Table III.3.7 PRODUCTION OF MAJOR AGRICULTURAL COMMODITIES IN SANTA CATARINA

Commodity	Year	Production (ton)			National ranking/1	Plantation Area (ha)		
		Brazil	Santa Catarina	Share (%)		Brazil	Santa Catarina	Share (%)
Apples	1988	2,150,149	1,110,387	51.6	1	22,292	11,965	53.7
Garlic	"	56,367	13,520	24.0	1	14,183	3,700	22.6
Tobacco	"	429,955	149,052	34.7	2	282,519	86,580	30.6
Onions	"	757,030	211,697	28.0	2	69,843	21,856	31.3
Beans	"	2,884,032	265,521	9.2	5	5,903,530	380,607	6.4
Wheat	"	5,549,466	169,260	3.1	5	3,441,498	99,880	2.9
Corn	"	24,700,904	2,371,200	9.6	6	13,152,801	988,000	7.5
Soya	"	18,049,413	930,823	5.2	8	10,515,250	386,648	3.7
Honey	1985	12,570	2,721	21.6	1			
	1986	14,812	3,315	27.4	1			
	1987	14.063	3,628	25.8	1			
Fish	1985	971,537	157,005	16.2	2			
	1986	941,712	157,812	16.8	2			
	1987	934,408	126,442	13.5	2			

Note: /1 National ranking was determined by quantitative comparison among the states.

Sources: IBGE, SEPLAN/SC (SE-01 and SE-07)

Table III.3.8 PRODUCTION AND ADD VALUE BY MANUFACTURING INDUSTRY AT CURRENT PRICES IN BRAZIL AND SANTA CATARINA, 1980/1985

(Unit: Cr$ 10^9)

Type of Manufacturing Industry	PRODUCTION BRAZIL				PRODUCTION SANTA CATARINA						ADD VALUE BY PRODUCTION BRAZIL				ADD VALUE BY PRODUCTION SANTA CATARINA			
	1980	Share	1985	Share	1980	Share	(*1)	1985	Share	(*1)	1980	Share	1985	Share	1980	Share	1985	Share
		%		%		%	%		%	%		%		%		%		%
1. Mining	208	2.04	52,933	4.67	8	2.07	3.8	947	2.21	1.8	148	3.43	45,991	8.78	5	2.99	624	3.22
2. Non-metallic product	425	4.18	33,178	2.93	20	5.17	4.7	1,791	4.18	5.4	234	5.42	20,523	3.92	12	7.19	1,112	5.74
3. Metallurgic product	1,397	13.73	150,494	13.29	24	6.20	1.7	2,241	5.23	1.5	480	11.15	58,370	11.14	11	6.59	1,077	5.55
4. Machinery	763	7.50	73,502	6.49	28	7.24	3.7	3,294	7.69	4.5	420	9.74	43,968	8.39	13	7.78	1,677	8.65
5. Elec/Comm. product	543	5.34	62,253	5.50	9	2.33	1.7	1,573	3.67	2.5	288	6.69	36,151	6.90	4	2.40	731	3.77
6. Vehicle	776	7.63	79,384	7.01	8	2.07	1.0	547	1.28	0.7	308	7.15	30,715	5.86	4	2.40	320	1.65
7. Timber	201	1.98	13,413	1.18	34	8.78	16.9	2,119	4.95	15.8	109	2.52	7,566	1.44	20	11.97	1,226	6.32
8. Furniture	146	1.44	12,946	1.14	11	2.84	7.5	1,110	2.59	8.6	74	1.71	6,844	1.31	6	3.59	618	3.19
9. Paper	264	2.59	30,119	2.66	20	5.17	7.6	2,336	5.45	7.8	114	2.66	14,015	2.68	6	3.59	957	4.94
10. Rubber	149	1.46	17,789	1.57	1	0.26	0.7	68	0.16	0.4	52	1.21	8,805	1.68	0	-	36	0.19
11. Leather	49	0.48	6,576	0.58	1	0.26	2.0	155	0.36	2.4	20	0.45	2,875	0.55	0	-	63	0.32
12. Chemical goods	1,476	17.34	224,533	19.82	9	2.33	0.5	929	2.17	0.4	600	13.96	82,797	15.80	4	2.40	456	2.35
13. Medicine	107	1.05	12,577	1.11	0	-	0.0	75	0.18	0.6	66	1.53	8,072	1.54	0	-	49	0.25
14. Soap/Perfume	84	0.83	9,003	0.79	0	-	0.0	14	0.03	0.2	39	0.91	4,264	0.81	0	-	8	0.04
15. Plastic product	197	1.94	20,632	1.82	19	4.91	9.6	1,713	4.00	8.3	95	2.20	10,713	2.04	9	5.39	983	5.07
16. Textile	635	6.24	61,888	5.46	55	14.20	8.7	6,093	14.22	9.8	258	5.99	28,434	5.43	19	11.37	2,230	11.50
17. Clothing	378	3.72	47,485	4.19	35	9.04	9.3	4,494	10.49	9.5	196	4.54	24,749	4.72	21	12.57	2,556	13.18
18. Food product	1,581	15.54	127,321	15.21	88	22.73	5.6	11,572	27.01	6.7	479	11.13	57,406	10.96	24	14.37	3,672	18.94
19. Beverage	112	1.10	11,486	1.01	2	0.52	1.8	180	0.42	1.6	56	1.29	5,936	1.13	1	0.60	97	0.50
20. Tobacco	60	0.59	6,379	0.57	7	1.81	11.7	888	2.07	13.9	31	0.73	9,278	0.69	3	1.80	497	2.56
21. Printing	157	1.54	14,449	1.28	2	0.52	1.3	176	0.41	1.2	104	2.41	12,797	1.77	1	0.60	108	0.56
22. Others	177	1.74	19,471	1.72	6	1.55	3.4	527	1.23	2.7	110	2.55	12,797	2.44	4	2.40	292	1.51
TOTAL:	10,174	100.00	1,132,811	100.00	387	100.00	3.8	42,842	100.0	3.8	4,281	100.00	523,909	100.00	167	100.00	19,389	100.00
Ratio: (1980 : 1985)	1	:	111.3		1	:		110.7			1	:	122.4		1	:	116.1	

Note : *1 Contribution by Santa Catarina to national total in percentage
Sources : SEPLAN, IBGE & SEPLAN/SC (SE-15, SE-18 and SE-20)

Table III.3.9 LAND USE FOR PRIMARY INDUSTRY, SANTA CATARINA IN 1985

Unit: sq. km

Type of land owner	No. of farm owner	Total area *	Agriculture			Pasture land		Forest		Unused
			Year-round	Seasonal	Rotational	Natural	Plantation	Natural	Plantation	
Farm Owner	179,889	60,739.04	769.88	14,623.91	2,963.74	17,746.31	5,021.62	12,283.23	5,067.11	2,263.24
Lease Land	16,357	2,941.54	23.07	1,278.22	85.52	565.66	137.58	413.24	369.59	68.66
Joint owned	16,936	1,676.72	22.99	962.79	66.12	203.99	78.60	206.25	69.13	66.85
Absentee land	21,449	2,667.28	29.45	902.17	133.48	716.35	191.49	551.46	49.83	93.05
Others	629	214.84	1.64	31.70	7.19	73.02	15.29	50.09	23.08	12.83
Unknown	82	19.85	0.27	4.86	1.29	4.67	2.83	4.29	0.63	1.01
Sub-total	235,342	68,259.27	847.30	17,803.65	3,257.34	19,310.00	5,447.41	13,508.56	5,579.37	2,505.64
	(Total land)									
Total	95,483	68,259.27		21,908.29		24,757.41		19,087.93		2,505.64
Share (%)	100.00	71.49		22.94		25.93		19.99		2.62

Note: * including undeveloped land
Sources : IBGE, SEPLAN/SC (SE-01 and SE-22)

Table III.3.10 TRANSPORTATION IN SANTA CATARINA

Road: Road length in 1988 (Unit: km)

Class :	Federal	Federal/State	State	Municipal	Total	Share/1
Present(1)	2,242	942	4,534	53,159	60,878	4.1
paved	1,994	546	2,000	298	4,838	
% /2	88.9	58.0	44.1	0.6	7.9	
Brazil	66,297	26,292	161,483	1,248,522	1,502,594	100.0
Project(2)	343	0	366	43,902	44,611	
Total ((1)+(2))	2,586	942	4,900	97,061	105,489	

Sea Port: Cargo handling in 1985-1988 (Unit: 10^3 ton)

Year:	1985	1986	1987	1988	Share /3	Growth rate /4
Imbituba	3,802	4,113	3,946	2,955	27.6	-8.1
Itajai	1,006	1,281	1,332	1,220	9.0	6.6
Sao Francisco do Sul	7,974	8,556	8,420	9,024	63.4	4.2
Total:Santa Catarina	12,782	13,949	13,698	13,199	100.0	1.1
Share/1	4.0	4.3	4.0	3.7		
Brazil	317,704	322,504	347,205	355,018		

