JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

STATE SECRETARIAT OF PLANNING AND GENERAL COORDINATION,
PARANÁ STATE, THE FEDERATIVE REPUBLIC OF BRAZIL

THE MASTER PLAN STUDY ON
THE UTILIZATION OF WATER RESOURCES IN PARANÁ STATE
IN
THE FEDERATIVE REPUBLIC OF BRAZIL

FINAL REPORT

SECTORAL REPORT VOLUME F
HYDROELECTRIC POWER GENERATION

December, 1995

Yachiyo Engineering Co., Ltd.
Tokyo, Japan

and

Nippon Koei Co., Ltd.
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Cost Estimate is Based
on The Price Level of August, 1994,
According to The Following Exchange Rate.

US$ 1.00 = ¥ 98.87
(as of August, 1994)

COMPOSITION OF FINAL REPORT

1. EXECUTIVE SUMMARY

2. MAIN REPORT
   - I. Strategy for Paraná State
   - II. Master Plan for Iguaçu River Basin
   - III. Master Plan for Tibagi River Basin

3. SECTORAL REPORT
   - A. Socio-economy
   - B. Meteorology, Hydrology and Surface Water Resources
   - C. Hydrogeology and Groundwater Resources
   - D. Domestic and Industrial Water
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   - G. Water Utilization Plan
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THE MASTER PLAN STUDY ON THE UTILIZATION OF WATER RESOURCES IN PARANÁ STATE IN THE FEDERATIVE REPUBLIC OF BRAZIL

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CHAPTER 1 EXISTING POWER SUPPLY SYSTEM

1.1 Whole Brazil

Power system in Brazil is composed of four major regional systems; north, northeast, southeast and south systems as shown in Figure-1, and other several small isolated systems in the north regions. The regional systems are presently interconnected between the north and northeast systems and between the southeast and south systems. World-largest hydropower station on the Parana river; Itaipu, which is owned jointly by Brazil and Paraguay, is connected to the south/southeast system.

DNAEE, which belongs to the Ministry of Mines and Energy (MME), is a competent authority on power sector in Brazil and is responsible for framing national electric power policy. Eletrobras, which is a partly government-owned corporation under jurisdiction of MME, is responsible for implementing the national electric power policy. Eletrobras operates the power systems in Brazil via four regional subsidiary companies; Eletronrte for the north system, Chesf for the northeast system, Furnas for southeast system and Eletrosul for the south system. These companies operate major power plants and trunk transmission lines in the respective regions. Major trunk transmission links are indicated on Figure-1.

In addition to the regional power companies, most of states have their own electric power companies to distribute electricity in respective states. Those state companies also have the right to develop and operate generating plants mainly for their own consumption. Further to those federal and state power companies, there are many small power companies for local power supply and other industrial companies which possess generation plant for their own use.

Since major load centers such as Sao Paulo and Rio de Janeiro are located in the southeast region, more than 75 % of electricity in Brazil are generated and consumed in the interconnected south/southeast system. In addition, most of electric power generated at the Itaipu power station is transmitted directly to Sao Paulo area. Total generating capacity and energy consumption in Brazil in 1992 are, according to the 10-Year Plan 1994-2003 (Ref.1), 51.32 GW and 224 TWh, respectively as shown below.

Interconnected System	Installed Capacity (GW) Hydro	Thermal	Total	Energy Consumption (TWh) *3
North/Northeast System *1	11.77	1.23	13.00	47.5
South/Southeast System	35.21*2	3.11	38.32	176.5
Total	46.98	4.34	51.32	224.0
	(91.5%)	(8.5%)	(100%)	

*1: including isolated systems
*2: including 50 % of the 12.6GW Itaipu capacity
*3: 10-year plan values plus 5% to account for the self-producers

As seen in the above table, share of hydropower in Brazil reaches 91.5 % in the installed capacity. Share of energy production by hydro power would be more than 97 % of Brazil's total electric energy produced in 1992.

1.2 State of Paraná

As shown on Figure-1, power system in the state of Parana belongs to the South System which is under control of Eletrosul and covers four states; Parana, Santa Catarina, Rio Grande do Sul and Mato Grosso do Sul. The south system is interconnected with the adjoining Southeast System which covers the five states and one federal district such as Sao Paulo, Rio de Janeiro and Brasilia.

Power supply/distribution in the Parana state is made mainly by COPEL (Companhia Paranaense de Energia); state-owned power company of the state. In addition, some small companies handle power distribution for local areas and also some industrial companies generate power for use by themselves.

On the western border of the state formed by the Parana river, Itaipu hydropower station (12.6 GW) is under operation from 1985 by the Brazil/Paraguay binational company. On the northern border of the state formed by the Paranapanema river, four hydropower plants of CESP (Sao Paulo state's power company) are in service. Power generation within the territory of the Parana state excepting on the state border rivers is made mainly by the two power companies; COPEL and Eletrosul.

Evolution of generation capacity and energy production/utilization in the state in the past 11 years (1983-93) is shown in Tables-1 and 2. Total installed capacity of generating plants in the Parana state (except the border rivers) and their energy production in 1993, according to COPEL's year book 1993 (ref.2), are 5,958 MW and 23,738 GWh, respectively as shown below.

Electric Sources in Parana State (except border rivers) 1993

Producers	Installed Capacity (MW)			Energy Production (GWh)		
	Hydro	Thermal	Total	Hydro	Thermal	Total
COPEL	3,319	20	3,339	11,029	36	11,065
Eletrosul	2,382	0	2,382	11,689	0	11,689
Self-producers & others	72	166	238	438	543	981
Total	5,773	187	5,959	23,156	579	23,735
	(96.9%)	(3.1%)	(100%)	(97.6%)	(2.4%)	(100%)

As seen in this table, hydropower shares about 97 % of total power generation in the Parana state in both generation capacity and energy.

On the other hand, electric energy consumed in the Parana state in 1993 was only 13,387 GWh as seen in Table-2. This corresponds to 56 % of total energy production in the state. The remaining surplus, 44 % of energy generated, was supplied to neighboring states through the Eletrosul's transmission network.

The Parana state is broadly divided into 5 river basins; i.e., 4 basins of Iguacu, Piquiri, Ivai and Tibagi rivers which are primary or secondary tributaries of the Parana river and another basin composed of Litoranea coastal rivers. At present, major source of electric power in the Parana state is the Iguacu river. In view of the generation capacity in 1993, the Iguacu river has 4 power stations with an aggregate capacity of 5,318 MW and it shares 89 % of the total capacity in the state.

Major hydropower stations (> 5 MW) in service in 1993 in the state are listed in Table-3 and their locations are shown in Figure-2. Network of major transmission lines and substations is shown in Figure-3.

CHAPTER 2 POWER DEMAND PROJECTION

2.1 Official Demand Forecast

In Brazil, official forecast of future growth of electric power demand as well as strategic planning of national power supply expansion is worked out by GCPS (Coordination Group of Planning of Electric System) formed under Eletrobras. GCPS elaborates two forecasts for different time ranges; short term (10 years) and long/medium term (20 to 30 years). The short term forecast is worked out every year for a succeeding 10 years range and the long term forecast is renewed at an interval of about 5 years.

The latest short term forecast is given in "10-Year Expansion Plan 1994-2003" (herein referred to as the 10-year plan) issued in December 1993. The latest formal long term plan is "Plano 2010" which was issued in 1987 for the years up to 2010. However, a next new plan "Plano 2015" is presently under preparation by GCPS and likely to be formalized in 1994 or 1995. Fundamental data for the new plan is presented in a COPEL's seminar document prepared in July 1993. JICA's forecast refers to those GCPS's data; the 10-year plan and the Plano 2015 seminar document.

According to the 10-year plan, population of Brazil increased to 1.6 times for the period from 1970 to 1992 at an average annual rate of 2.1 %. In the same period, the gross domestic product (GDP) and electric energy consumption increased at an average rate of 4.2 % and 8.4 %, respectively. As for the future growth, the 10-year plan envisions that GDP increases at an annual rate of 4.4 % for the period of 1993-1998 and at a 5.0 % annual rate for the period of 1998-2003, i.e. at the 10-year average rate of 4.7 %. This average rate is close to the JICA team's estimate (5 %) of the GDP growth.

On the other hand, the Plano 2015 being finalized by Eletrobras/GCPS envisions four different economic growth scenarios for the period from 1990 to 2015. Annual growth rate of GDP estimated in the Plano 2015 for each scenario is as follows:

	Annual growth rate of GDP (%)				
Scenario	1990-95	1995-00	2000-05	2005-15	1990-2015
I	1.6	2.0	5.0	4.0	3.3
II	2.0	5.0	5.0	4.0	4.0
III	3.8	6.0	6.0	5.0	5.2
IV	3.8	7.0	6.0	6.0	5.8

The Scenario II in the Plano 2015 envisions moderate growth of national economy and, as far as the period up to 2003 concerned, it is almost consistent to the economic growth envisaged in the 10-year plan. This scenario after 1995 in the Plano-2015 is also not so widely different from the JICA team's projection of national economy. Those economic growth scenarios in the 10-year plan and Plano-2015 are indicated in Figure-4 along with the JICA team's estimation.

2.2 Assumed Long Term Forecast

In respect of power demand growth in Brazil, the JICA team considers that estimations in the 10-year plan for the near future and the scenario II for the remote future give most realistic figures. Accordingly, this JICA team's power demand study refers to the demand projections in the 10-year plan for the period up to 2003 and in the scenario II of the Plano 2015 for the period from 2005 to 2015. For the demand growth between 2003 and 2005, it is estimated on the assumption that the demand increases linearly from the value of 2003 in the 10-year plan to the value of 2005 in the Plano 2015.

As the power system of the Parana state is interconnected to the south/southeast regional network, amount of electric energy to be produced in the Parana state depends not only on the demand in the state but also on the whole demand of the interconnected system. In the 10-year plan and the Plano-2015, energy demands are projected region by region applying various increasing rates different by regions. The demand increasing rates averaged for Brazil and for the regions covered by the south/southeast system are as follows.

	Annual increase rate of energy demand (%)				
	1993-98	1998-03	2003-05	2005-10	2010-15
South/Southeast System	4.0	4.6	7.4	3.5	3.2
Whole Brazil	4.3	5.1	8.7	4.0	3.8

Yearly electric energy demands projected on the basis of the above increasing rates are shown in Table-4 and the demand growth curves for Brazil and the south/southeast system are shown in Figure-5. Actual energy consumption in 1992 and projected demands in 2005 and 2015 are summarized below:

	Energy Demand (TWh)		
	Actual	Projected	
	1992	2005	2015
South/southeast system	176.5	319.0	444.3
Whole Brazil	224.0	430.6	631.3

On the other hand, in the GCPS's data, estimation of peak power demand growth is not clearly indicated. Its reason would be that majority of power sources in Brazil is hydropower and most of major hydropower stations have large reservoirs suitable for peaking operation. Installed capacities of those stations are determined at sufficiently high level taking into account of extreme draught years and regional variation in availability of river water.

Load factors of Brazil's power system estimated in Plano-2015 were 0.69 for 1990 and 0.75 for the years after 2000. In this JICA team's study, peak power demands are estimated applying the load factors of 0.7 for 1992 and 0.75 for 2005 and 2015. The result is tabulated below.

