, the external accounts are indicating a growing negative trade balance which will require controls over overall demand. But in the short term, growth is expected to continue, though at lower rates and dependent on the political calendar (a reduced growth rate is expected in 1997 and higher rates in 1998 because of the presidential election that year). Inflation is expected to continue falling, leading perhaps to a small readjustment of the exchange rate.

This will continue to be the main point of the stabilization program, and one should not expect any sudden corrections in the exchange rate. In the medium term, the potential for growth is enormous because an expansion of domestic consumption will open up various alternatives for investment. The interior of São Paulo is

Table 7 - Industrial Consumption and number of Consumers of Electricity, Indicators (1985=100) and Absolute Values (1995), for the State of São Paulo and Brazil

Industrial Consumption	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1995 (TWh)
State of São Paulo	114.6	111.4	118.1	123.0	115.0	115.8	114.3	120.5	124.2	123.7	39.6
Brazil	108.5	108.8	115.8	119.8	116.7	120.2	121.6	126.7	130.4	131.8	118.0
Consumers											
State of São Paulo	119.8	127.1	130.6	139.2	143.0	146.7	146.6	148.7	152.0	157.9	140,749

Source: CPFL.

Table 8 - Estimates of Electricity Consumption for the State of São Paulo by Class (1995 - 2007) - Index (1995=100).

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Household	100.0	108.9	114.8	121.1	127.6	134.5	141.8	149.4	157.4	165.9	174.9	184.4	194.4
Industrial	100.0	100.9	103.9	107.0	110.3	113.7	117.2	120.8	124.6	128.4	132.5	136.7	141.0
Commercial	100.0	108.7	115.2	122.0	129.3	136.9	145.1	153.7	162.8	172.5	182.8	193.7	205.2
Others	100.0	104.0	107.8	111.9	115.9	120.0	124.3	128.7	133.3	138.2	143.2	148.3	153.7
Total	100.0	104.5	108.9	113.5	118.3	123.4	128.6	134.1	139.9	146.0	152.4	159.0	166.0

Sources: CESP and CPFL.

likely to show better performance than the Brazilian average because it is the main beneficiary of the decentralization of the economy taking place, which has tended to reduce the weight of productive activity in the metropolis of São Paulo. Table 8 presents the estimates of electricity consumption for the State of São Paulo, between 1995 and 2007. This remains true even if it is considered the negative impact of trade liberalization and the atmosphere of intense competition between companies associated with the new context of the "globalization" of the world economy (SEADE, 1997). In fact, the interior of São Paulo has become extremely competitive as a new industrial location because it has favorable conditions to attract new investment: a good infrastructure and the possibility of planning the logistics of production supply and demand; a qualified labor market and a dynamic managerial class; a good quality of life; proximity to suppliers and to production lines; an enterprise culture; the support of industrial services and support for production.

The institutions which fund research, a good quality urban existence, and even a business environment which takes advantage of the new relationships between companies, employers and employees are all key characteristics of these new locations. These aspects have led many Brazilian analysts to expect a re-agglomeration effect of manufacturing activity around the South and Southeast of the country, especially in the interior of State of São Paulo. Table 9 shows some data about electricity consumption forecasts for CESP, CPFL and Eletropaulo.

The main attraction of the interior of São Paulo is its industry and the proximity to the São Paulo metropolitan region. This has reinforced the way activity was redistributed in the region at the end of the 1980s and the beginning of the 1990s. This process has tended to stimulate the relocation to the interior of the State of São Paulo and to nearby regions of the activities which before had taken place in the metropolitan area. Increases of productive capacity, including new plants, shall provide a further contribution to the continuity of decentralization of activities previously located in the metropolitan area of São Paulo. This situation is revealed by any list of announced investments for the State of São Paulo.

The increases of productive capacity and of manufacturing employment will be better effected in the interior of the state, particularly in the medium-sized municipalities situated along the main highways and possessing good infrastructure conditions, specially in the region near from Campinas. The largest potential for growth is shifting from large cities and metropolitan areas, towards smaller municipalities located next to areas already industrialized. There are plans by private industry and by the government to expand the available infrastructure of the interior of the State of São Paulo. Three programs may have a big impact: the privatization of the road and railway network, the continuation of construction of the Tietê-Paraná Waterway and the installation of the Brazil-Bolivia gas

pipeline by Petrobrás, which links Bolivian gas reserves to the Southeast of Brazil going through the interior of State of São Paulo.

The gas pipeline construction will improve utilities potential. It will reinforce the structural conditions of the State of São Paulo to attract new investments. The availability of gas for thermal generation of electricity will open up new alternatives for the utilities and industries, essential to deal with the difference between the growth of demand and the potential of the electrical sector.

There are programs already in operation for the joint generation of electricity involving the sugar-alcohol industry (Walter, 1994). Utilities commercialize surplus energy via medium-term purchasing contracts. The potential for cogeneration is estimated around 200 MW of surplus power for commercialization in some years.