Air Port: Movement at Florianopolis Airport in 1985-1987

Year:	1985	1986	1987	Growth rate /5
No. of Flight	17,954	19,010	18,231	0.8
Passenger in (Person)	112,580	157,313	170,008	22.9
" out (")	117,568	160,098	174,691	21.9
" transit(")	76,783	95,334	99,243	13.7
Cargo handling (ton)	1,774	1,954	1,768	-1.7
Post " (")	18	195	171	208.2

Note: /1 Share of Santa Catarina to total in Brazil in percentage
/2 Occupancy ratio by paved road
National average = 133,623 km / 1,502,594 km = 8.9%
/3 Distribution by port for 1985-1988
/4 Annual average growth rate for 1985-1988
/5 Annual average growth rate for 1985-1987

Sources: IBGE, SEPLAN/SC (SE-01 and SE-19)

Table III.3.11 TELEPHONE ACTIVITY IN SANTA CATARINA

Year:	1986	1987	1988	Growth rate (% p.a.)
No. of Exchange Office	656	719	806	10.8
Brazil	9,926	11,477	13,264	15.6
Share(%)	6.6	6.3	6.1	
No. of Telephone set	299,900	323,461	351,205	8.2
Brazil	12,580,408	13,158,309	13,905,290	5.1
Share(%)	2.4	2.5	2.5	
No. of Calls	40,099,365	51,030,029	48,460,325	9.9
(Long distance)	37,227,730	48,611,480	46,609,141	11.9
(Local)	2,871,635	2,418,549	1,851,184	-19.7
Brazil	893,952,126	982,747,626	1,170,322,063	14.4
Share(%)	4.5	5.2	4.1	

Sources: IBGE (SE-01 and SE-19)

Table III.4.1 *ENERGY CONSUMPTION IN SANTA CATARINA, 1980 - 1989*

(Unit : MWh)

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Ann. avr.
1. Self generation	446,636	407,320	413,534	482,337	404,018	332,552	281,294	411,468	378,335	385,759	394,325
Hydro-power	446,511	407,287	413,503	482,312	404,007	332,551	281,294	411,468	378,335	385,759	394,303
Thermal-power	125	33	31	25	11	1	0	0	0	0	23
2. Power purchased	3,071,755	3,350,407	3,626,847	3,877,355	4,489,566	5,079,091	5,340,419	5,766,991	6,208,556	6,674,855	4,748,584
3. Total energy	3,518,391	3,757,727	4,040,381	4,359,692	4,893,584	5,411,643	5,621,713	6,178,459	6,586,891	7,060,614	5,142,910
4. Power resale	183,858	188,427	162,752	41,685	70,532	85,204	90,617	98,627	99,224	102,981	112,391
5. Total consumption	3,149,874	3,380,061	3,589,526	3,993,766	4,472,741	4,979,501	5,181,644	5,685,205	6,008,591	6,456,705	4,689,761
Residential	515,190	600,596	642,424	763,323	817,737	883,842	952,642	1,104,762	1,188,219	1,326,651	879,539
Industry	1,827,353	1,895,016	1,995,513	2,155,807	2,496,113	2,840,939	2,947,883	3,113,514	3,281,997	3,506,690	2,606,083
Commercial	364,900	378,974	396,785	441,787	463,364	472,902	466,124	537,254	555,211	593,415	467,072
Rural	210,592	254,748	286,909	320,905	363,051	420,433	466,723	526,231	546,629	585,024	398,125
Government	73,214	78,302	70,801	75,196	79,435	89,118	84,163	99,660	115,441	116,779	88,211
Public light	123,800	131,093	140,984	167,101	173,661	187,296	173,698	205,023	214,256	216,328	173,324
Public service	28,483	33,373	48,566	61,047	71,201	76,896	83,269	89,698	98,131	103,456	69,412
Self consumption	6,342	7,959	7,544	8,600	8,179	8,075	7,142	9,063	8,707	8,362	7,997
6. Power loss	184,659	189,239	288,103	324,241	350,311	346,938	349,452	394,627	479,076	500,928	340,757

	Distribution in 1989 (%)		Annual growth rate (%) 1980/85	1985/89	1980/89	No. of customers 1980	1989	Growth (% p.a.)
1. Self generation	5.46		-5.7	3.8	-1.6			
Hydro-power	5.46		-5.7	3.8	-1.6			
Thermal-power	0.00		-61.9	-100.0	-100.0			
2. Power purchased	94.54		10.6	7.1	9.0			
3. Total energy	100.00		9.0	6.9	8.0			
4. Power resale	1.46		-14.3	4.9	-6.2			
5. Total consumption	91.45	100.00	9.6	6.7	8.3	527,656	1,013,717	7.5
Residential	18.79	20.55	11.4	10.7	11.1	413,154	772,528	7.2
Industry	49.67	54.31	9.2	5.4	7.5	7,312	20,837	12.3
Commrcial	8.40	9.19	5.3	5.8	5.6	53,040	78,623	4.5
Rural	8.29	9.06	14.8	8.6	12.0	48,437	129,749	11.6
Government	1.65	1.81	4.0	7.0	5.3	5,303	10,567	8.0
Public light	3.06	3.35	8.6	3.7	6.4	180	216	2.0
Public service	1.47	1.60	22.0	7.7	15.4	230	672	12.7
Self consumption	0.12	0.13	5.0	0.9	3.1	0	525	
6. Power loss	7.09		13.4	9.6	11.7			

Sources : IBGE & SEPLAN/SC (SE-32 and SE-33)

Table III.5.1 POWER EXPANSION PROJECTS FOR 1995/1999 PERIOD

Power Project	Unit	Capacity (MW)	Total Capacity (MW)	
Carvao - 50 MW 1/4	1	50.0	50	*
Carvao - 50 MW 2/4	1	50.0	50	*
Carvao - 50 MW 3/4	1	50.0	50	*
Carvao - 50 MW 4/4	1	50.0	50	*
Campos Novos	4	220.0	880	
Sto. Caxias	4	250.0	1,000	
Candiota III - 2	1	350.0	350	*
Garabi - 50 %	6	150.0	900	
Machadinho	4	300.0	1,200	
Maua	2	236.0	472	
Candiota III - 3	1	350.0	350	*
Barra Grande	4	230.0	920	
Sao Jeronimo	2	222.0	444	
Cebolao	2	97.0	194	
Monjolinho	2	36.0	72	
Pai Quere	2	144.0	288	
Cana Brava	3	160.0	480	
P. Primavera	18	100.0	1,800	
Simplicio	3	60.0	180	
Miranda	3	130.0	390	
Queimado	2	50.0	100	
Anta	2	8.0	16	
Sapucaia	3	100.0	300	
Couto Magalhaes	4	55.0	220	
Formoso	3	113.3	340	
Itaocara	3	70.0	210	
Serra do Facao	3	70.0	210	
Bocaina	3	55.0	165	
Picada	2	50.0	100	
Rosal	2	29.0	58	
Capim Branco	3	200.0	600	
Irape	3	140.0	420	
Sobragi	2	55.0	110	
Corumba II	2	117.5	235	
Franca Amaral	2	16.0	32	
Foz do Bezerra	2	180.0	360	
Peixe	4	278.0	1,112	
Angra II	1	1245.0	1,245	**
Angra III	1	1245.0	1,245	**
Total		(100.0 %)	17,198 MW	
Hydro power		(80.3 %)	13,808 MW	
Thermal power		(5.2 %)	900 MW	*
Nuclear power		(14.5 %)	2408 MW	**

Remarks; * Thermal power plant
** Nuclear power plant

Table III.5.2 ANNUALIZED PROJECT OUTPUT

(Unit: MW/year)

		NPV at 1989 (ICEQ)	1994 (initial)	1995	1996	1997	1998	1999	2000 (final)
1-	Guaranteed energy								
	Southeast	-	23,275	23,895	24,844	25,382	28,811	29,172	30,552
	South	-	5,474	5,829	6,123	6,319	7,257	7,430	7,782
	Total	-	28,749	29,724	30,967	31,701	36,068	36,602	38,334
2-	Increment								
		4,195.60	-	975	1,243	734	4,367	534	1,732

ICEQ = 4,195.60 MW/year

Table III.5.3 ANNUALIZED NUCLEAR PROJECT OUTPUT

(Unit: MW/year)

Plant	Time		Percentage of construction	Guaranteed energy
Angra II	1985 - 09			
(F.C.Max. = 65 %)		1995	0.65 x 0.89	180.06
		1996	0.65 x 0.94	760.70
		1997	0.65 x 0.95	768.79
		1998	0.65 x 0.98	793.07
		1999	0.65 x 1.00	809.25
Angra III	1997 - 09			
(F.C.Max. = 65 %)		1997	0.65 x 0.89	180.06
		1998	0.65 x 0.94	760.70
		1999	0.65 x 0.95	768.79