	Peak Power Demand (GW)		
	Estimated	Projected	
	1992	2005	2015
South/southeast system	28.8	48.6	67.6
Whole Brazil	36.6	65.5	96.1

CHAPTER 3 HYDROPOWER DEVELOPMENT EXPANSION PROGRAM

3.1 Whole Brazil

National plan on power supply expansion including generation expansion and transmission expansion is studied by Eletrobras/GCPS to meet the future electricity demand growth. The results are presented in the 10-year plan and the long term national plan for electric energy. According to the latest plans in the 10-year plan (1994-2003) and the Plano-2015 (Scenario II), expansion of future generation capacity envisioned by GCPS is as shown in Table-6. The total generation capacities at present and envisioned for 2005 and 2015 are as follows:

	Generation Capacity (GW)			Firm Energy (TWh)		
	Actual	Projected		Estimated		
	1992	2005	2015	1992	2005	2015
South/Southeast System	38.32	71.50	80.40	191	354	402
Whole Brazil	51.32	94.80	140.10	257	478	703

The firm energy shown in this table is the energy which can be supplied firmly by whole of generation plants including present ones. These figures were estimated by the JICA team from the envisioned generation capacity applying the capacity factor of 0.57 which is the factor of present system. Yearly energy production capacities estimated similarly from the yearly generation capacities listed in Table-6 are indicated in Figure-6 along with the projected energy demands. As seen in this Figure, the energy sources in the south/southeast system, particularly hydropower source, become short at the year around 2010. Eletrobras/GCPS envisions that northern and southern power systems of Brazil will be connected to each other at around 2010 and a part of electricity produced in the north will be transmitted to the south thereafter.

3.2 Paraná State

As for the Parana state, the following four new hydropower plants are planned to be put into service up to 2004 in the 10-year plan.

Power Station	Installed Capacity	River	Start-up Year
Jordao Diversion	6.5MW	Iguacu	Mar. 1996
Salto Caxias	1,240 MW	Iguacu	Dec. 1998
Jataizinho	156 MW	Tibagi	Sept. 2002
Cebolao	156 MW	Tibagi	Sept. 2003
Total	1,559 MW		

Other than these power stations, the Parana state has many candidates of hydropower projects on the rivers in the state. Table-6 shows 42 inventoried hydropower stations. Location of those power stations are indicated on map in Figure-2. Those candidate projects are located on the rivers of Iguacu and its tributaries, Tibagi, Ivai, Piquiri, Paranapanema and Parana as well as on the rivers in coastal basin. Out of 42, only 13 plants are planned to be commissioned up to 2015. Total hydropower generation capacity of the 13 plants is 8,868 MW as summarized below:

Hydropower Generation Capacity in Parana State

	River	Total Installed Capacity (MW)	
Existing (1993)			5,773
Up to 2005	Jordao	6.5	
	Iguacu	1,240	
	Tibagi	312	
	Total	1,559	
	Accumulated		7,332
Up to 2015	Iguacu, Jordao	154	
	Tibagi	784	
	Ivai	598	
	Total	1,536	
	Accumulated		8,868

CHAPTER 4 WATER DEMAND PROJECTION FOR HYDROPOWER IN PARANÁ STATE

4.1 Operation Method

Any hydropower plant connected to the network of the interconnected power system is operated so as to meet the system's total load along with the other plants in the system. The operation of one plant is basically dependent on availability of natural river flow at the plant. However, the south/southeast system network covers very wide area which contains several hydrologically different regions. Even if power deficit occurs in a region due to temporary shortage of river water in producing required energy, the deficit is probably recovered by power supply from the other regions where water is still abundant. So, the daily or monthly water demand for each plant varies with availability of water in entire regions in the system and cannot be calculated only from river flow in the basin where the plant is located. Accordingly, water demand for hydropower plant is defined here as the rate of discharge required for generating the firm energy designated for the plant.

4.2 Characteristics of Hydropower Water Demand

Approximate water demand of each plant for continuous generation of power equivalent to average hourly firm energy which is given by dividing the value of the firm energy (GWh) by 8760 hours is calculated as shown in Table - 7.

On the other hand, the DNAEE's regulation stipulates the minimum water discharge to be released downstream from the power station, i.e. 80 % of monthly average minimum discharge in the historical series of natural discharge (see Annex A). Any hydropower plant is controlled so as to follow this regulation.

The water demand for hydropower plants has different characteristics to the other water demands for such as domestic water, industrial water and agricultural water. The water used for hydropower plants only passes through water turbine for generation and is not consumed. Therefore, the water demand for hydropower plants does not affect downstream water consumption significantly.

CHAPTER 5 CONSTRUCTION COST OF HYDROPOWER STATIONS IN PARANÁ STATE

As stated in the Section 3, there are 42 candidate hydropower plants in the Parana state. According to data presented by COPEL, construction costs of those plants are as shown in Table - 8. The cost in the COPEL's data expressed in Brazilian currency was converted to US$ using a conversion rate table (ref 3) given by COPEL.

CHAPTER 6 FEATURES OF HYDROPOWER STATIONS OF MAJOR RIVERS IN PARANÁ STATE

Further detailed features of the hydropower stations in Iguaçu, Chopim, Jordao, Ivai, Piquiri and Tibagi rivers are presented in Table-9 and Figures-7 to 12.

Literature Cited

Ref.1 Eletrobras/GCPS, (Dec. 1993), "Plano Decenal de Expansao 1994-2003"

Ref.2 COPEL, (1993), "Informe Estatistico Anual - 1993"

Ref.3 COPEL, (1993), "Taxas de Conversao do Dolar Americano em Unidade Monetaria National"

Ref.4 Eletrobras/COPEL, (Jul. 1993), "Seminario Regional, Plano National de Energia Eletrica 1993/2015, PLANO 2015"

TABLES

Table - 1 Evolution of Peak Power Generation Capacity in Parana State 1983-93

Unit: MW

Description	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Hydro Power	**4,503.0**	**4,502.4**	**4,502.3**	**4,503.4**	**4,503.1**	**4,502.9**	**4,506.9**	**4,506.9**	**4,506.9**	**5,137.7**	**5,771.3**
Concessionares	4,438.9	4,439.0	4,439.8	4,439.8	4,439.8	4,439.6	4,439.6	4,439.6	4,439.6	5,069.6	5,699.2
COPEL	2,056.3	2,056.4	2,057.1	2,057.1	2,057.1	2,057.0	2,057.0	2,057.0	2,057.0	2,687.0	3,316.6
ELETROSUL	2,382.0	2,382.0	2,382.0	2,382.0	2,382.0	2,382.0	2,382.0	2,382.0	2,382.0	2,382.0	2,382.0
FORCEL	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Self producers	64.1	63.4	62.6	63.7	63.3	63.3	67.3	67.3	67.3	68.1	72.1
Thermal Power (including Diesel)	**155.9**	**155.3**	**155.9**	**153.5**	**153.1**	**162.6**	**169.7**	**174.5**	**175.0**	**178.6**	**186.9**
Concessionare											
COPEL	30.0	30.0	30.0	20.0	20.0	20.5	20.5	20.5	20.5	20.5	20.5
Self producers	125.9	125.3	125.9	133.5	133.1	142.1	149.2	154.0	154.5	158.1	166.4
Total	4,658.9	4,657.7	4,658.2	4,656.9	4,656.2	4,665.5	4,676.6	4,681.4	4,681.9	5,316.2	5,958.2

Source: COPEL'sYear Book 1993

Unit: GWh

Description		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Resources		**17,568**	**22,642**	**19,505**	**27,361**	**39,644**	**37,980**	**46,803**	**55,791**	**47,089**	**50,328**	**57,917**
Generation in State		14,604	19,961	13,992	14,440	18,967	15,918	19,824	25,646	14,971	20,531	23,738
COPEL	Total	6,417	7,664	5,042	4,878	7,254	6,244	7,383	10,791	5,489	8,300	11,065
	H	*6,374*	*7,588*	*4,978*	*4,827*	*7,213*	*6,214*	*7,365*	*10,753*	*5,461*	*8,265*	*11,029*
	T	*43*	*76*	*64*	*51*	*41*	*30*	*18*	*38*	*28*	*35*	*36*
ELETROSUL	H	7,551	11,619	8,259	8,753	10,930	8,850	11,571	13,927	8,593	11,312	11,689
FORCEL	H	1	2	2	3	3	3	3	3	3	3	3
Self producers	Total	635	676	689	806	780	821	867	925	886	916	981
	H	*332*	*346*	*326*	*361*	*386*	*392*	*397*	*390*	*371*	*383*	*438*
	T+D	*303*	*330*	*363*	*445*	*394*	*429*	*470*	*535*	*515*	*533*	*543*
Generation on border rivers - 50%		2,874	2,568	5,248	12,827	20,594	21,941	26,900	30,067	32,041	29,719	34,101
Itaipu		0	0	3,164	10,926	17,903	19,254	23,615	26,545	28,759	26,134	29,998
CESP		2,874	2,568	2,084	1,901	2,691	2,687	3,285	3,522	3,282	3,585	4,103
Received from		90	113	265	94	83	121	79	78	77	78	78
CESP (Ribeira)		34	41	46	30	15	8	7	6	1	0	0
CLFSC		36	38	42	43	45	45	46	47	49	52	49
CELESC (Rio Negro)		17	19	20	21	23	24	26	25	26	26	29
ANDE (Paraguai)		3	15	0	0	0	44	0	0	1	0	0
Interconnected system		0	0	157	0	0	0	0	0	0	0	0
Utilization		**17,568**	**22,642**	**19,505**	**27,361**	**39,644**	**37,980**	**46,803**	**55,791**	**47,089**	**50,328**	**57,917**
In Parana		7,095	7,804	8,884	9,073	9,973	10,680	11,084	11,402	12,082	12,467	13,387
Direct distribution		6,539	7,270	8,348	8,577	9,190	9,912	10,310	10,670	11,084	11,584	12,395
Concessionares		5,928	6,622	7,691	7,845	8,465	9,124	9,471	9,767	10,226	10,697	11,432
COPEL		5,739	6,416	7,462	7,603	8,202	8,847	9,179	9,473	9,924	10,377	11,100
COCEL		62	69	83	88	93	97	101	99	97	106	107
CFLO		66	72	76	82	92	100	108	111	117	122	131
CLFSC		36	38	42	43	45	45	46	47	49	52	52
CELESC (Rio Negro)		18	19	20	20	23	24	26	25	26	27	29
FORCEL		7	8	8	9	10	11	11	12	13	13	13
Self producers		611	648	657	732	725	788	839	903	858	887	963
Losses & differences		556	534	536	496	783	768	774	732	998	883	992
In Other State		10,473	14,838	10,621	18,288	29,671	27,300	35,719	44,389	35,007	37,861	44,530
COPEL (P. Union-SC)		17	20	23	23	24	25	25	25	26	26	29
Others		10,456	14,818	10,598	18,265	29,647	27,275	35,694	44,364	34,981	37,835	44,501

Remarks: H=hydro, T=Thermal, D=Diesel

Source: COPEL's Year Book 1993

Table-3 Existing Major Hydropower Stations in Parana Styate

Name of Station	Basin	Installed Capacity (MW)	Owner	Commis-sioned in
G.B.M da Rocha Netto (Foz do Areia)	Iguacu	1,676	COPEL	1980
Segredo	Iguacu	1,260	COPEL	1992
Salto Santiago	Iguacu	1,332	Eletrosul	1980
Salto Osorio	Iguacu	1,050	Eletrosul	1975
J. de Mesquita Filho	Iguacu	50	COPEL	1970
Salto Curucaca	Iguacu	7.4	Sta. Maria	1982
G.P.de Souza	Litoranea	252	COPEL	1970
Guaricana	Litoranea	36	COPEL	1957
Chamine	Litoranea	18	COPEL	1931
Marumbi	Litoranea	9.6	RFFSA	1961
Apucaraninha	Tibagi	9.5	COPEL	1949
Pres. Vargas	Tibagi	22.5	Klabin	1947
Mourao 1	Ivai	7.5	COPEL	1964
Total		5,731		

Source: COPEL/GTIB/SIPOT

Table-4 Energy Demand Projection 1993-2015

Unit: TWh

System	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
South/Southeast System	173.6	176.5	182.0	186.6	194.5	201.8	211.2	220.9	231.4	242.1	253.1	264.7	276.5
North/Northeast System	46.3	47.5	48.5	50.5	52.9	56.1	60.0	63.4	67.3	72.7	77.5	82.1	87.9
Brazil	219.9	224.0	230.5	237.1	247.4	257.9	271.2	284.3	298.7	314.8	330.6	346.8	364.4

System	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
South/Southeast System	297.0	319.0	330.2	341.7	353.6	366.0	378.8	391.1	403.8	416.8	430.4	444.3
North/Northeast System	99.1	111.6	117.6	124.0	130.6	137.7	145.1	152.7	160.6	169.0	177.7	187.0
Brazil	396.1	430.6	447.8	465.7	484.2	503.7	523.9	543.8	564.4	585.8	608.1	631.3

Average Growth Rates (%)

System	93-98	98-03	03-05	05-10	10-15
South/Southeast System	4.0	4.6	7.4	3.5	3.2
North/Northeast System	5.5	6.7	12.7	5.4	5.2
Brazil	4.3	5.1	8.7	4.0	3.8

Remarks: For the years 1991 and 1992, figures shown are actual consumption.