The scenario for the State of São Paulo indicates an accelerated growth in demand. This is the premise assumed by the market research done by companies in the area, presented in Table 8. This gives an estimate of consumption between 1997 and 2007 and the levels observed in 1995 and 1996.

These estimates show both a total increase in the demand for electric energy in the industrial sector of 66% between 1995 and 2007 and also higher levels of growth in domestic and commercial consumption - 94.4% and 105.2% - for the same period.

The projections for the State of São Paulo are based on average numbers in population growth of 1.5 per year between 1996 and 2001 and of 1.3% per year between 2002 and 2007. Estimates for the same period for Brazil show levels of 1.2% and 1.1% per year in the same periods (SEADE, 1997). The lower population growth rate for Brazil is the result of a fall in fertility over the last twenty years. The regional differences are explained by migratory flows. With a real increase in incomes, domestic demand grows faster than the number of homes.

Commercial consumption should increase at rates close to the ones of the household demand, because it is closely related to the increase in the population and the evolution of average family income. The creation of big commercial chains and large-scale establishments (shopping-centers) leads to an increase in consumption.

Certainly the industries which serve the domestic market will perform better if economic stability is consolidated. This would be the result of more income from exports and the increase in the standards of domestic consumption, with the incorporation of new consumers. The investment plans show that the largest estimates are in durable goods, mainly in the automobile industry and in electrical and electronic goods - specially domestic appliances. There are significant expansion plans in the food and beverages industry, and on a lesser scale in the chemical industry. For exporters, growth is restricted to pulp and paper as well as to some agro-industrial complexes. These estimates of production growth indicate average rates for GDP of around 4% per year until 2001 and of 5% between 2002 and 2007 (SEADE, 1997). The elasticity of energy demand in relation to income will lead to a higher rate in demand for electrical energy as occurred in

Table 9 - Electricity consumption forecast for CESP, CPFL and Eletropaulo (TWh).

	1996	2001	2006	Annual Average Increase (% per year)
CESP	9.334	12.207	15.173	5.0
CPFL	16.658	21.465	28.766	5.6
Eletropaulo	55.082	66.244	79.818	3.8
Total	81.074	99.916	123.757	4.3

Source: Eletrobrás.

the last ten or twenty years. In relation to the other types of energy demand, growth would be caused by the increase in income per capita and of a higher rate of population growth, that tend to increase domestic, commercial and public service demand.

The plans of Eletrobrás for the period 1996/2007 consider a need for increasing the installed power, in Brazil, from 57.564 GW in 1996, to 90.21 GW in 2006. On the other hand, the growth of the electricity consumption for the most important utilities in State of São Paulo can be observed in Table 9, indicating an increase forecast of 52,6% for the period.

The Table 10 presents the installed capacity (thermal and hydraulics) of those three companies, as well as the installed total capacity in Brazil. The State of São Paulo has been importing from another Brazilian states a significant portion of the electricity that it consumes. The participation of the generation of thermal origin is still very small in Brazil, and in the State of São Paulo it is a little larger, but it is also still quite reduced. The thermal participation in the installed capacity, in terms of Brazil, may develop from 8.7% in 1997 to 16.8% in 2006.

Most of the great Brazilian hydroelectric plants are located in the Southeastern and Southern regions of the country. The smallest rain intensity occurs during the winter (June, July and August) and the highest rain indexes occur in the summer (December, January and February). The operation of the electric system is strongly conditioned by that rain regime, which affects in an intense way the level of the water reservoirs. The construction of thermal plants in that area would allow the optimization of the use of those hydraulic resources, increasing the factor of utilization of the hydraulic plants and of the electric system as a whole.

Table 11- Industrial Economic Demand of Natural Gas for the State of São Paulo (1992 and 2000).

Replaceable Fuel	Oil Products (%)	Coal (%)	Biomass (%)	Electricity (%)	Gases (%)	Total (MMCMD)
1992	65	19	9	7	0.1	8.6
2000	59	26	7	8	0.1	12.7

Final Use	Boilers (%)	Ovens (%)	Heaters (%)	Dryers (%)	Others (%)	Total (MMCMD)
1992	55	13	3	4	25	8.6
2000	54	12	4	3	27	12.7

Industrial Sector	Paper and Cellulose (%)	Chemical and Petrochemical (%)	Transport Equipment (%)	Ceramic (%)	Glass (%)	Textiles (%)	Victuals & Beverages (%)	Others (%)	Total (MMCMD)
1992	24	16	12	8	9	6	8	17	8.6
2000	22	19	12	10	8	7	7	15	12.7

Source: ABG.

Table 10 - Installed power capacity for CESP, CPFL and Eletropaulo, and for Brazil, in 1996 (MW).

	Hydro	Termo	Total
CESP	10,109	0.67	10,110
CPFL	115	36	151
Eletropaulo	927	470	
Brazil (Interconnected System)	52,160	3,724	1,397

Source: Eletrobrás.