	NPV at 1989 - 01	1994	1995	1996	1997	1998	1999
	-	0	180.06	760.70	948.85	1,553.77	1,578.04
Increment	753.275	-	180.06	580.64	188.15	604.92	24.27

EN = 753.27 MW/year

Table III.5.4 ANNUALIZED INVESTMENT FOR HYDRO/THERMAL POWER PROJECTS (1/2)

(Unit: Million US$)

	Initial Operation	Annualized investment	NPV at 1989-01	Disbursement													
				Total	up to '88	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
*Carvao - 50 MW 1/4	96-12	5.83	54.98	101.73	0.00	0.00	0.00	0.59	1.53	13.98	31.01	39.23	15.39	0.00	0.00	0.00	0.00
*Carvao - 50 MW 2/4	97-12	5.30	49.99	101.73	0.00	0.00	0.00	0.00	0.59	1.53	13.98	31.01	39.23	15.39	0.00	0.00	0.00
*Carvao - 50 MW 3/4	97-12	5.30	49.99	101.73	0.00	0.00	0.00	0.00	0.59	1.53	13.98	31.01	39.23	15.39	0.00	0.00	0.00
*Carvao - 50 MW 4/4	98-12	4.82	45.44	101.73	0.00	0.00	0.00	0.00	0.00	0.59	1.53	13.98	31.01	39.23	15.39	0.00	0.00
Campos Novos	97-09	30.07	298.09	560.72	10.91	4.70	5.70	7.01	42.07	52.32	77.14	114.36	147.80	64.19	34.52	0.00	0.00
Sto. Caxias	97-09	43.95	435.74	811.57	0.00	0.00	0.01	27.74	56.66	122.17	137.13	181.65	206.21	69.24	10.76	0.00	0.00
*Candiota III - 2	97-12	26.60	250.78	462.85	0.00	0.00	0.00	0.00	41.66	64.80	115.71	134.22	64.80	41.66	0.00	0.00	0.00
Garabi - 50 %	98-03	41.21	408.71	816.01	0.62	0.32	5.00	24.30	48.60	89.11	97.21	129.62	137.72	121.52	81.01	80.98	0.00
Machadinho	98-03	62.12	615.95	1,119.21	26.62	6.00	6.00	12.97	103.74	151.28	248.53	216.12	183.70	108.06	56.19	0.00	0.00
Maua	98-09	19.14	189.77	390.05	0.00	0.00	1.65	4.20	9.64	21.57	53.35	79.45	79.45	79.45	61.29	0.00	0.00
*Candiota III - 3	98-12	30.20	284.66	577.89	0.00	0.00	0.00	0.00	0.00	52.07	81.00	144.63	167.12	81.00	52.07	0.00	0.00
Barra Grande	99-03	32.88	326.04	706.64	1.17	0.10	1.40	3.52	7.04	19.01	49.28	114.04	173.88	204.15	105.60	27.45	0.00
Sao Jeronimo	99-06	13.71	135.89	300.10	0.00	0.00	1.25	1.75	1.50	10.33	21.25	48.61	61.13	61.13	59.09	34.06	0.00
Cebolao	99-09	7.05	69.93	165.96	0.00	0.16	0.38	1.12	0.83	2.49	0.00	12.56	26.24	45.72	46.68	29.78	0.00
Monjolinho	99-09	5.35	53.07	127.03	0.00	0.00	0.00	0.32	0.64	0.64	1.27	5.08	22.86	39.38	39.38	17.46	0.00
Pai Quere	99-09	17.35	172.05	403.50	0.00	0.00	0.00	1.01	2.02	4.04	8.07	40.35	72.63	121.05	80.70	73.63	0.00
Cana Brava	95-03	40.02	396.76	622.57	1.65	8.27	11.17	82.21	137.89	173.94	155.09	52.35	0.00	0.00	0.00	0.00	0.00
P. Primavera	95-05	237.03	2350.11	3,091.74	866.92	124.73	344.15	344.28	353.44	373.57	295.06	209.72	93.71	52.28	27.88	0.00	0.00
Simplicio	95-10	19.39	192.23	314.77	9.57	0.00	5.33	11.29	41.58	102.06	80.67	54.88	7.55	1.84	0.00	0.00	0.00
Miranda	96-03	18.32	181.66	300.76	5.46	0.00	0.00	19.11	50.65	78.03	84.50	39.46	20.29	3.26	0.00	0.00	0.00
Queimado	96-09	6.25	61.95	113.32	0.00	0.00	0.00	1.18	4.44	17.65	36.82	34.12	15.91	3.20	0.00	0.00	0.00
Sapucaia / Anta	96-12	22.47	222.74	404.66	8.89	0.00	4.92	5.42	21.45	43.04	98.56	119.63	90.82	9.02	2.91	0.00	0.00
Couto Magalhaes	97-03	18.96	188.03	324.25	13.46	0.00	0.00	11.66	38.39	48.88	73.43	86.73	32.03	19.27	0.00	0.00	0.00
Formoso	97-03	27.69	274.58	515.26	4.09	0.00	0.00	10.29	20.29	58.02	122.78	153.36	80.05	51.21	15.07	0.00	0.00
Itaocara	97-03	16.23	160.89	303.46	6.35	0.00	0.09	4.97	6.73	33.23	51.56	86.00	87.04	27.49	0.00	0.00	0.00
Serra do Facao	97-03	15.37	152.42	290.99	0.00	0.00	0.38	6.55	7.75	33.75	56.39	77.02	77.67	31.48	0.00	0.00	0.00

*: Thermal Power Station

Table III.5.4 ANNUALIZED INVESTMENT FOR HYDRO/THERMAL POWER PROJECTS (2/2)

(Unit: Million US$)

	Initial Operation	Annualized investment	NPV at 1989-01	Disbursement													
				Total	up to '88	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Bocaina	98-03	17.98	178.27	383.66	5.09	0.00	0.00	5.57	0.00	3.26	15.63	68.02	113.62	107.77	53.01	11.69	0.00
Picada	98-03	7.07	70.14	163.93	0.00	0.00	0.00	0.00	0.00	1.74	6.75	17.09	27.38	40.93	51.21	18.83	0.00
Rosal	98-03	4.61	45.70	96.88	0.00	0.00	0.00	1.35	1.30	1.33	9.68	16.26	27.75	28.47	10.74	0.00	0.00
Capim Branco	98-06	24.46	242.52	511.04	3.78	0.00	0.00	8.55	2.64	17.65	53.58	81.57	122.41	148.98	56.22	15.63	0.00
Irape	98-06	22.34	221.55	432.94	0.41	0.00	0.00	4.44	17.37	37.67	72.13	106.59	129.01	47.67	12.93	3.92	0.00
Sobragi	98-06	6.46	64.06	151.33	0.00	0.00	0.00	0.00	0.00	1.46	6.18	15.01	24.12	36.20	45.37	16.81	6.18
Corumba II	98-09	21.19	210.05	447.39	0.00	0.00	0.00	6.07	7.05	7.47	28.69	88.42	129.04	124.24	51.52	4.89	0.00
Franca Amaral	98-09	2.71	26.84	57.68	0.00	0.00	0.00	0.72	0.74	0.82	4.13	9.74	16.00	16.73	8.80	0.00	0.00
Foz do Bezerra	99-03	22.61	224.19	494.79	2.58	0.00	2.14	0.04	7.09	8.08	40.48	62.30	103.59	126.16	27.05	45.30	0.00
Peixe	99-03	61.39	608.70	1,364.00	0.00	0.00	6.16	6.91	11.97	14.64	84.60	185.12	267.68	358.43	323.48	105.01	0.00
TOTAL		963.45	9514.35	17233.77		144.28	395.73	615.14	1047.88	1663.75	2327.15	2899.39	2934.90	2347.59	1398.87	485.34	6.18

Table III.5.5 ANNUALIZED ENERGY DEFICIT AND ANNUALIZED FUEL COST

(Unit: MIllion US$)