For the years 1991 to 2003, figures shown are based on the GCPS's 10-year plan but self-producers' demand estimated at 5 % of system's demand was added to values indicated in the 10-year plan.

For the years 2005 to 2015, figures shown are based on the COPEL's data for Plano 2015 and include self-producers' demand. Demand in 2004 is interpolated value. For value of 2004, linear growth between 2003 and 2005 was assumed.

Table - 5 Evolution of Generation Capacity 1992-2015

10-Year PLan 1994-2003 Unit : MW

SYSTEM	TYPE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
South/Southeast System (*1)		38,318	39,110	40,661	41,573	41,931	42,767	44,930	49,220	51,840	54,382	56,237	57,934
	H	35,205	35,997	37,548	38,110	38,408	39,214	40,997	43,628	45,898	48,380	50,235	51,522
	T	3,113	3,113	3,113	3,463	3,523	3,553	3,933	5,592	5,942	6,002	6,002	6,412
North/Northeast System (*2)		12,997	13,060	14,167	15,750	16,323	16,541	16,885	16,988	17,131	17,355	18,747	21,050
	H	11,767	11,770	12,816	14,415	14,918	14,912	14,945	14,945	15,084	15,282	16,639	18,921
	T	1,230	1,290	1,351	1,335	1,405	1,629	1,940	2,043	2,047	2,073	2,108	2,129
Brazil		51,315	52,170	54,828	57,323	58,254	59,308	61,815	66,208	68,971	71,737	74,984	78,984
	H	46,972	47,767	50,364	52,525	53,326	54,126	55,942	58,573	60,982	63,662	66,874	70,443
	T	4,343	4,403	4,464	4,798	4,928	5,182	5,873	7,635	7,989	8,075	8,110	8,541

Plano 2015 (Scenario II) Unit : MW

SYSTEM	TYPE	2005	2010	2015
South/Southeast System (*1)		71,500	74,700	80,400
	H	66,000	69,200	74,900
	T	5,500	5,500	5,500
North/Northeast System (*2)		23,300	40,500	59,700
	H	22,300	39,500	58,700
	T	1,000	1,000	1,000
Brazil		94,800	115,200	140,100
	H	88,300	108,700	133,600
	T	6,500	6,500	6,500

Remarks: (*1) including 50 % of Itaipu capacity.
(*2) including isolated systems
H Hydro
T Thermal

Table - 6 List of Inventoried Hydropower Stations in Parana State

No.	Name of Power Station	Basin	River System	Intalled Capacity MW	Firm Energy GWh	Planned Start-up Year
1	Jordao Diversion	Iguacu	Jordao	6.5	526 *	Mar. 96
2	Salto Caxias	Iguacu	Iguacu	1,240	4,853	Dec. 98
3	Jataizinho	Tibagi	Tibagi	156	758	2002
4	Cebolao	Tibagi	Tibagi	156	757	2003
	Total (up to 2005)			1,559	6,894	
5	Sao Jeronimo	Tibagi	Tibagi	284	1,386	2006
6	Maua	Tibagi	Tibagi	388	1,617	2007
7	Telemaco Borba	Tibagi	Tibagi	112	541	2008
8	Agua do Vere	Iguacu	Chopim	96	411	
9	Curucaca	Iguacu	Jordao	52	225	
10	Erveira	Iguacu	Chopim	96	398	
11	Foz do Chopim 2	Iguacu	Chopim	60	252	
12	Fundao	Iguacu	Jordao	154	640	2006~15
13	Jacu	Iguacu	Jordao	122	527	
14	Pinhao	Iguacu	Jordao	42	184	
15	Salto Alema	Iguacu	Chopim	70	281	
16	Salto Chopim	Iguacu	Chopim	98	410	
17	Salto Gr. Chopim	Iguacu	Chopim	52	200	
18	Sao Joao	Iguacu	Chopim	68	265	
19	Sao Luiz	Iguacu	Chopim	42	158	
20	Tagua	Iguacu	Jordao	36	136	
21	Altamira	Piquiri	Piquiri	116	412	
22	Barra Grande	Piquiri	Piquiri	34	140	
23	Bela.V.do Ivai	Ivai	Ivai	96	412	2006~15
24	Ercilandia	Piquiri	Piquiri	102	403	
25	Foz do Alonzo	Ivai	Ivai	138	587	2006~15
26	Foz do Cobre	Piquiri	Piquiri	18	79	
27	Guampara	Piquiri	Piquiri	32	123	
28	Ivatuva	Ivai	Ivai	144	622	2006~15
29	Salto Ariranha	Ivai	Ivai	168	604	
30	Sao Joao do Ivai	Ivai	Ivai	98	420	2006~15
31	Tres Figueiras	Ivai	Ivai	120	526	
32	Ubauna	Ivai	Ivai	122	508	2006~15
33	Volta Grande	Piquiri	Piquiri	34	131	
34	Ourinhos	Paranapanema	Paranapanema	48	201	
35	Santa Branca	Tibagi	Tibagi	67	302	
36	Tibagi	Tibagi	Tibagi	47	222	
37	Nova Aurora	Piquiri	Piquiri	172	639	
38	Rio Bonito	Piquiri	Piquiri	16	53	
39	Salto Apertados	Piquiri	Piquiri	156	604	
40	Itaoca	Ribeira	Ribeira	40	237	
41	Capanema	Iguacu	Iguacu	1,200	3,653	
42	Ilha Grande	Parana	Parana	1,320	9,408	
	Planned Total (2006 to 2015)			1,536	6,733	
	Grand Total (1996 to 2015)			3,095	13,627	

Remarks : * denotes increment of energy in the existing Segredo plant and Jordao small plant.

Table - 7 Water Demand of Existing and Inventoried Hydropower Stations in Parana State (1)

No.	Name of Power Station	Basin	River System	Catchment Area km2	Installed Capacity MW	Firm Energy GWh	Head (reference) m	Water Demand *3 m3/s
E1	G.B.M da Rocha Netto (Foz do Areia)	Iguacu	Iguacu	29,900	1,676	4,929 *1	135	510
E2	Segredo	Iguacu	Iguacu	34,100	1,260	5,296 *1	110	672
E3	Salto Santiago	Iguacu	Iguacu	43,900	1,332	5,557 *1	102	761
E4	Salto Osorio	Iguacu	Iguacu	45,900	1,050	4,822 *1	68	990
E5	J. de Mesquita Filho	Iguacu	Chopim	7,500	50	308	61 *2	71
E6	Salto Curucaca	Iguacu	Jordao	2,250	7.4	32	59 *2	8
E7	G.P.de Souza	Litoranea	Capivari	945	252	945 *1	714	18
E8	Guaricana	Litoranea	Arraial	165	36	119	323 *2	5
E9	Chamine	Litoranea	Sao Joao	243	18	102	309 *2	5
E10	Marumbi	Litoranea	Ipiranga	49	9.6	42	473 *2	1
E11	Apucaraninha	Tibagi	Apucaraninha	580	9.5	59	153 *2	5
E12	Pres. Vargas	Tibagi	Tibagi	14,900	22.5	175	35 *2	70
E13	Mourao 1	Ivai	Mourao	612	7.5	46	68 *2	9
1	Jordao Diversion	Iguacu	Jordao	4,730	6.5	499	72	10 *4
2	Salto Caxias	Iguacu	Iguacu	57,000	1,240	4,853	65	1,043
3	Sao Jeronimo	Tibagi	Tibagi	17,800	284	1,386	85	N.A.
4	Jataizinho	Tibagi	Tibagi	21,200	156	758	39	N.A.
5	Cebolao	Tibagi	Tibagi	20,000	156	757	41	N.A.
6	Maua	Tibagi	Tibagi	15,600	388	1,617	128	N.A.
7	Telemaco Borba	Tibagi	Tibagi	13,400	112	541	49	N.A.
8	Agua do Vere	Iguacu	Chopim	6,700	96	411	39	147
9	Curucaca	Iguacu	Jordao	2,230	52	225	55	57

Notes: Nos. E1 to E13 are existing plants, Nos. 1,2,. . are planned plants. N.A.: Not Available

Table - 7 Water Demand of Existing and Inventoried Hydropower Stations in Parana State (2)

No.	Name of Power Station	Basin	River System	Catchment Area km2	Installed Capacity MW	Firm Energy GWh	Head (reference) m	Water Demand m3/s
10	Erveira	Iguacu	Chopim	7,040	96	398	37	150
11	Foz do Chopim 2	Iguacu	Chopim	7,470	60	252	23	153
12	Fundao	Iguacu	Jordao	4,110	154	640	92	97
13	Jacu	Iguacu	Jordao	4,060	122	527	75	98
14	Pinhao	Iguacu	Jordao	3,530	42	184	30	86
15	Salto Alema	Iguacu	Chopim	2,820	70	281	62	63
16	Salto Chopim	Iguacu	Chopim	6,190	98	410	42	136
17	Salto Gr. Chopim	Iguacu	Chopim	3,300	52	200	38	73
18	Sao Joao	Iguacu	Chopim	2,010	68	265	81	46
19	Sao Luiz	Iguacu	Chopim	1,740	42	158	55	40
20	Tagua	Iguacu	Jordao	2,200	36	136	39	49
21	Altamira	Piquiri	Piquiri	4,000	116	412	90	64
22	Barra Grande	Piquiri	Piquiri	1,650	34	140	69	28
23	Bela.V.do Ivai	Ivai	Ivai	20,000	96	412	21	274
24	Ercilandia	Piquiri	Piquiri	19,500	102	403	19	296
25	Foz do Alonzo	Ivai	Ivai	12,500	138	587	43	191
26	Foz do Cobre	Piquiri	Piquiri	1,900	18	79	33	33
27	Guampara	Piquiri	Piquiri	1,400	32	123	81	21
28	Ivatuva	Ivai	Ivai	23,400	144	622	28	310
29	Salto Ariranha	Ivai	Ivai	8,600	168	604	63	134
30	Sao Joao d. Ivai	Ivai	Ivai	15,000	98	420	27	217
31	Tres Figueiras	Ivai	Ivai	30,600	120	526	19	387
32	Ubauna	Ivai	Ivai	13,000	122	508	36	197

Table - 7 Water Demand of Existing and Inventoried Hydropower Stations in Parana State (3)

No.	Name of Power Station	Basin	River System	Catchment Area km2	Installed Capacity MW	Firm Energy GWh	Head (reference) m	Water Demand m3/s
33	Volta Grande	Piquiri	Piquiri	2,800	34	131	42	44
34	Ourinhos	Paranapanema	Paranapanema	28,000	48	201	13 *2	216
35	Santa Branca	Tibagi	Tibagi	7,310	67	302	48	N.A.
36	Tibagi	Tibagi	Tibagi	8,550	47	222	30	N.A.
37	Nova Aurora	Piquiri	Piquiri	11,500	172	639	49	182
38	Rio Bonito	Piquiri	Piquiri	1,100	16	53	50	15
39	Salto Apertados	Piquiri	Piquiri	17,100	156	604	32	264
40	Itaoca	Ribeira	Ribeira	7,868	40	237	20 *2	165
41	Capanema	Iguacu	Iguacu	62,500	1,200	3,653	43	1,186
42	Ilha Grande	Parana	Parana	802,000	1,320	9,408	17	7,728

Remarks:

*1 : With dependability of 95 % (mean value of the 10-year plan)

*2 : Maximum gross head

*3 : Approximate average water demand to generate the firm energy, which was calculated on assumption that plant efficiency is 0.86 and loss head is 3% of reference head.