6. NATURAL GAS FROM BOLIVIA

In the Plan 1997/2006 of Eletrobrás (1996) it is scheduled the construction of four thermal power plants in the State of São Paulo (SP) fed by the coming natural gas of Bolivia, with a total power of 1800 MW (UTE GÁS BOL I, II, III, IV) at an average capacity factor of 88,2%. In the State of Southern Mato Grosso (MS), through which it will also pass the gas from Bolivia, are foreseen three thermal power plants using natural gas as fuel, with a total power of 450 MW (UTE Campo Grande I of 300 MW, and UTE Corumbá I and II, of 75 MW each one). In the State of Mato Grosso (MT) are foreseen, also using the natural gas of the GÁSBOL pipeline two thermal power plants, with a total power of 450 MW (UTE Cuiabá I of 110 MW and UTE Cuiabá II of 340 MW).

In the State of São Paulo, and near its limits, are also scheduled several hydraulic power plants, with an installed capacity close to 4,000 MW, with an average capacity factor near 60%.

In the plans of Eletrobrás (1996) the natural gas power plants had its unitary costs of installation estimated in 1,140 US\$/kW, (the investment in the pipeline of 390 US\$/kW is included in that value) and the cost of operation of 19.8 US\$/MWh. The operation costs and maintenance were computed in 2 US\$/MWh (variable) and 8 US\$/kYear (fixed).

According to the Brazilian government's studies mentioned by Suzuki et al. (1997), the increase of the natural gas in Brazilian energetic matrix is expected to increase from 2.5% in 1994, to 10.0% in 2000 and to 12% in 2010. Recent evaluations (Cozza, 1997) assume that 95% of the natural gas coming from Bolivia will be destined to power plants and to industries. There are in study 11 projects of private power plants, whose investments surpasses US\$ 3 billion, with a total power of 1,285 MW in a first phase and more 2,130 MW in a

second phase, amounting 3,415 MW, all based on the Bolivian gas. Petrobrás intends, by means of partnerships with other companies, to construct other 10 natural gas fired power plants at their oil refineries in eight Brazilian states. There are also projects for more two gas fired plants in Brasília and Goiânia using the Bolivian gas. The initial capacity of the pipeline Bolivia-Brazil, of 3150 km of extension, will be of 8 million of cubic meters per day (MMCMD) of natural gas starting from the end of 1998, and it will have capacity to transport up to 30 million of cubic meters per day of natural gas.

The pipeline from Bolivia will cost US\$ 2 billions. The Brazilian part of the pipeline will have 2,590 km of extension, and the Bolivian part extension will be 560 km.

Comgás distributes now in the State of São Paulo 3.8 MMCMD, and in 1999 that value should pass to 5.2 MMCMD. In the areas where Comgás already possesses nets of gas distribution, the demand of natural gas is estimated in 9.6 MMCMD, while in the area where gas networks will be installed the consumption potential is 5.45 MMCMD of natural gas (ABG, 1997). The potential for fuels substitution, using natural gas is presented in Table 11. There are also studies about the potential utilization of biomass and other alternative resources for power generation (Trindade, 1997).

7. CONCLUSION

São Paulo is the Brazilian state with the largest economic production, the largest population and the largest industrial park in the country. A great part of the industry from São Paulo concentrates in the metropolitan area of São Paulo, but in the interior, several cities are becoming important in many industrial sectors. The State of São Paulo, in 1995, consumed 79.2 TWh of electricity, with the consumption of the industrial sector equal to 39.6 TWh. In that same year Brazil produced a total of 249.9 TWh. By analyzing the evolution tendencies of energy consumption in São Paulo in the last years is possible to identify important aspects of the energetic development of this State, particularly in relation to the perspectives of natural gas utilization in gas turbines for power generation.

If all the Bolivian natural gas to be supplied by Gásbol would be used for the generation of electric energy in combined cycle power plants, there would be the initial possibility of installing about 1,700 MW, generating about 13 TWh per year. If all the future capacity of the pipeline would be used for the generation of electric energy the installed total capacity could be 6,300 MW, generating near 49 TWh per year.

Eletrobrás is planning the installation of 2,700 MW based on Gásbol natural gas until 2007. This figure would represent about 13 MMCMD of natural gas (43.3 % of Gásbol total capacity). Industries want to use at least 12 MMCMD to substitute other fuels, which represents 40 % of Gásbol total capacity. This situation could make possible to use 5 MMCMD (16.7 of Gásbol capacity) in other applications, like domestic uses and transportation. The additional electrical energy demand for the State of São Paulo needed between 1997 and 2007 is around 47.3 TWh. This figure would correspond to a installed power based only on natural gas of about 6,100 MW (corresponding to 29 MMCMD of natural gas, or 96.7% of Gásbol capacity).

The figures estimated by Eletrobrás seem feasible, and, if the necessary funding is provided, it could led to a minimum installed capacity based on Gásbol in São Paulo State of about 1800 MW (corresponding to 13.9 TWh), with the remaining energy (33.2 TWh) provided by hydraulic plants and industrial cogeneration by 2007.

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