	NPV at 1989	1992 (initial)	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003 (final)
1. Simulated energy deficit (Million MWh)	-	1.40	1.16	0.93	1.29	1.15	1.23	1.56	1.48	1.27	1.81	1.75	1.63
2. Power generation by thermal power plants (Million MWh)	-	13.98	16.78	19.82	21.99	26.26	27.76	31.66	31.33	31.20	31.20	30.94	31.00
1. Presumed energy deficit (CDFE)	-	389.64	348.44	279.49	387.70	345.78	370.39	467.74	442.89	409.72	541.58	524.58	490.08
2. Fuel Cost (CGTE)	-	554.87	556.39	569.30	602.82	635.96	661.75	735.79	736.30	733.01	733.57	727.06	728.40
Total	-	944.51	904.83	848.79	990.52	981.74	1,032.14	1,203.52	1,179.19	1,132.73	1,275.15	1,251.64	1,218.48
1. Increment of energy deficit (CDFE)	28.18	-	-41.20	-68.95	108.21	-41.92	24.61	97.35	-24.85	-33.16	131.86	-17.00	-34.49
2. Increment of fuel cost (CGTE)	85.78	-	1.52	12.91	33.52	33.14	25.79	74.04	0.51	-13.29	10.56	-6.51	1.34
3. Increment Total (CDFE) + (CGTE)	103.60	-	-39.68	-56.04	141.73	-8.78	50.39	171.39	-24.34	-46.45	142.42	-23.52	-33.15

CDIE: Implicit cost of deficit = US$ 300/MWh

Table III.5.6 UNIT COST OF FUEL

Type of fuel	Fuel consumption Ton/MWh	Fuel cost US$/MWh	Unit price US$/ton
Coal:			
Condiota, open-air	1.000	8.000	8.00
Candiota, underground	0.666	12.000	18.02
Tubarao, underground	0.600	15.180	25.30
Jacui, underground	0.600	18.690	31.15
Oil:			
RASF, ultra viscosity	0.250	37.740	150.96
Oleo Combustivel	0.400	49.740	124.35

Table III.5.7 ANNUALIZED OPERATION AND MAINTENANCE COST

Plant	Capacity (MW)	COME (NPV) Thousand US$/y	Unit O/M cost US$/kW/y	NPV at 1989	1995	1996	1997	1998	1999	2000
Carvao - 50 MW	200	631.64	7.43	85.01	0	0	50	100	50	0
Campos Novos	880	1,166.73	3.05	382.54	0	0	220	660	0	0
Sto. Caxias	1000	1,304.10	3.00	434.70	0	0	250	750	0	0
Candiota III - 2	350	509.13	3.43	148.43	0	0	0	350	0	0
Garabi - 50 %	900	1,107.59	3.04	364.34	0	0	0	450	450	0
Machadinho	1200	1,457.24	2.93	497.35	0	0	0	900	300	0
Maua	472	630.55	3.30	191.08	0	0	0	236	236	0
Candiota III - 3	350	462.84	3.43	134.94	0	0	0	0	350	0
Barra Grande	920	1,050.31	3.03	346.64	0	0	0	0	690	230
Sao Jeronimo	444	570.03	3.33	171.18	0	0	0	0	444	0
Cebolao	194	264.16	3.70	71.40	0	0	0	0	97	97
Monjolinho	72	157.92	5.96	26.50	0	0	0	0	36	36
Pai Quere	288	373.08	3.52	105.99	0	0	0	0	144	144
Cana Brava	480	894.13	3.30	270.95	480	0	0	0	0	0
P. Primavera	1800	2,497.58	2.78	898.41	400	600	600	200	0	0
Simplicio	180	356.97	3.74	95.45	60	120	0	0	0	0
Miranda	390	676.45	3.38	200.13	0	390	0	0	0	0
Queimado	100	239.04	4.88	48.98	0	50	50	0	0	0
Anta	16	110.69	14.83	7.46	0	0	16	0	0	0
Sapucaia	300	489.83	3.50	139.95	0	0	300	0	0	0
Couto Magalhaes	220	365.09	3.64	100.30	0	0	165	55	0	0
Formoso	340	545.63	3.44	158.61	0	0	340	0	0	0
Itaocara	210	358.56	3.66	97.97	0	0	210	0	0	0
Serra do Facao	210	358.56	3.66	97.97	0	0	210	0	0	0
Bocaina	165	264.51	3.78	69.98	0	0	0	165	0	0
Picada	100	206.96	4.88	42.41	0	0	0	100	0	0
Rosal	58	167.02	6.79	24.60	0	0	0	58	0	0
Capim Branco	600	789.59	3.20	246.75	0	0	0	400	200	0
Irape	420	578.62	3.35	172.72	0	0	0	280	140	0
Sobragi	110	215.06	4.61	46.65	0	0	0	110	0	0
Corumba II	235	343.50	3.61	95.15	0	0	0	118	117	0
Franca Amaral	32	126.17	9.74	12.95	0	0	0	16	16	0
Foz do Bezerra	360	474.68	3.42	138.80	0	0	0	0	360	0
Peixe	1112	1,240.18	2.96	418.98	0	0	0	0	834	278
Total		20,984.159			940	1160	2411	4948	4464	785

COME = 20.98 Million US$/year

FIGURE

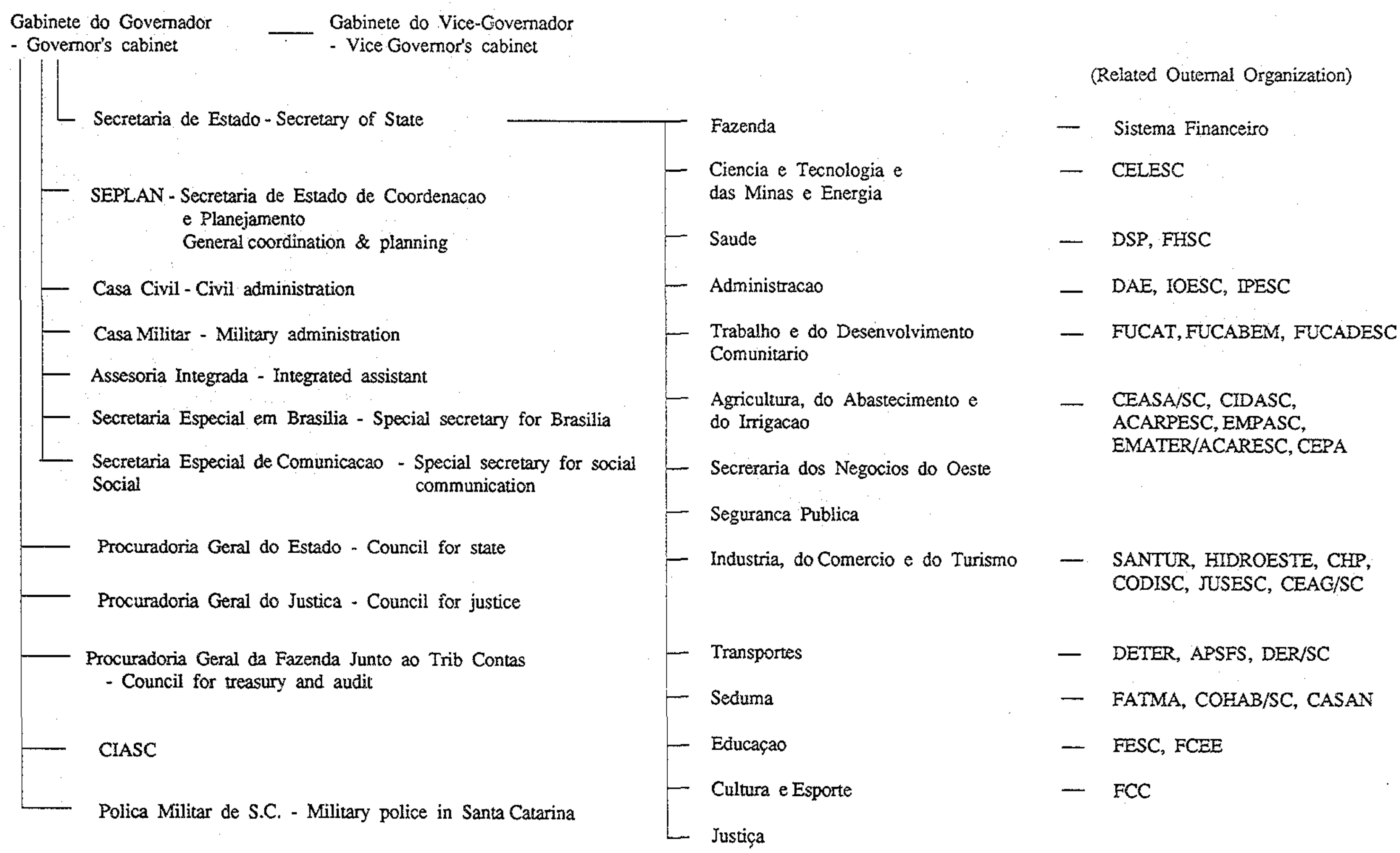

Fig. III. 3. 1 ORGANIZATION OF STATE GOVERNMENT, STATE OF SANTA CATARINA

LIST OF REFERENCE AND DATA BOOKS

No	Title	Issued by
	GENARAL	
SE-01	Anuario Estatistico do Brasil - 1987/88/89	IBGE
02	Indicadores - Vol.8 No.12/Volume No.1,2,3,4	IBGE
03	Numeros do Santa Catarina - 85/86/87	SEPLAN, SC
04	Plano de Governo do Estado de Santa Catarina (Marco/87 a Marco/91)	
05	Analise Conjuntural de Santa Catarina - No.7,8 e 9	SEPLAN,SC
06	Relacao dos Municipios Catarinenses por Regioes - 1990	SEPLAN,SC
07	Desempenho da Economia Catarinense - 1970/1982,1983/1986,1983,1984,1985,1986 (6 Volumes)	SEPLAN,SC
08	Santa Catarina - Um Bom Negocio	GOVERNO DO ESTADO DE S.C.
09	Proenergia - 1980	CODE SC
10	Santa Catarina, Brazil Its People, Land and Production - 1982	SEPLAN,SC
11	Projecao Diaria Comparativa (BTN/DOLAR OFICIAL e PARALELO) Fundacao Celos	BANCO do BRASIL
	DEMOGRAPHY	
SE-12	Censo Demografico 1980 Vol.1/3/4,5	IBGE
13	Santa Catarina - Estudo da Evolucao Populacional (1970/2010) 1989	SEPLAN,SC