*4 : Minimum discharge

N.A. : Not Available

Table - 8 Construction Cost of Inventoried Hydropower Stations in Parana State (1)

No.	Name of Power Station	Basin	Installed Capacity MW	Construction Cost in Original Estimate			Price Conver. Coeff.	Construction Cost Converted to Current Price by JICA (Dec.93)		
				Million US$		Estimated Date		Mill'n US$	US$/kW	* US$/MWh
1	Jordao Diversion	Iguacu	6.5	**	92.3	Dec.92	1.000	92.3	14,200	203.4
2	Salto Caxias	Iguacu	1,240		887.6	Dec.92	1.000	887.6	715.8	19.2
3	Sao Jeronimo	Tibagi	284		268.6	Dec.93	N.A.	281.6	1,025	21.7
4	Jataizinho	Tibagi	156		183.2	Dec.93	N.A.	177.4	1,137	24.9
5	Cebolao	Tibagi	156		180.6	Dec.93	N.A.	174.8	1,120	24.6
6	Maua	Tibagi	388		367.8	Dec. 93	N.A.	385.6	1,054	25.4
7	Telemaco Borba	Tibagi	112		132.1	Dec.93	N.A.	127.9	1,142	25.4
8	Agua do Vere	Iguacu	96		102	Jul.81	1.697	174	1,809	43
9	Curucaca	Iguacu	52		31	Jul.81	1.697	53	1,015	24
10	Erveira	Iguacu	96		117	Jul.81	1.697	198	2,067	50
11	Foz do Chopim 2	Iguacu	60		N.A.			(100)	1,667	40
12	Fundao	Iguacu	154		126	Jul.81	1.697	214	1,393	34
13	Jacu	Iguacu	122		150	Jul.81	1.697	255	2,086	49
14	Pinhao	Iguacu	42		71	Jul.81	1.697	121	2,869	66
15	Salto Alema	Iguacu	70		95	Jul.81	1.697	162	2,313	58
16	Salto Chopim	Iguacu	98		146	Jul.81	1.697	247	2,521	61
17	Salto Gr. Chopim	Iguacu	52		71	Jul.81	1.697	121	2,324	61
18	Sao Joao	Iguacu	68		69	Jul.81	1.697	117	1,724	45
19	Sao Luiz	Iguacu	42		47	Jul.81	1.697	80	1,898	51
20	Tagua	Iguacu	36		84	Jul.81	1.697	143	3,975	106
21	Altamira	Piquiri	116		164	Jul.81	1.697	278	2,400	68
22	Barra Grande	Piquiri	34		77	Jul.81	1.697	131	3,854	94
23	Bela.V.do Ivai	Ivai	96		106	Jul.81	1.697	180	1,875	44
24	Ercilandia	Piquiri	102		135	Jul.81	1.697	229	2,249	57
25	Foz do Alonzo	Ivai	138		132	Jul.81	1.697	224	1,620	38

Table - 8 Construction Cost of Inventoried Hydropower Stations in Parana State (2)

No.	Name of Power Station	Basin	Installed Capacity MW	Construction Cost in Original Estimate: Million US$	Estimated Date	Price Conver. Coeff.	Construction Cost Converted to Current Price by JICA (Dec.93): Mill'n US$	US$/kW	* US$/MWh
26	Foz do Cobre	Piquiri	18	48	Jul.81	1.697	81	4,511	104
27	Guampara	Piquiri	32	75	Jul.81	1.697	127	3,958	104
28	Ivatuva	Ivai	144	135	Jul.81	1.697	229	1,593	37
29	Salto Ariranha	Ivai	168	169	Jul.81	1.697	287	1,710	48
30	Sao Joao do Ivai	Ivai	98	104	Jul.81	1.697	176	1,799	42
31	Tres Figueiras	Ivai	120	201	Jul.81	1.697	340	2,837	65
32	Ubauna	Ivai	122	136	Jul.81	1.697	231	1,894	46
33	Volta Grande	Piquiri	34	74	Jul.81	1.697	126	3,697	97
34	Ourinhos	Paranapanema	48	150	Dec.90	1.154	173	3,602	87
35	Santa Branca	Tibagi	67	103.7	Dec.93	N.A.	103.7	1,574	36.9
36	Tibagi	Tibagi	47	101.5	Dec.93	N.A	101.5	2,159	48.9
37	Nova Aurora	Piquiri	172	236	Jul.81	1.697	400	2,326	63
38	Rio Bonito	Piquiri	16	46	Jul.81	1.697	79	4,917	150
39	Salto Apertados	Piquiri	156	172	Jul.81	1.697	291	1,866	49
40	Itaoca	Ribeira	40	111	Dec.90	1.154	128	3,204	55
41	Capanema	Iguacu	1,200	953	Dec.91	1.210	1,154	961	32
42	Ilha Grande	Parana	1,320	2,378	Dec.91	1.210	2,877	2,180	31
	Total						12,059		

* : Unit cost of firm energy = (Construction cost x CRF)/Annual firm energy
CRF = capital recovery factor = 0.10086 at 10 % discount rate and 50 years life

** : including cost for facility to divert water to existing Segredo reservoir.

N.A.: data not available ( ) : assumed value

Table - 9 Data on Hydropower Projects in Parana State (1/5)

No.	Name of Power Station	Basin	River System	Catchment Area km2	Installed Capacity MW	Plant Disch. (Firm) m3/s	Reservoir Level LWL EL. m	Reservoir Level HWL EL. m	Drawdown m	Reservoir Volume (MCM) LWL MCM	Reservoir Volume (MCM) HWL MCM	Reservoir Volume (MCM) Active MCM	Reservoir Area at HWL km2	Tail Water Level El. m	Minimum Disch. m3/s	Spillway Max. Disch. m3/s
E1	G.B.M da Rocha Netto (Foz do Areia)	Iguacu	Iguacu	29,900	1,676	510	700	742	42	1,974	5,778	3,804	141.9	602.0	79.0	*10,030*
E2	Segredo (complex)	Iguacu	Iguacu	34,100	1,260	736	602	607	5	2,562	2,943	381	80.6	490.0	94.0	*16,000*
E3	Salto Santiago	Iguacu	Iguacu	43,900	1,332	761	480.9	506	25.1	2,662	6,775	4,113	208.3	397.0	115.0	*24,000*
E4	Salto Osorio	Iguacu	Iguacu	45,900	1,050	990	397	397	0	1,124	1,124	0	56.0	324.0	119.0	*28,000*
2	Salto Caxias	Iguacu	Iguacu	57,000	1,240	1,043	325	325	0	3,160	3,160	0	124.0	259.0	140.0	*48,400*
41	Capanema	Iguacu	Iguacu	62,500	1,200	1,186	259	259	0	1,200	1,200	0	87.0	213.2	145.0	*33,300*
	Total				7,758							8,298				
19	Sao Luiz	Iguacu	Chopim	1,740	42	40	750	750	0	48	48	0	4.0	692.0	2.0	*2,350*
18	Sao Joao	Iguacu	Chopim	2,010	68	46	692	692	0	101	101	0	6.6	607.0	2.0	*2,490*
15	Salto Alema	Iguacu	Chopim	2,820	70	63	570	570	0	600	600	0	22.5	506.0	3.0	*2,900*
17	Salto Gr. Chopim	Iguacu	Chopim	3,300	52	73	506	506	0	172	172	0	14.9	468.0	4.0	*3,090*
16	Salto Chopim	Iguacu	Chopim	6,190	98	136	468	468	0	577	577	0	42.6	425.0	7.0	*4,090*
8	Agua do Vere	Iguacu	Chopim	6,700	96	147	425	425	0	168	168	0	14.2	385.0	8.0	*4,140*
10	Erveira	Iguacu	Chopim	7,040	96	150	385	385	0	166	166	0	17.3	348.0	8.0	*4,320*
11	Foz do Chopim 2	Iguacu	Chopim	7,470	60	153	348	348	0	2	2	0	0.5	325.0	8.0	*4,330*
E5	J. de Mesquita Filho	Iguacu	Chopim	7,500	50	71		*348*			2	*1*	*0.5*	*287.5*		*8,370*
	Total				632							1				
20	Tagua	Iguacu	Jordao	2,200	36	49	892	905	13	197	655	458	42.9	866.0	7.0	*1,410*
9	Curucaca	Iguacu	Jordao	2,230	52	57	866	866	0	2	2	0	1.2	810.0	7.0	*1,450*
E6	Salto Curucaca	Iguacu	Jordao	2,250	7.4	8										
14	Pinhao	Iguacu	Jordao	3,530	42	86	810	810	0	49	49	0	10.5	780.0	11.0	*1,849*
13	Jacu	Iguacu	Jordao	4,060	122	98	780	780	0	340	340	0	17.8	701.0	12.0	*1,990*
12	Fundao	Iguacu	Jordao	4,110	154	97	701	701	0	215	215	0	7.3	604.0	12.0	*2,000*
1	Jordao Diversion	Iguacu	Jordao	4,730	6.5	10										
	Total				420							458				

Table - 9 Data on Hydropower Projects in Parana State (2/3)