No	Title	Issued by
SE-14	Estimativa da Populacao Residente em 01 de Julho de 1990, Segundo as Unidades da Federacao e Municipios	IBGE-DEGE,SC
	ECONOMIC INDICIES	
SE-15	Censo Economico 1985 - Tabelas com dados de (SC) e (BR) Paginas 102/103/104/105	IBGE
16	Aspectos Socio - economicos - Regiao Sul/Brasil 1985 e 1986	SEPLAN,SC
17	Santa Catarina no Contexto Nacional - 1986	SEPLAN,SC
18	Santa Catarina - Macro indicadores - 1986	SEPLAN,SC
19	Desempenho da Economia Catarinese em 1983 - 1989	SEPLAN,SC
20	Desempenho da Economia Catarinense em 1988	SEPLAN,SC
21	Desempenho da Economia Catarinense - Produto Interno Bruto - 1989	SEPLAN,SC
22	Censo Agropecuario de Santa Catarina - 1985	IBGE/SEPLAN-BR
23	Indicadores Conjunturais da Industria - Dezembro 1988 e 1989	SEPLAN,SC
24	Censo Comercial - 1985	IBGE/DEGE,SC-BR
	OTHERS	
SE-25	Diario Oficial da Uniao com as Medidas Provisorias (MP) do Governo Federal (Dcsde 15/03/90)	DIARIO OFICIAL
26	Informe Setorial BRDE-1,2,3	BRDE

No	Title	Issued by
SE-27	O Potencial Catarinense - Federacao das Industrias do Estado de Santa Catarina - FIESC/Setor Economico	FIE,SC
28	Santa Catarina - Estado onde investir - Secretaria de Estado da Industria do Comercio e do Turismo	IDCT,SC
29	Sistema Interligado Sul/Sudeste - Relatorio Final - Ciclo 1989 (Fev/90)	GCPS, ELETROBRAS
30	Sistema Interligado Sul/Sudeste - Relatorio Parcial do Programa Decenal de Geragao e Restricoes Financeiras - Fromacao e Analise Julho /89	GCPS, ELETROBRAS
31	Annual Report/1989	ELETROBRAS
32	Boletim Estatistico da CELESC - 1990	CELESC
33	Mercado CELESC por Municipio Consumo e No de Consumidores 1985/1989 - Tabelas	CELESC
34	Marginal Costanalysis and Pricing of water and Electric Power	INTER-AMERICAN DEVELOPMENT BANK
35	Costing and Pricing Electricity in Developing Countries	ASIAN DEVELOPMENT BANK
36	World Development Repont	IBRD/OXFORD

ANNEX IV

ELECTRIC POWER SUPPLY AND POWER DEMAND

ANNEX IV. ELECTRIC POWER SUPPLY AND POWER DEMAND

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

CELESC is a state government owned utility and responsible for the supply of electric power in the state of Santa Catarina. CELESC's own generation is only about 5 % of the total requirement of the state, the remaining 95% being purchased from ELETROSUL, ITAIPU Binational and others.

To obtain the stable and cheaper power, CELESC intends to develop its own hydro power plants in the Itajai river basin. For this purpose, studies on the existing power supply, power market and demand forecast were carried out not only for CELESC's power system in the state but also for the south/southeast power system which is interconnected with the CELESC's system.

2. ORGANIZATION OF THE POWER INDUSTRIES

DNAEE is responsible for framing the electric power policy, approving the implementation program for power construction, deciding the electric power tariffs, etc. and generally controlling Brazilian power industries as the competent authority.

The nation wide electric power supply is entrusted to ELETROBRAS, a partly state-owned corporation under the jurisdiction of the Ministry of Infrastructure.

ELETROBRAS is responsible for implementing the Brazilian electric power policy by planning, financing and supervising the program for the construction, transmission and distribution systems. ELETROBRAS is the principal funding agency of the power sector, both federal and state utilities and operates throughout Brazil via four regional subsidiaries : ELETRONORTE in the north and middle west, CHESF in the northeast, FURNAS in the southeast and middle west, and ELETROSUL in the south. In addition, ELETROBRAS has two state subsidiaries, LIGHT in the state of Rio de Janeiro, and ESCELSA in the state of Espirito Santo. ELETROBRAS is also a partner in state electric utilities and holds 50 % of the stock of ITAIPU Binational. The nation wide organization chart for electric power industries is shown in Fig. IV.2.1.

The major state governments also have their own electric power enterprises other than ELETROBRAS group and have also the right to develop the power generating plants by themselves within their territories with the DNAEE's approval.

CELESC is a Santa Catarina state government owned utility and is responsible for supplying electrical power to the state of Santa Catarina. CELESC was established in 1956 by the merger of power companies. In 1989, CELESC had its owned generating facilities of 74.3 MW in total installed capacity which corresponds to about 5 % of the state demand. The rest is purchased from others mainly from ELETROSUL and ITAIPU Binational.

3. EXISTING POWER SUPPLY SYSTEM

3.1 Whole Brazil and South/Southeast System

ELETROBRAS has divided the whole country of Brazil into four regional areas and established the subsidiary companies, ELETRONORTE, CHESF, FURNAS and ELETROSUL. These subsidiary companies have their own power transmission network. They are also interconnected in two major power systems, namely, north/northeast and south/southeast systems. These two systems are operated separately from each other and will not be interconected until 2000. Most major load centers and major power plants in each system have been interconnected by the trunk transmission lines of ultra high voltage of above 230 kV. The trunk lines are shown in Fig. IV.3.1.

The existing power supply systems of Brazil in 1989 is summarized as follows ;

	Hydro	Thermal	Total
Installed Capacity (MW)			
ELETROBRAS	20,900	3,092	23,992
Systems;			
FURNAS	(6,800)	(1,323)	(8,123)
CHESF	(6,894)	(553)	(7,447)
ELETROSUL	(2,602)	(620)	(3,222)
ELETRONORTE	(3,623)	(596)	(4,219)
ESCELSA	(159)	-	(159)
LIGHT	(822)	-	(822)
Other companies	17,819	1,572	19,391
ITAIPU Binational	10,500	-	10,500
Total	49,219	4,664	53,883
	(91.3%)	(8.7%)	(100%)
Energy			
Production (GWh)	223,865	8,840	232,705
	(96.2%)	(3.8%)	(100%)

Remarks; (1) Private producers are not included.
(2) Includes ITAIPU supply.

This table shows that hydro power provides 91% of the total installed capacity and 96% in total energy production respectively. Details of the existing power stations in the South/Southeast system are given in Table IV.3.1.

3.2 CELESC Power System

CELESC's transmission and distribution lines have been linked with the south/–southeast of the Brazil transmission system through ELETROSUL's substations in the state. CELESC takes care of 100% of power demand in the state of Santa Catarina territories with area of 95,483 km^2. The existing power supply facilities owned and operated by CELESC itself in 1989 comprise 12 run-of-river type hydro power plants of 74.3 MW in total installed capacity, transmission lines of 2,794.7 km in total length and substation transformers of 2,933.9 MVA in total installed capacity. The transmission system in CELESC is illustrated in Fig. IV 3.2. The details of the existing power stations in Santa Catarina and existing substations in CELESC are shown in Tables IV. 3.2 and IV.3.3 respectively. The annual report prepared by CELESC in 1989 states that CELESC generated the power energy of 385,758 MWh by 12 hydropower plants in 1989 and annual mean capacity factor for 1979 - 1989 period was 60 % for the annual power output energy. The total annual energy required and power energy supplied in the state in 1989 was as follows;

Description		Energy (MWh)
Generated by CELESC's owned plants		385.758 (5.5%)
Purchased from	- ELETROSUL	4,651.852 (65.9%)
	- ITAIPU Binational	2,002.628 (28.3%)
	- Others	20.375 (0.3%)
Total		7,060.613 (100%)

The above table shows that 94.5% of the required energy of the total is purchased from ELETROSUL, ITAIPU and others, CELESC's own generation being only 5.5%. The power trading between CELESC and ELETROSUL has been made at 14 points of substations of CELESC and/or ELETROSUL in 69 kV and/or 138 kV including ITAIPU's power.