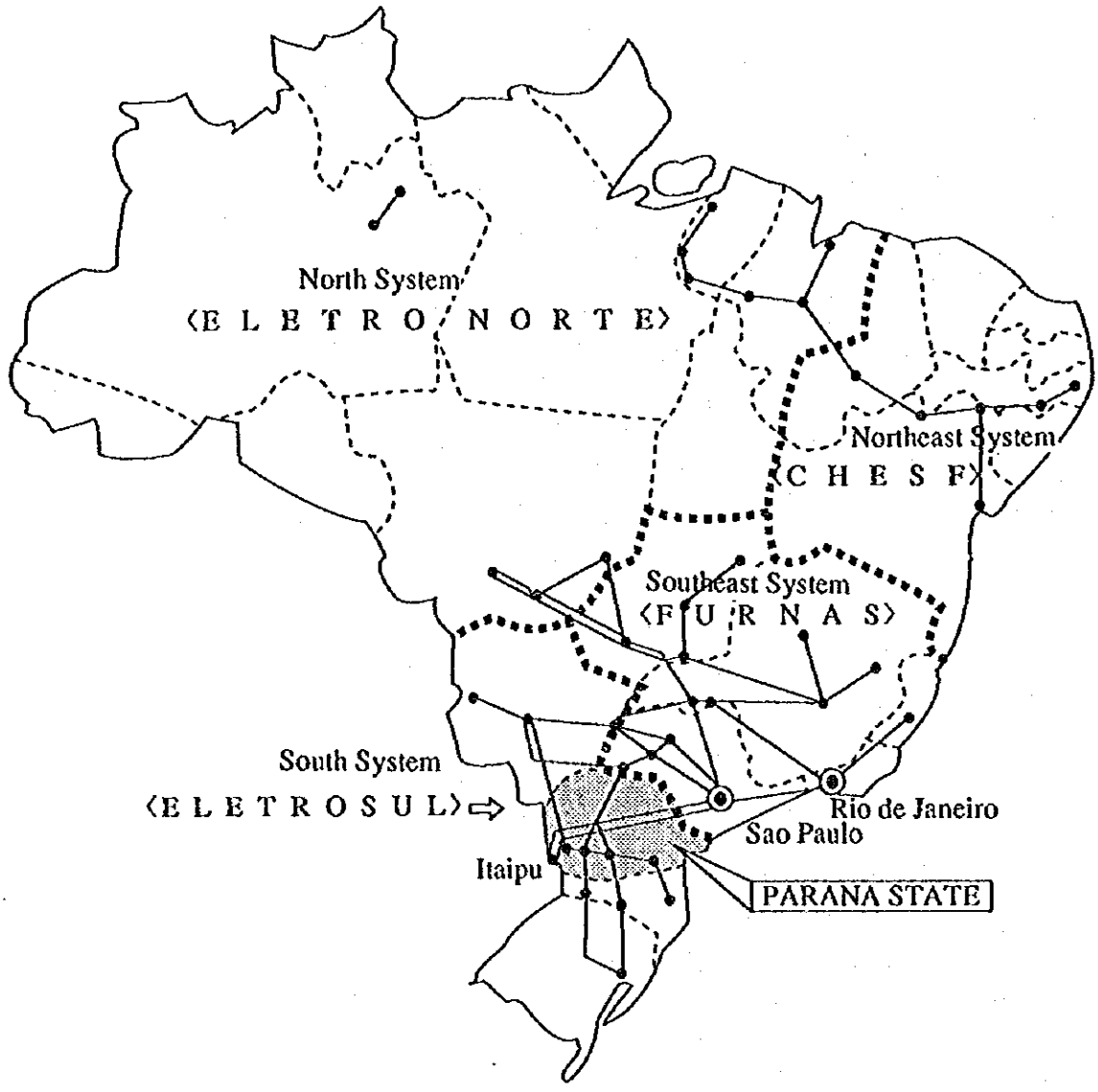
No.	Name of Power Station	Basin	River System	Catchment Area km2	Installed Capacity MW	Plant Disch. (Firm) m3/s	Reservoir Level LWL EL. m	Reservoir Level HWL EL. m	Reservoir Level Drawdown m	Reservoir Volume (MCM) LWL MCM	Reservoir Volume (MCM) HWL MCM	Reservoir Volume (MCM) Active MCM	Reservoir Area at HWL km2	Tail Water Level EL. m	Minimum Disch. m3/s	Spillway Max. Disch. m3/s
E11	Apucaraninha	Tibagi	Apucaraninha	580	9.5	5		*612*		*0.5*	*1.0*	*0.5*	*0.5*	*459.4*		*63*
35	Santa Branca	Tibagi	Tibagi	7,310	67	99	766	770	4	125	224	99	30.1	721.0	9.0	*3,456*
36	Tibagi	Tibagi	Tibagi	8,550	47	115	721	721	0	69	69	0	9.4	691.3	11.0	*4,151*
7	Telemaco Borba	Tibagi	Tibagi	13,400	112	170	690	690	0	233	233	0	16.5	640.0	23.0	*7,180*
E12	Pres. Vargas	Tibagi	Tibagi	14,900	22.5	70		*567*			*0.3*			*534.0*		*3,063*
6	Maua	Tibagi	Tibagi	15,600	388	172	604	640	36	1,014	3,700	2,686	112.9	510.0	30.0	*8,715*
3	Sao Jeronimo	Tibagi	Tibagi	17,800	284	258	510	510	0	1,744	1,744	0	60.2	425.0	36.0	*10,350*
5	Cebolao	Tibagi	Tibagi	20,000	156	274	425	425	0	315	315	0	25.6	383.0	42.0	*12,085*
4	Jataizinho	Tibagi	Tibagi	21,200	156	285	383	383	0	390	390	0	31.7	343.3	45.0	*13,074*
	Total				1,242							2,786				
E13	Mourao 1	Ivai	Mourao	612	7.5	9		*609*			*65*	*57*	*11.3*	*540.6*		*594*
29	Salto Ariranha	Ivai	Ivai	8,600	168	134	459	480	21	1,340	4,790	3,450	236.1	416.0	7.0	*5,300*
25	Foz do Alonzo	Ivai	Ivai	12,500	138	191	416	416	0	472	472	0	43.9	372.0	23.0	*7,190*
32	Ubauna	Ivai	Ivai	13,000	122	197	372	372	0	372	372	0	25.0	335.0	24.0	*7,380*
30	Sao Joao d. Ivai	Ivai	Ivai	15,000	98	217	335	335	0	245	245	0	24.0	308.0	32.0	*8,240*
23	Bela.V.do Ivai	Ivai	Ivai	20,000	96	274	308	308	0	280	280	0	30.0	287.0	45.0	*9,980*
28	Ivaruva	Ivai	Ivai	23,400	144	310	287	287	0	310	310	0	31.9	259.0	50.0	*10,900*
31	Tres Figueiras	Ivai	Ivai	30,600	120	387	259	259	0	720	720	0	119.7	240.0	61.0	*11,900*
	Total				894							3,507				
38	Rio Bonito	Piquiri	Piquiri	1,100	16	15	699	715	16	44	132	88	6.6	664.0	3.0	*1,530*
27	Guampara	Piquiri	Piquiri	1,400	32	21	637	664	27	127	456	329	20.1	581.0	3.0	*1,900*
22	Barra Grande	Piquiri	Piquiri	1,650	34	28	577	581	4	150	196	46	12.7	510.0	4.0	*2,230*
26	Foz do Cobre	Piquiri	Piquiri	1,900	18	33	510	510	0	158	158	0	8.7	476.0	5.0	*2,540*
33	Volta Grande	Piquiri	Piquiri	2,800	34	44	476	476	0	336	336	0	16.1	433.0	7.0	*3,610*
21	Altamira	Piquiri	Piquiri	4,000	116	64	407	433	26	606	2,096	1,490	85.9	340.0	10.0	*4,880*
37	Nova Aurora	Piquiri	Piquiri	11,500	172	182	340	340	0	4,060	4,060	0	186.0	290.0	28.0	*10,300*
39	Salto Apertados	Piquiri	Piquiri	17,100	156	264	290	290	0	760	760	0	77.0	258.0	42.0	*12,200*
24	Ercilandia	Piquiri	Piquiri	19,500	102	296	258	258	0	288	288	0	36.7	239.0	48.0	*12,500*
	Total				680							1,953				

Table - 9 Data on Hydropower Projects in Parana State (3/3)

No.	Name of Power Station	Basin	River System	Catchment Area km2	Installed Capacity MW	Plant Disch. (Firm) m3/s	Reservoir Level LWL EL. m	Reservoir Level HWL EL. m	Reservoir Level Drawdown m	Reservoir Volume (MCM) LWL MCM	Reservoir Volume (MCM) HWL MCM	Reservoir Volume (MCM) Active MCM	Reservoir Area at HWL km2	Tail Water Level El. m	Minimum Disch. m3/s	Spillway Max. Disch. m3/s
E8	Guaricana	Litoranea	Arraial	165	36	5		*707*		2	*7*	*5*	*0.9*	*384.0*		*750*
E7	G.P.de Souza	Litoranea	Capivari	945	252	18	822	845	23	23	179	156	13.1	90.7	7.0	*1,014*
E10	Marumbi	Litoranea	Ipiranga	49	9.6	1		*691.5*						*214.0*		*1,500*
E9	Chamine	Litoranea	Sao Joao	243	18	5		*722.8*		*0.1*	*0.4*	*0.3*	*0.1*	*414.0*		*360*
40	Itaoca	Ribeira	Ribeira	7,868	40	165										
	Total				356							161				
34	Ourinhos	Paranapanema	Paranapanema	28,000	48	216		*398*			*63*		*4.0*	*385.0*		*6,880*
42	Ilha Grande	Parana	Parana	802,000	1,320	7,728	239	239	0	24,300	24,300	0	3,270.0	220.4	2,651.0	*62,700*
	Total				1,368							0				

Sources: Italic figures: Dados de Hidreletricas no Estado do Parana (Sistema IGU), COPEL
Others: Eletrobras's Reservoir Database Printout, COPEL

FIGURES



LEGEND

▪▪▪▪▪▪▪▪▪ Boundary of regional power systems

〈 〉 Regional power company

●——● Existing major trunk transmission lines (138 kV - 750 kV)

Figure - 1 Power Systems in Brazil

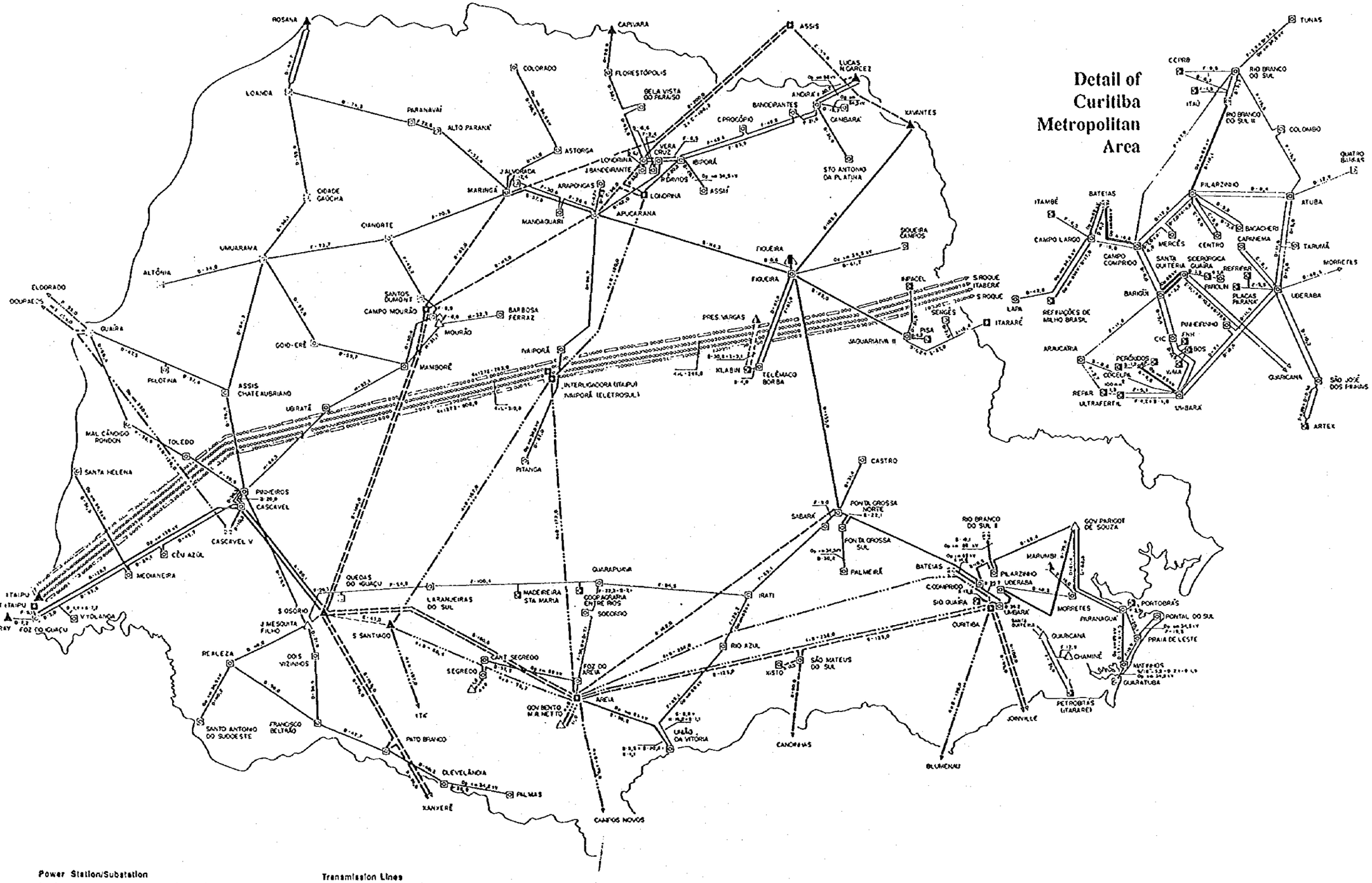
List of Hydropower Stations

No.	Name of Power Station	No.	Name of Power Station	No.	Name of Power Station
E1	G.B.M.da Rocha Netto (Foz do Areia)	* 1	Jordao Diversion	22	Barra Grande
E2	Segredo (complex)	* 2	Salto Caxias	* 23	Bela V.do Ivai
E3	Salto Santiago	* 3	Sao Jeronimo	24	Ercilandia
E4	Salto Osorio	* 4	Jataizinho	* 25	Foz do Alonzo
E5	J. de Mesquita Filho	* 5	Cebolao	26	Foz do Cobre
E6	Salto Curucaca	* 7	Telemaco Borba	27	Guampara
E7	G.P.de Souza	8	Agua do Vere	* 28	Ivaruva
E8	Guaricana	9	Curucaca	29	Salto Arranha
E9	Chamine	10	Ereira	* 30	Sao Joao d. Ivai
E10	Marumbi	11	Foz do Chopim 2	* 31	Ubaina
E11	Apucaraninha	* 12	Fundao	33	Volta Grande
E12	Pres. Vargas	13	Jacu	34	Ourinhos
E13	Mourao 1	14	Pinhao	35	Santa Branca
		15	Salto Alema	36	Tibagi
		16	Salto Chopim	37	Nova Aurora
		17	Salto Gr. Chopim	38	Rio Bonito
		18	Sao Joao	39	Salto Apertados
		19	Sao Luiz	40	Itaoca
		20	Tagus	41	Capanema
		21	Altamira	42	Ilha Grande

▲ Existing * Selected 13 sites
Δ Planned Planned until 2015

Figure- 2 Existing and Inventoried Hydropower Stations in Parana State

Source : COPEL.



Source: Ref.2

Figure-3
Transmission System in Parana State

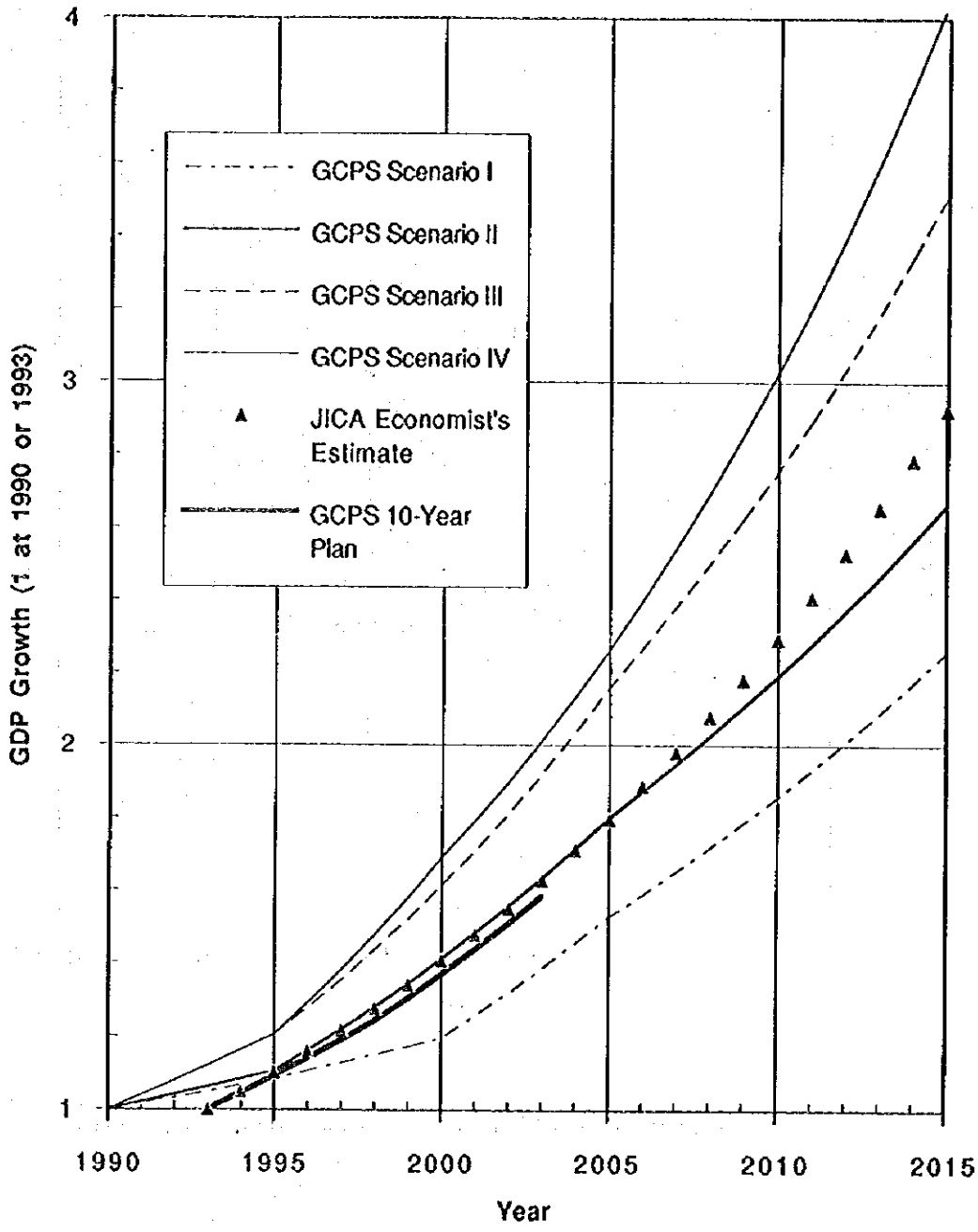
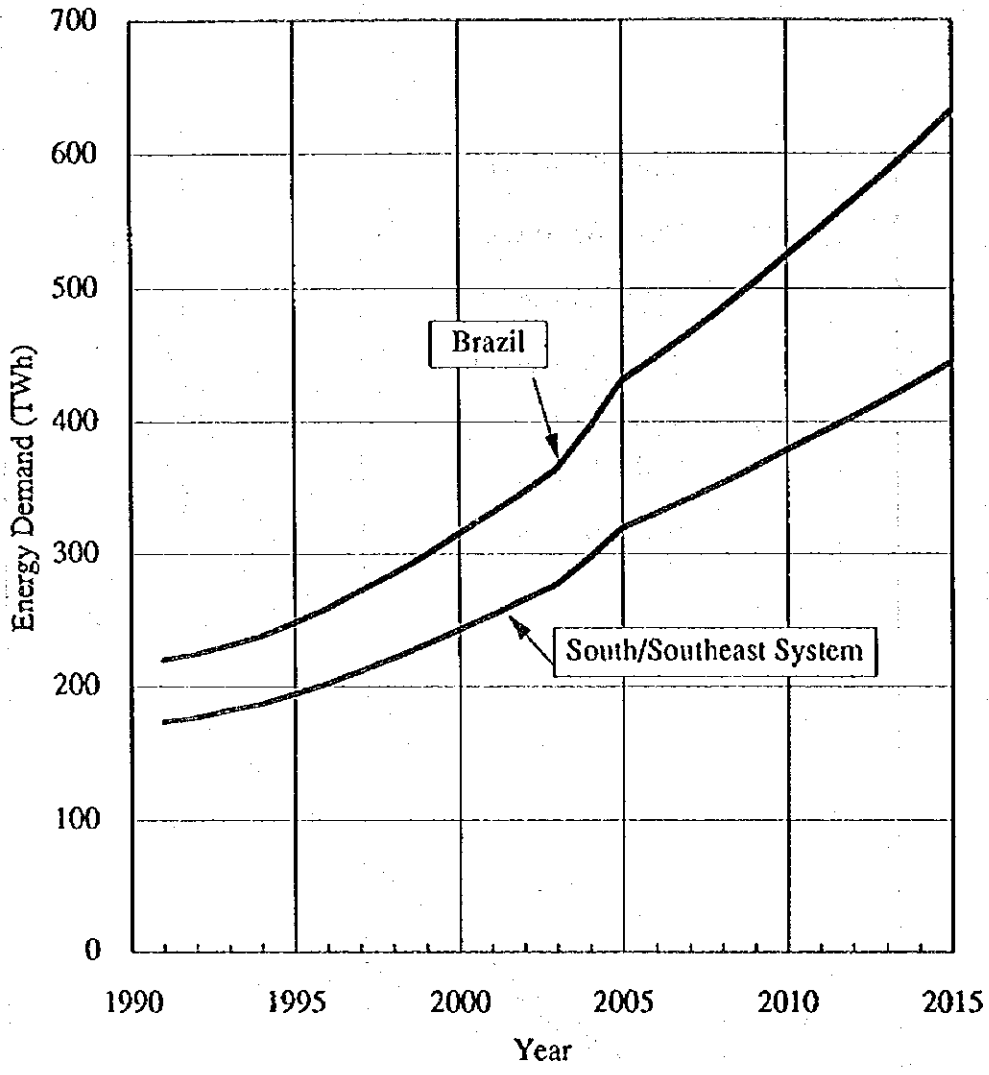