4. POWER MARKET

4.1 Present Power Demand in CELESC

In 1989, the total energy required in CELESC was recorded at 7,061 GWh, which had increased by 7.24 % against that in 1988 and 6,560 GWh was sold to the consumers and supplied to the several local power distribution companies in the state which are to be merged into CELESC in the future. The difference between the above values, 501 GWh (7.1% of the required energy) consists of transmission, distribution losses and others.

The electric power and energy demand and sold in 1989 of CELESC are summarized as follows and the detailed breakdown are shown in Table IV.4.1.

Required energy (kWh) ;	7,060,613,209	
Generated ;	385,758,503	
Received ;	6,674,854,706	
Sold energy (kWh) ;	6,559,686,177	
Municipal district Supply companies ;	102,981,432	
Consumers ;	6,456,704,745	(100%)
Residential ;	(1,326,651,373)	(20.5%)
Industrial ;	(3,506,689,574)	(54.3%)
Commercial ;	(593,415,110)	(9.2%)
Rural ;	(585,023,925)	(9.1%)
Public and others ;	(444,924,763)	(6.9%)
Losses and difference (kWh) ;	500,927,032	
Annual peak demand (kW) ;	1,228,400	

This summary shows that the ratios of sold energy of each consumer class are 21% (residential), 54% (industrial), 9% (commercial), 9% (Rural) and 7% (Public and others). It is generally said that the share of sold energy to the industrial sector in an industrialized country is around 60 to 70%. Comparing this figure with the share of the sold energy for industrial sector, it seems that the state of Santa Catarina is now under industrialization.

4.2 Load Curves

Typical daily load curves and daily load duration curves of the whole CELESC and the Itajai valley on 19 July, 22 Nov., 1989, 07 Mar., 03, 07 and 08 July 1990 and annual load curves of the whole CELESC for 10 years from 1980 to 1989 are shown in Tables IV.4.2 and IV.4.3 and Figs. IV.4.1 and IV.4.2 respectively. Variation of peak load for the period of 1980-1990 and also variation of annual load factor for 1970-1989 period are given in Figs.IV.4.3 and IV.4.4 respectively.

It was clarified from these tables and figures that;

(1) The ratio of peak at night time to that at day time was calculated at 0.83 to 0.95 on week days. The pattern of daily load curves is in the process of gradually shifting its peak from night time to day time, however, at the present, it shows still night time peak type.

(2) The daily load factors were calculated at 0.75 to 0.86 on week days, 0.72 on Saturday and 0.66 on Sunday respectively.

(3) The change of monthly peak demand during 1980-1989 period in Fig. IV.4.3 shows that the monthly peak demand gradually increases and becomes its peak during April, May and June. While, Fig. IV.4.4 shows that the annual load factor for the period of 19 years from 1970 varies from about 53% in 1973 to 62% in 1980, and after 1983, it is improved up to about 66% at the average annual improvement rate of about 1%.

4.3 Historical Trends of Power Market in CELESC

Historical energy consumption in the state of Santa Catarina for recent 10-years from 1979 to 1989 are shown as follows ;

(Unit ; GWh)

Year	Residential	Industrial	Commercial	Rural	Public & Others	Total
1979	451	1,151	320	161	193	2,676
1980	515	1,827	365	211	232	3,150
1981	601	1,895	379	255	251	3,381
1982	642	1,996	387	287	268	3,580
1983	763	2,156	442	321	312	3,994
1984	818	2,496	463	363	332	4,472
1985	884	2,841	473	420	361	4,779
1986	953	2,948	466	467	348	5,182
1987	1,105	3,114	537	526	403	5,685
1988	1,188	3,282	555	547	437	6,009
1989	1,327	3,506	593	585	445	6,456
Aver. growth rate (%)	11.40	8.50	6.36	13.77	8.71	9.21

Average growth rate of the Gross Domestic Product (GDP) and the Gross Regional Domestic Product (GRDP) for recent 9-years from 1979 to 1988 were calculated at 0.6% and 3.3% respectively.

Accompanying the increase in economical activities of the nation and living standards of the people, the power market has also expanded at annual rate higher than that of GDP and GRDP.

In order to examine the relation between growth of regional economy and power consumption, the coefficients of correlation between the GRDP of the state of Santa Catarina and energy consumption of each class and between the residential and other uses from 1979 to 1988 were calculated as follows ;

	Correlation Coefficient Between	
	GRDP and Each Class	Residential and Others
Residential	0.955	-
Industrial	0.954	0.981
Commercial	0.923	0.951
Rural	0.964	0.994
Public & Others	0.932	0.990

This table shows that there is good correlation not only between GRDP and energy consumption for residential, industrial, commercial, rural and public uses but also between residential and other uses.

4.4 Electric Tariffs

The electric power and energy tariff system has been established by DNAEE for the power supply to the consumers and for the power trading between the concessionaires. The tariffs were revised and published by the official gazetteers on Mar. 15 and Jun. 07, 1990 respectively.

The major tariff schedules are as follows ;

(1) Tariffs for consumers

- Large consumer

A3	- 69 KV	- Power	14.32	US$/kW
		Energy	36.02	US$/MWh
A3a	- 30KV to 44 KV	- Power	5.15	US$/kW
		Energy	79.40	US$/MWh
A4	- 2.3 KV to 25 KV	- Power	5.78	US$/kW
		Energy	84.55	US$/MWh
A5	- Underground	- Power	8.15	US$/kW
		Energy	84.55	US$/MWh

- Small consumer

Residential (B1);

Less than	30	kWh		55.82 US$/MWh
Between	31	and	100 kWh	89.31 US$/MWh
Between	101	and	200 kWh	111.64 US$/MWh
Between	201	and	300 kWh	171.18 US$/MWh

More than	300 kWh	186.06 US$/MWh
Rural (B2);		84.76 US$/MWh
Other (B3);		162.87 US$/MWh
Public illumination (B4);		50.94 US$/MWh

Remark : 1US$=CR$ 45.00, on 15, Mar. 1990

(2) Tariffs Between Concessionaires

The marginal cost tariff has been applied to the power trading between CELESC and ELETROSUL or other regional concessionaire. It consists of the sum of tariff T_1, tariff T_2 and tariff T_3. Tariff T_1 is the tariff for long term contracted power energy (E_1) set out by the Electric System Planning Coordination Group (GCPS). Tariff T_2 is the tariff for the difference between short term contracted power energy (E_2) estimated by operational plan of CELESC and E_1. Tariff T_3 is the tariff for the difference between actually consumed power energy (E_3) and E_2. The tariffs for respective T_1, T_2 and T_3 are as follows;

- ELETROSUL ---> CELESC

(Tariff T_1)	Energy	(US$/MWh)	(T_1)	28.88
	Power	(US$/kW)		
	Peak		(T_1P)	5.47
	Off peak		(T_1FP)	0.33

- ELETROSUL ---> CELESC

(Tariff T_2)	Energy	(US$/MWh)	(T_2)	9.63
	Power	(US$/kW)		
	Peak		(T_2P)	1.82
	Off peak		(T_2FP)	0.11

- Regional Concessions

(Tariff T_3)	Energy	(US$/MWh)	(T_3)	0.96

Power	(US$/kW)		
Peak		(T_3P)	0.18
Off peak		(T_3FP)	0.01
Energy	(US$/MWh)	(T_3S)	21.54

Remark : 1 US$ = CR$ 55.66, on 07 Jun. 1990

The average electric power tariff in Brazil declined from US$ 53.3/MWh in December 1988 to US$ 37.4/MWh in May 1989. Then, the prices for the tariffs was revised as stated before. Generally, the average tariff seems to be still cheaper than in such countries as Middle and South America.

5. POWER DEMAND FORECAST

5.1 Demand Forecast for whole Brazil and South/Southeast System

The National Electric Energy Plan for 1987/2010 (Plano 2010) was reviewed and revised in the 10-year Expansion Plan (1990-1999) issued by GCPS and approved by the Ministry in January 1990.

The latest demand projection in the 10-year plan in whole Brazil and south/southeast system is shown in Table IV.5.1 and summarized as follows ;

Region	1989	1990	1995	2000
(Whole Brazil)				
Energy (GWh);				
North	7,801	9,107	15,962	22,576
Northeast	30,251	32,408	47,810	62,884
Southeast	122,647	128,484	164,354	209,074
Middle West	8,000	8,827	14,122	20,161
South	26,687	27,959	38,109	49,562
Total	195,386	206,785	280,357	364,257
(South/Southeast)				
Energy (GWh)	149,334	156,443	202,463	258,636
Power (MW) ∠1	25,990	27,140	33,890	41,940

Remark ∠1 ; Power was calculated based on the assumed load factors between 0.656 and 0.704.