Figure - 4 GDP Growth Scenarios of Brazil



Source: 10-Year Plan 1994-2003 and data for Plano-2015

Figure - 5 Energy Demand Projection 1993-2015

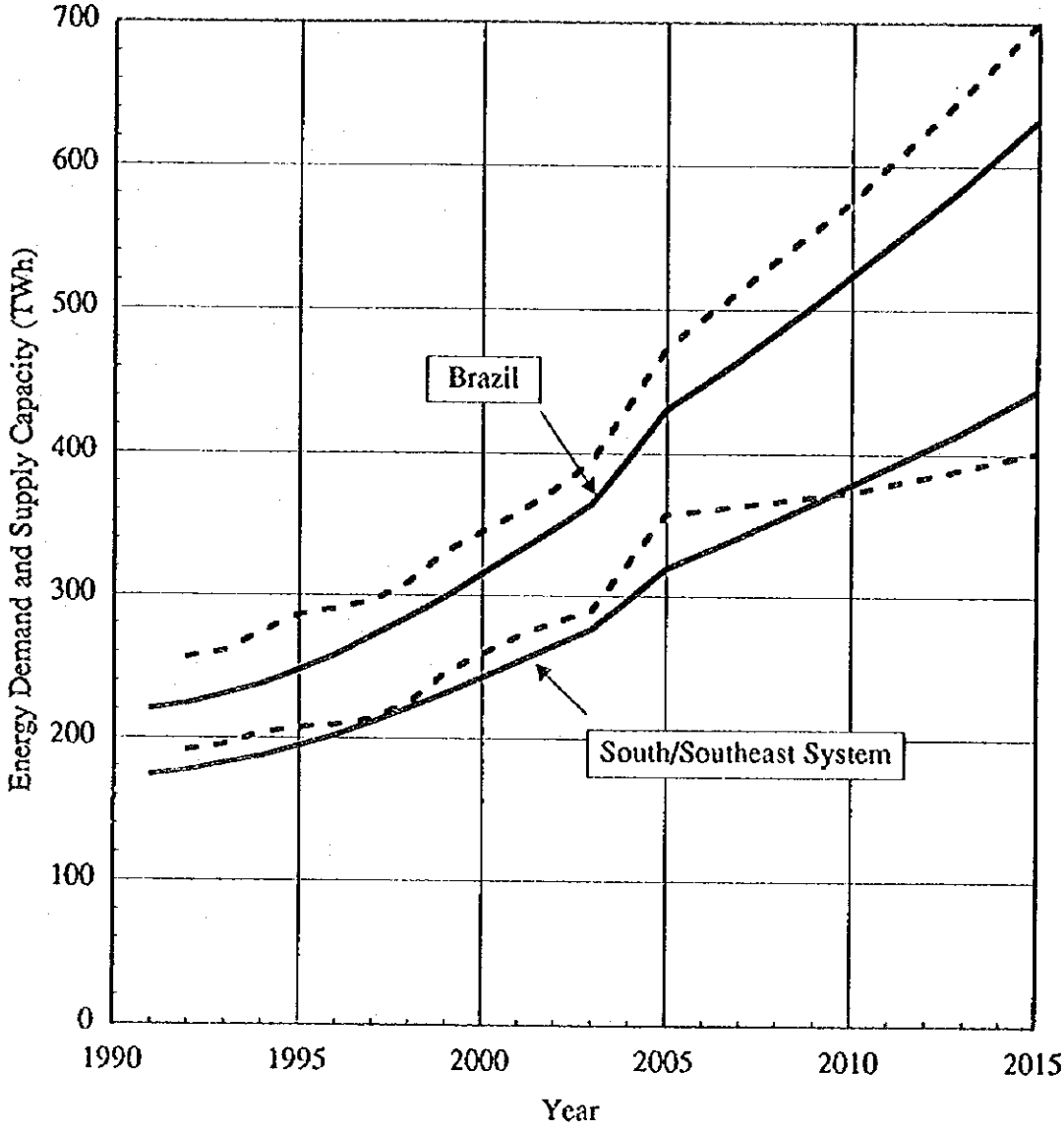
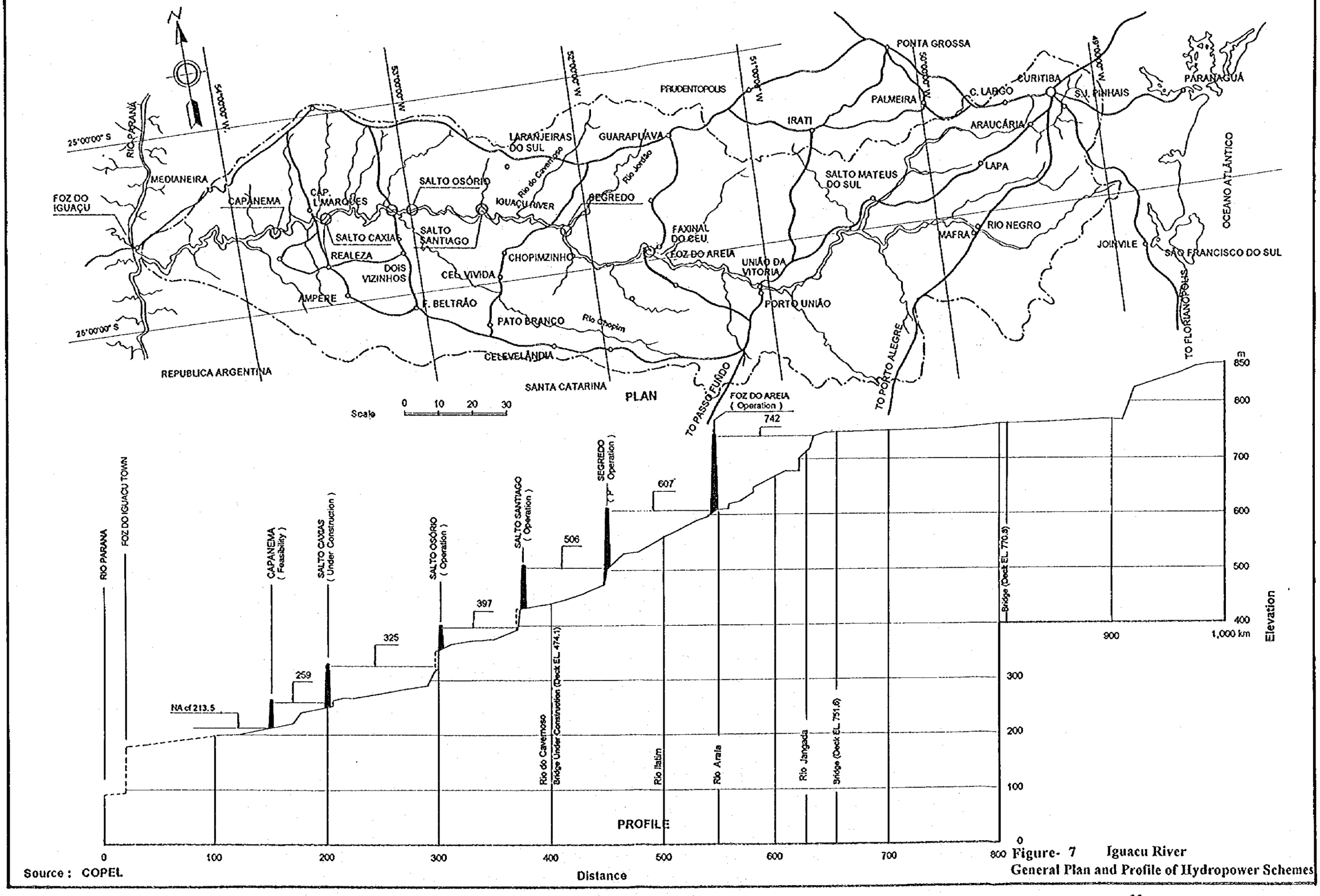
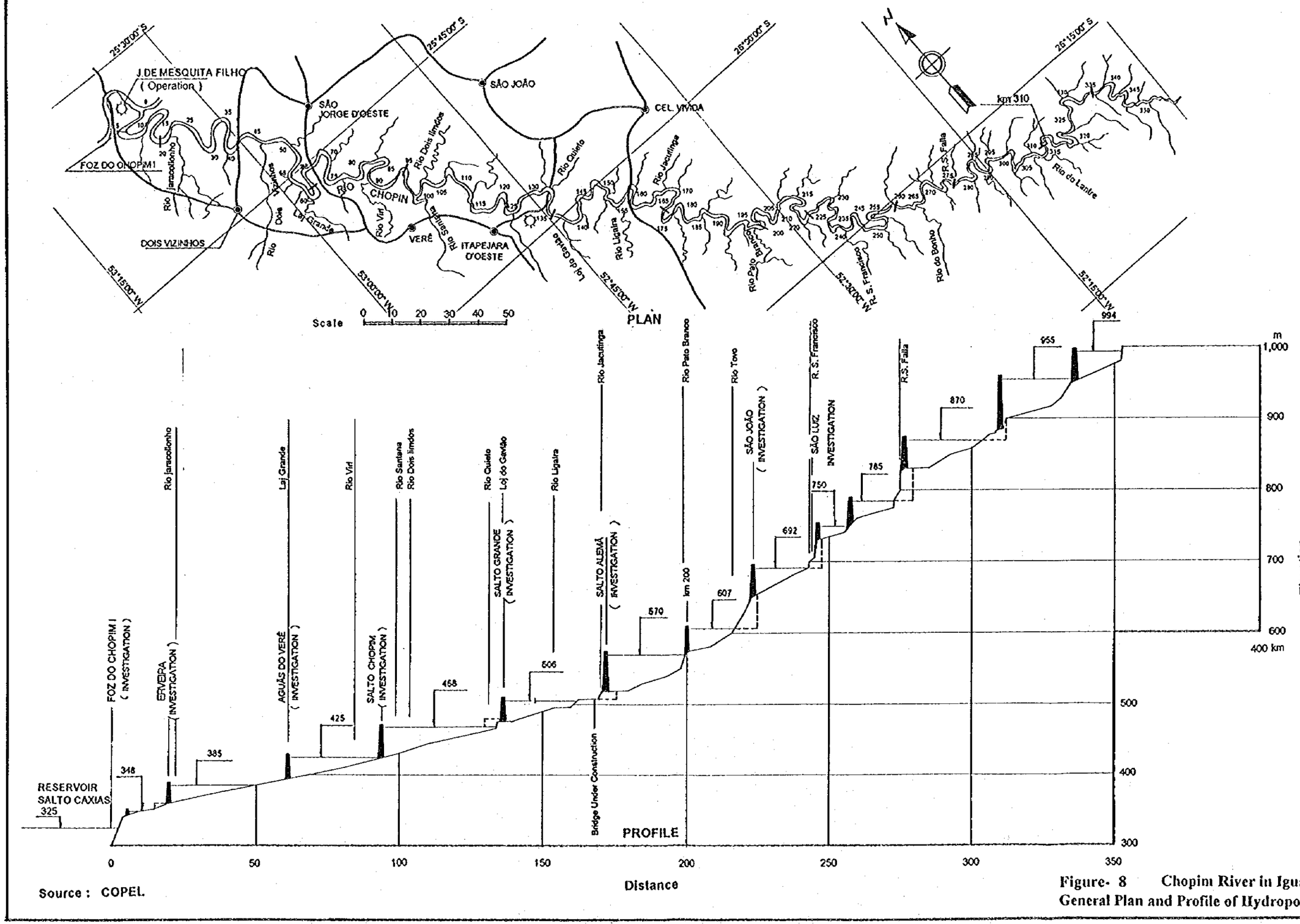