5.2 Demand Forecast for CELESC System

Power demand forecast in state of Santa Catarina is made and reviewed every year by CELESC referring to the current state economic activity and also a past trend of energy supply. The latest demand forecast up to 2001, which forecast each class of consumer on July 1990 by CELESC is shown in Table IV 5.2 and summarized as follows ;

	1989 /1	1990	1995	2000	2001
Energy (GWh)					
Consumption	6,457	6,563	8,596	10,985	11,513
Bulk supply	103	110	137	169	176
Losses, others	501	502	657	840	880
Total required	7,061	7,175	9,390	11,994	12,569
Power (MW)	1,228	1,246	1,571	1,938	2,020

Remark /1 : Actual values

CELESC's forecast was made based by ELETROBRAS's method. This forecast was reviewed by division into sectors. Major parameters to assess the power demand are assumed as follows;

Parameter	Category of Consumer				
	Residential	Industrial	Commercial	Rural	Public and Others
(i) Annual growth rate of energy consumption (%)	5 ~ 8	5 ~ 7	4.5 ~ 5.5	4 ~ 7	3 ~ 5
(ii) Annual growth rate of population (%)	1.8	-	-	-	-
(iii) Annual growth rate of GRDP (%)	-	3	-	-	-

The power demand for each sector was assessed using the foregoing assumed values and summed up to compare with the power demand forecasted by CELESC. The result of this comparison showed that the power demand curve assessed in this study approximately coincides with that forecasted by CELESC. Thus it was concluded that CELESC's forecast is reasonable.

6. POWER BALANCE

6.1 Power Expansion Program

In compliance with the foregoing demand forecast, ELETROBRAS provided a power generation expansion program for National Electric Power Plan (Plano 2010) for 1987/2001 and it was revised by GCPS in 1989.

The electric power plants taken up in this power generation program comprise large scale power plants selected from among an inventory study and consist of the existing power plants, power plants under construction and/or committed their construction within the state of Santa Catarina and in the south/southeast power system. Table IV.6.1 shows the power expansion projects which are planned within the state of Santa Catarina. Table IV.6.2 shows the power expansion program for the south/southeast power system. They are summarized as follows:

(1) Power expansion program in the state of Santa Catarina

Year	Installed capacity (MW)	
	CELESC	ELETROSUL
1990	3.8	-
1991	0.9	350
1992	15.0	-
1993	65.0	-
1994	-	-
1995	-	810
1996	-	810
1997	-	440
1998	-	1,640
1999	-	72
2000 onward	-	2,964

(2) Power expansion program in south/southeast system

Year	Installed Capacity (MW)			Firm Energy
	Hydro	Thermal	Total	(GWh/year)
(Existing plants)				
Southeast	21,870	1,907	23,777	96,600
South	5,617	1,140	6,757	27,400
ITAIPU	10,500	-	10,500	42,600
(Ongoing and new plants)				
1990	2,478	-	2,478	10,061
1991	1,205	350	1,555	6,314
1992	846	350	1,196	4,856
1993	683	450	1,133	4,600
1994	1,641	1,050	2,691	10,926
1995	3,019	1,720	4,739	19,242
1996	1,894	-	1,894	7,690
1997	2,894	350	3,244	13,171
1998	3,219	1,245	4,464	18,125
1999	2,668	350	3,018	12,254
2000 to 2004	6,039	-	6,039	24,520

Remark ; Firm energy was calculated using the assumed capacity factor of 0.4635 which is 90% of capacity factor of south/southeast system in 1989.

6.2 Balance of Power

The relationship between the demand forecast and power expansion program for the south/southeast power system including CELESC's one is shown in Figs IV.6.1 and IV.6.2. These figures show that both power output and energy between demand and supply are in balance with a reasonable reserve of power. While, CELESC's own power supply capacity will increase to about 11% of the total power demand in 1993. If there are no power scheme to be developed afterward, share of power energy to be generated by CELESC to the total demand will remarkably reduce as the power demand increases.

7. POSSIBILITY OF ALTERNATIVE THERMAL POWER PLANT

CELESC has no intention to construct a thermal power plant at present because of its high construction cost.

In order to study the possibility of coal fired thermal power plant as an alternative plan of hydro power plants in the Itajai river basin, the viability study for "URUSSANGA" Power Plant was reviewed and following energy cost of coal fired thermal plant was estimated;

Unit Capacity (MW)	Energy Cost (US$/MWh)
18	81
22	77
33	72
50	65

Result of the hydropower inventory survey clarified that the unit cost of the guaranteed energy is US$17 to 18/MWh for unit capacity of 35 to 60 MW and US$63 to 68/MWh for unit capacity of 5 to 8 MW. Comparing these unit costs of the guaranteed energy with the foregoing energy costs of coal fired power plant for respective capacities, it was concluded that hydropower project is more economical than the coal fired power plant for all cases of unit capacity.

TABLES

Table IV.3.1 EXISTING POWER STATIONS IN SOUTH/SOUTHEAST POWER SYSTEM (1989) (1/4)

Enterprise	Power Station	Type	Installed Capacity (MW)
Region; Southeast			
CERJ	S. Hydro ∠2 Total	H ∠1	(66.4)
CEB	Paranoa	H	27.0
	Thermal	T ∠3	10.0
	Total	-	(37.0)
CELG	C. Dourada	H	439.0
	S. Hydro Total	H	10.0
	Thermal	T	3.0
	Total	-	(452.0)
ESCELSA	Mascarenhas	H	104.0
	S. Hydro Total	H	51.4
	Suissa		30.0
	Others		21.4
	Total	-	(155.4)
CEMAT	S. Hydro Total	H	22.0
	Thermal	T	6.0
	Total	-	(28.0)
CPFL	Public Producers	H	5.0
	Others	H	90.0
	Carioba	T	30.0
	Total	-	(125.0)
ELETROPAULO	H. Borden	H	719.0
	Public Produc.	H	9.0
	Rasgao	H	22.0
	Others	H	18.0
	Piratininga	T	410.0
	Total	-	(1,178.0)
CESP	Caconde	H	80.4
	Euclides Cunha	H	108.8
	A. S. Oliveira	H	32.2
	Agua Vermelha	H	1,380.0
	Ilha Solteira	H	3,230.0
	Jupia	H	1,411.2

Remarks: ∠1; H means hydropower plant.
∠2; S. Hydro means small scale hydropower plant.
∠3; T means thermal power plant.
∠4; N means nuclear power plant.

Table IV.3.1 EXISTING POWER STATIONS IN SOUTH/SOUTHEAST POWER SYSTEM (1989) (2/4)

Enterprise	Power Station	Type	Installed Capacity (MW)
CESP	Barra Bonita	H	140.8
	A. S. Lima	H	143.1
	Ibitinga	H	131.5
	Promissao	H	264.0
	N. Avanhandava	H	302.4
	A. A. Laydner	H	97.0
	Xavantes	H	414.0
	I. N. Garcez	H	70.4
	Capivara	H	640.0
	Rosana	H	80.0
	Paraibuna	H	85.0
	Jaguari	H	27.6
	S. Hydro	H	15.0
	Total	-	(8,654.2)
LIGHT	Nilo Pecanha	H	324.7
	Fontes	H	110.5
	Pereira Passos	H	93.5
	Ilha Dos Pombos	H	167.6
	Total	-	(696.3)
CEMIG	Camargos	H	45.0
	Itutinga	H	48.6
	Jaguara	H	425.6
	Volta Grande	H	380.0
	Emborcacao	H	1,000.0
	Sao Simao	H	1,608.0
	Tres Marias	H	387.6
	Salto Grande	H	102.0
	S. Hydro Total	H	140.0
	(Subtotal)	-	(4,136.8)
	Igarape	T	125.0
	Diamantina	T	3.0
	(Subtotal)	-	(128.0)
	Total	-	(4,264.8)
FURNAS	Furnas	H	1,216.0
	M. De Moraes	H	476.0
	Estreito	H	1,050.0
	Porto Columbia	H	320.0
	Marimbondo	H	1,440.0
	Funil	H	216.0
	Itumbiara	H	2,082.0
	(Subtotal)	-	(6,800.0)

Table IV.3.1 EXISTING POWER STATIONS IN SOUTH/SOUTHEAST POWER SYSTEM (1989) (3/4)