Figure - 6 Evolution of Energy Supply Capacity



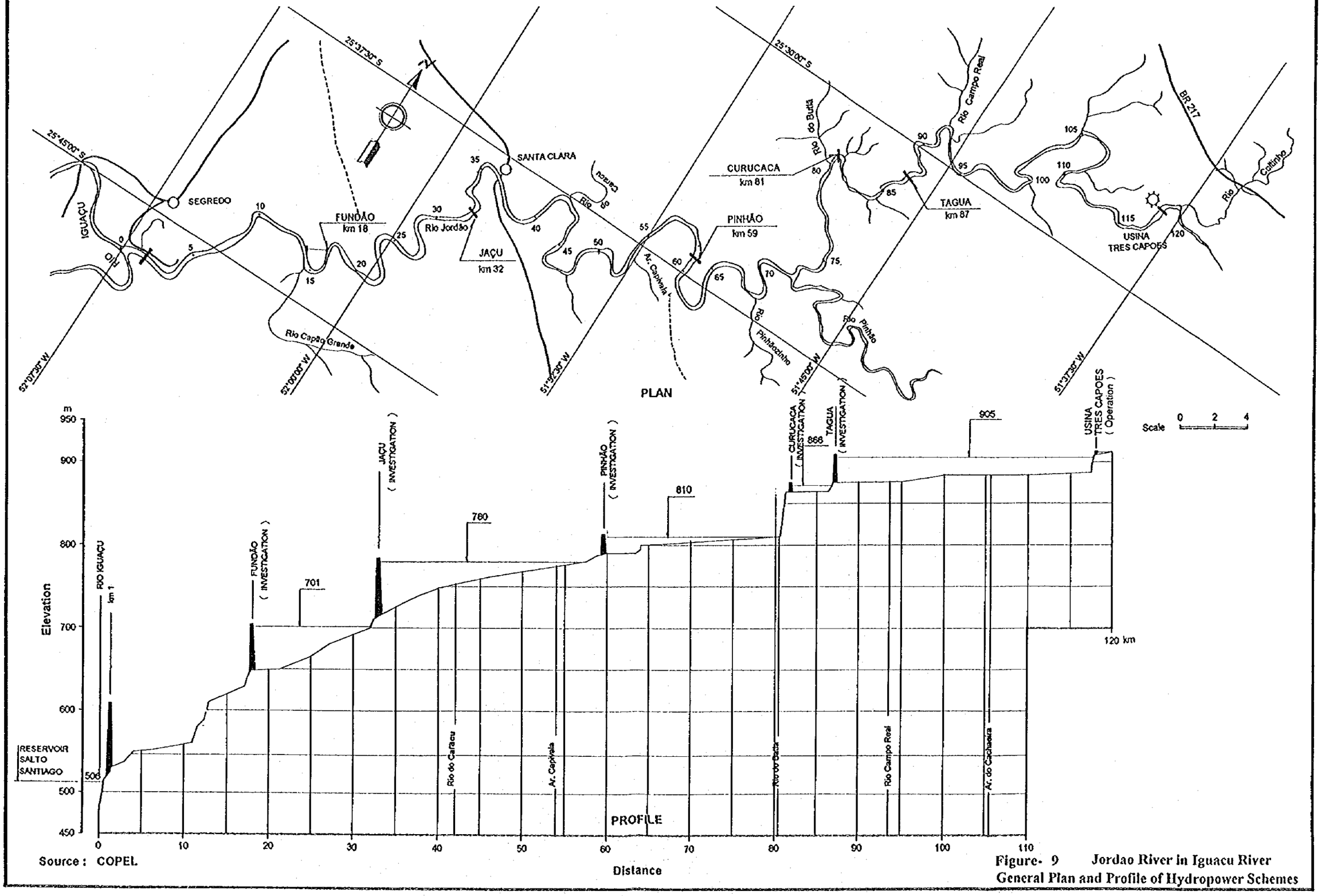
Source : COPEL

Figure- 7 Iguacu River
General Plan and Profile of Hydropower Schemes



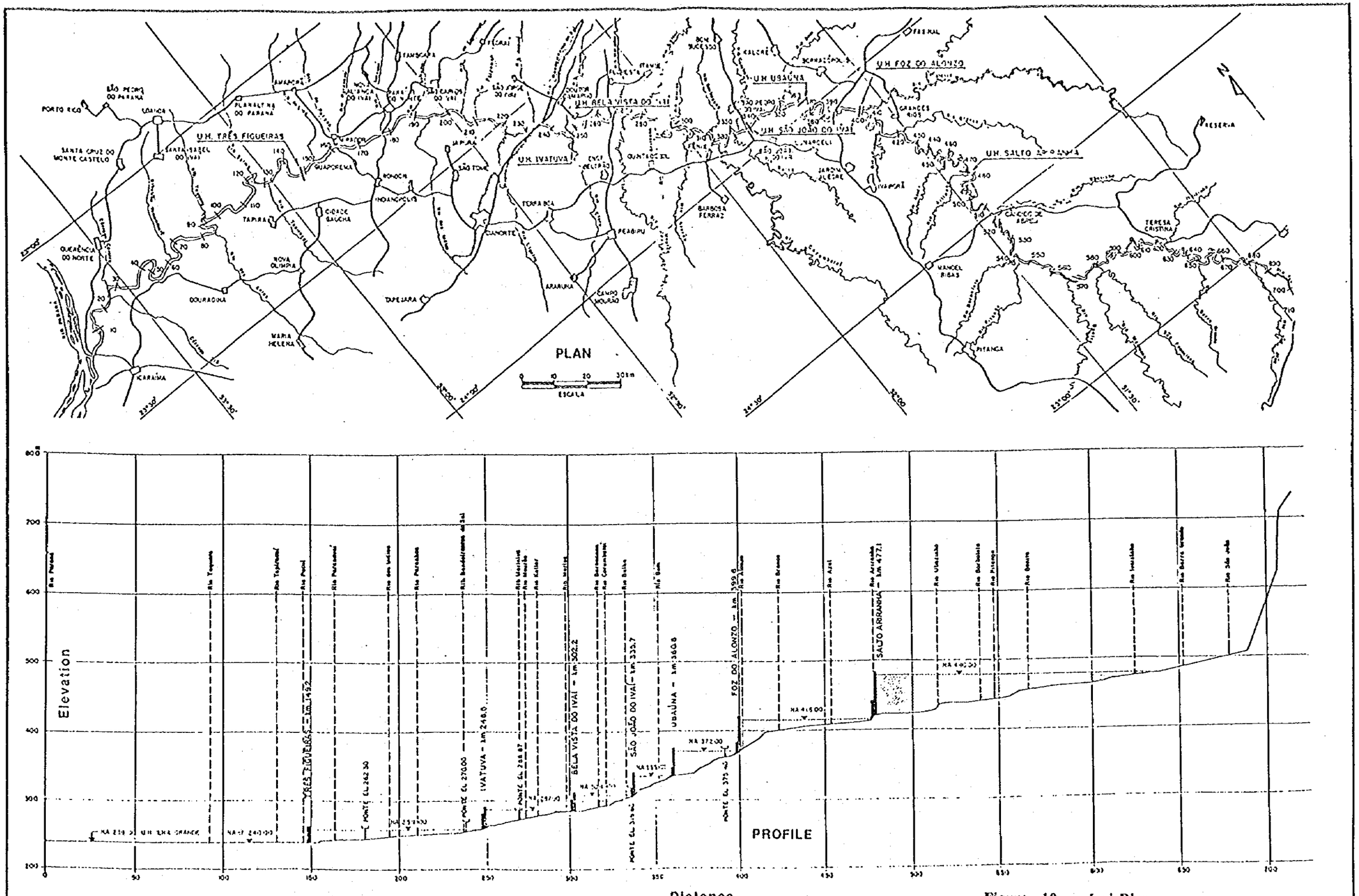
Source : COPEL

Figure- 8 Chopim River in Iguacu Basin
General Plan and Profile of Hydropower Schemes



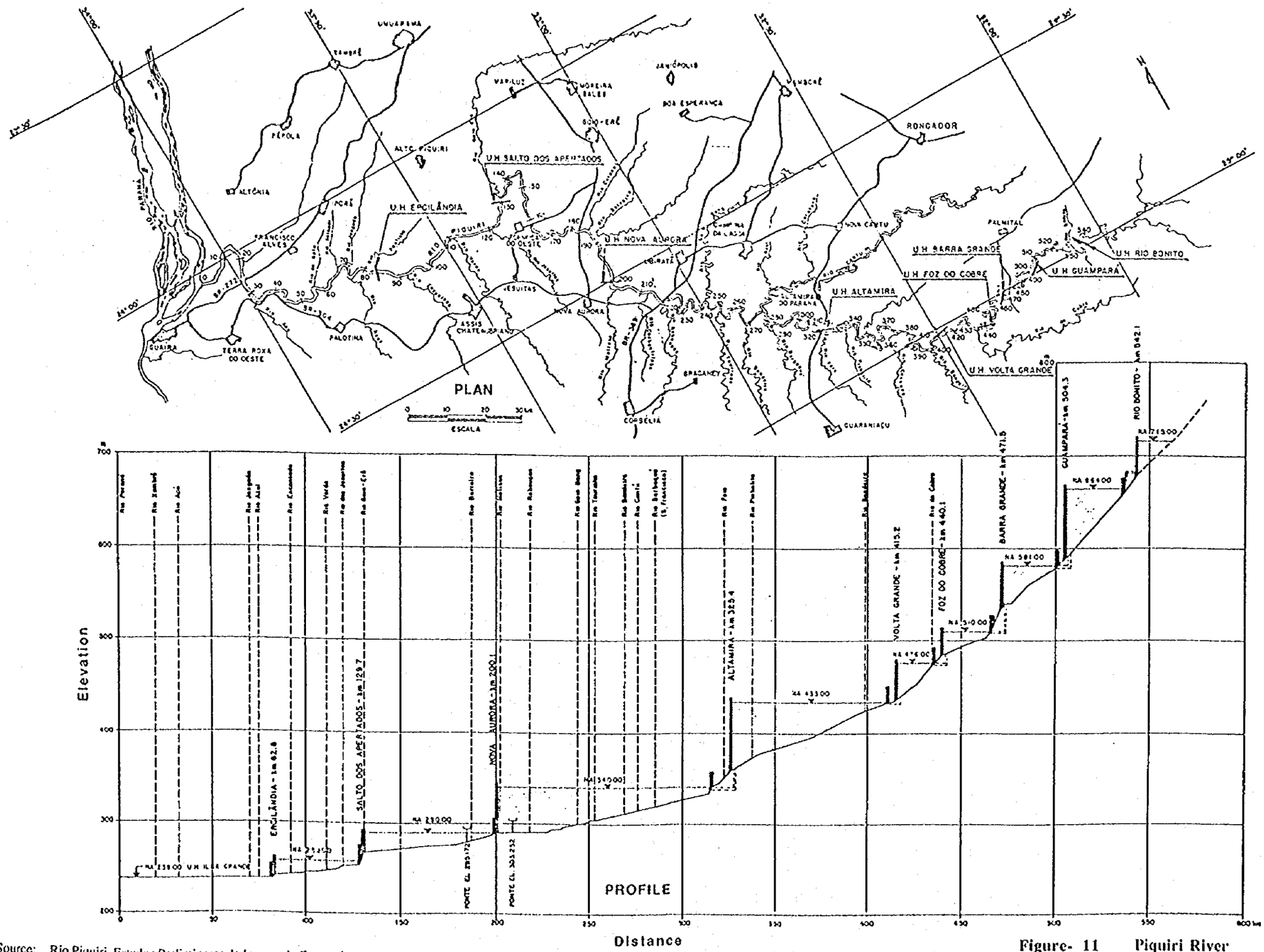
Source : COPEL

Figure- 9 Jordao River in Iguacu River General Plan and Profile of Hydropower Schemes



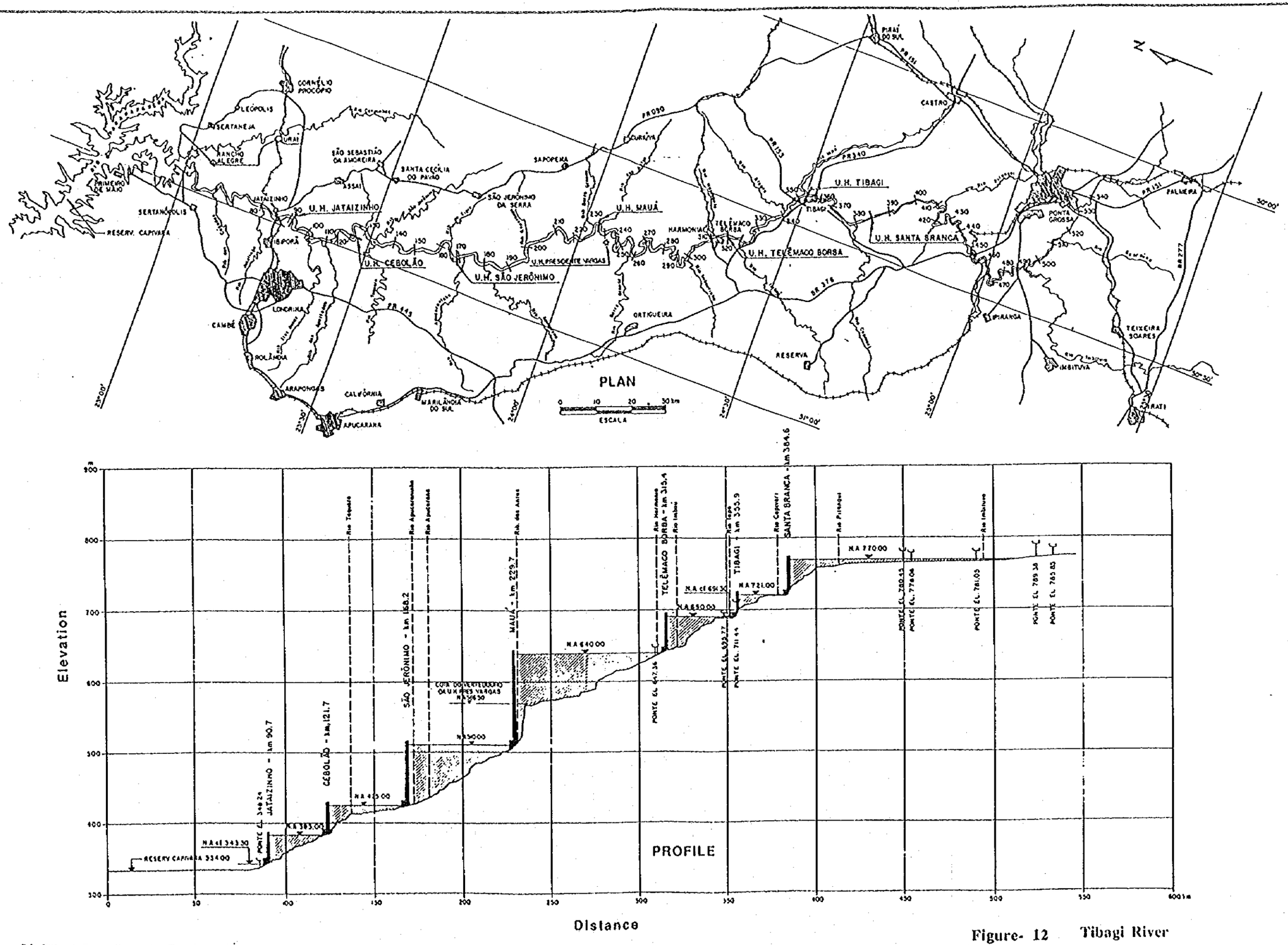
Source: Rio Ivai, Estudos de Inventario Energetico, Volumes I and II
COPEL, July 1984

Figure- 10 Ivai River
General Plan and Profile of Hydropower Schemes



Source: Rio Piquiri, Estudos Preliminares de Inventario Energetico, Relatorio, COPEL, December 1984

Figure- 11 Piquiri River General Plan and Profile of Hydropower Schemes



Source: Rio Tibagi, Reavaliacao dos Estudos de Inventario Energetico, COPEL, May 1994

Figure- 12 Tibagi River
General Plan and Profile of Hydropower Schemes

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