Enterprise	Power Station	Type	Installed Capacity (MW)
FURNAS	Santa Cruz	T	600.0
	P. Silveira	T	30.0
	Sao Goncalo	T	33.0
	(Subtotal)	T	(663.0)
	Angra	N ∠4	657.0
	Total	-	(8,120.0)
Region; Southeast		H	21,870.1
		T	1,250.0
		N	657.0
	Total	-	(23,777.1)
Region; South			
CEEE	Passo Real	H	125.0
	Jacui	H	150.0
	Itauba	H	500.0
	Bugres	H	11.0
	Canastra	H	44.0
	Others	H	21.0
	(Subtotal)	-	(851.0)
	P. Medici A	T	126.0
	P. Medici B	T	320.0
	San Jeronimo	T	20.0
	Nutepa	T	24.0
	(Subtotal)	-	(490.0)
	Total	-	(1,341.0)
COPEL	G. B. Munhoz	H	1,674.0
	G. P. Souza	H	247.0
	J. Mesquita F	H	44.1
	Guaricana	H	39.0
	Others	H	53.7
	(Subtotal)	H	(2,057.8)
	Figueira	T	20.0
	Total	-	(2,077.8)

Table IV.3.1 EXISTING POWER STATIONS IN SOUTH/SOUTHEAST POWER SYSTEM (1989) (4/4)

Enterprise	Power Station	Type	Installed Capacity (MW)
ELETROSUL	Passo Fundo	H	220.0
	Salto Osorio	H	1,050.0
	Salto Santiago	H	1,352.0
	(Subtotal)	H	(2,602.0)
	J. Lacerda A + E	T	482.0
	Charqueadas	T	72.0
	Alegrete	T	66.0
	(Subtotal)	T	(620.0)
	Total	-	(3,222.0)
CELESC	S. Hydro Total	H	(75.0)
ENERSUL	S. Hydro	H	31.6
	Thermal	T	9.4
	Total	-	(41.0)
Region; South		H	5,617.4
		T	1,139.4
	Total	-	(6,756.8)
Region; Southeast		H	21,870.1
		T	1,250.0
		N	657.0
	Total	-	(23,777.1)
ITAIPU Binational		50 HZ	6,300.0
		60 HZ	4,200.0
	Total	-	(10,500.0)
Total -- Southeast/South/ITAIPU Binational			41,033.9

Table IV.3.2 EXISTING POWER STATIONS IN SANTA CATARINA (1989)

(1) Owned by CELESC

Name of Station	Type	Installed Capacity (MW)	Firm Capacity (MW)	Firm Energy (MWh/year)	Commission Date
Palmeiras	Hydro	17.6	6.9	60000	1964
Garcia	Hydro	9.6	4.8	42000	1963
Cedros	Hydro	7.6	4.3	38000	1949
Salto	Hydro	6.3	4.3	38000	1914
Brachinho	Hydro	16.5	3.6	32000	1931
Celso Ramos	Hydro	5.8	2.6	22800	1963
Caveiras	Hydro	3.8	2.6	22800	1920
Ivo Silveira	Hydro	3.0	2.4	21000	1967
Peri	Hydro	1.4	1.4	12300	1965
Pirai	Hydro	1.5	0.5	4300	1908
Rio do Peixe	Hydro	0.7	0.5	4300	1956
Sao Lourenco	Hydro	0.5	0.3	2600	1914
Total		74.3	34.2	300100	

(2) Owned by ELETROSUL

Name of Station	Type	Installed Capacity (MW)	Firm Capacity (MW)	Firm Energy (GWh/year)	Commission Date
Jorge Lacerda I	Thermal	100			Mar/1964
Jorge Lacerda II	Thermal	132	385 /1	3300 /2	Jun/1963
Jorge Lacerda III	Thermal	250			Nov/1949
Total		482	385	3300	

/1: Figure shows sum of firm capacity in three stations.

/2: Figure shows sum of firm energy in three stations.

Table IV.3.3 EXISTING SUBSTATIONS (CELESC) (1/5)

Name	Trans. ⊿1	Capacity (MVA)	Voltage (kV / kV)
Coqueiros	TT1	25	69 / 13.8
	TT2	25	69 / 13.8
	TT3	12.5	69 / 13.8
Ilha Norte	TT1	16.67	138 / 13.8
Rocado	TT4	26.67	138 / 13.8
	TT5	26.67	138 / 13.8
Tijucas	TT1	26.67	138 / 23
Trindade	TT1	26.67	138 / 13.8
	TT2	26.67	138 / 13.8
Canoinhas	TT1	16.67	138 / 13.8
	TT2	16.67	138 / 13.8
Jaragua do Sul	TT1	16.67	69 / 13.8
	TT2	25	69 / 13.8
	TT3	15.65	69 / 34.5
	TT4	26.67	138 / 13.8
Joinville I	TT1	12	69 / 34.5
	TT2	10	69 / 13.8
Joinville III	TT1	26.67	69 / 13.8
	TT2	15.65	69 / 13.8
Joinville IV	TT1	66.67 ~ 26.67	138 / 69 ~ 138 / 13.8
	TT2	66.67 ~ 26.67	138 / 69 ~ 138 / 13.8
	TT3	66.67 ~ 26.67	138 / 69 ~ 138 / 13.8
Joinville V	TT1	7.5	69 / 13.8
	TT2	9.4	69 / 13.8
	TT3	9.4	69 / 13.8
	TT4	7.5	69 / 13.8
Mafra	TT1	12.5	138 / 69
	TT2	16.67	69 / 13.8
	TT3	16.67	69 / 13.8
	TT4	12.5	138 / 69
	TT5	7.5	69 / 34.5
Rio Negrinho	TT1	16.67	138 / 13.8
Sao Bento do Sul	TT1	16.67	138 / 13.8
	TT2	26.67	138 / 13.8
Sao Francisco do Sul	TT1	15.65	69 / 13.8
	TT2	10	69 / 13.8

⊿1; TT1 to TT8 mean series No. of transformer.

Table IV.3.3 EXISTING SUBSTATIONS (CELESC) (2/5)

Name	Trans.	Capacity (MVA)	Voltage (kV / kV)
Blumenau Garcia	TT1	33.33	138 / 69
	TT2	31.25	138 / 69
	TT3	33.33	138 / 69
	TT4	15.65	69 / 23
	TT5	15.67	69 / 23
	TT6	16.87	69 / 23
	TT8	7.5	69 / 23
Blumenau II	TT1	26.67	138 / 69
	TT2	25	138 / 69
	TT4	66.67	138 / 69
	TT5	66.67	138 / 69
	TT7	9.375	69 / 13.8
Brusque	TT1	16.6	69 / 23
	TT2	26	138 / 23
	TT3	26	138 / 23
Camboriu	TT1	16.67	69 / 13.8
	TT2	10	69 / 13.8
	TT3	10	69 / 13.8
	TT7	10	69 / 23
	TT8	9.4	69 / 23
Ibirama	TT1	7.5	69 / 23
	TT2	7.5	69 / 23
Itajai Salseiros	TT1	16.67	69 / 23
	TT2	16.67	69 / 23
	TT3	16.67	69 / 23
Picarras	TT1	16.67	69 / 13.8
Rio do Sul	TT1	15	69 / 23
	TT2	9.4	69 / 23
	TT3	10	69 / 23
Rio do Sul II	TT2	33.33	138 / 69
	TT3	26.67	138 / 23
Salto	TT1	11	69 / 23
	TT2	11	69 / 23
	TT3	13.2	69 / 23
Timbo	TT3	9.4	69 / 23
	TT4	26.67	69 / 23
	TT5	9.4	69 / 23
Otacilio Costa	TT1	33.33	138 / 69
	TT2	31.25	69 / 23
	TT4	33.33	138 / 69

Table IV.3.3 EXISTING SUBSTATIONS (CELESC) (3/5)

Name	Trans.	Capacity (MVA)	Voltage (kV / kV)
Ponte Alta	TT1	3.125	69 / 23
Sao Cristovao	TT2	16.67	69 / 23
Sao Joaquim	TT1	9.4	138 / 23
Vidal Ramos Jr.	TT1	33.3	138 / 69
	TT2	33.3	138 / 69
	TT5	10	69 / 23
	TT6	26.67	69 / 23
Cacador	TT1	16.67	138 / 23
	TT2	16.67	138 / 23
Capinzal	TT1	9.375	69 / 23
	TT2	6.25	69 / 23
	TT3	3.125	69 / 23
Campos Novos	TT1	16.67	138 / 23
Fraiburgo	TT1	10	69 / 23
	TT2	10	69/ 23
Herval D'Oeste	TT2	33.33	138 / 69
	TT3	12.5	138 / 69
	TT5	16.67	69 / 23
	TT6	16.67	69 / 23
Videira	TT1	26.67	138 / 23
	TT3	15.6	138 / 69
Arabuta	TT1	3.125	69 / 23
	TT2	3.125	69 / 23
Chapeco	TT1	16.67	69 / 23
	TT2	16.67	69 / 23
	TT3	26.67	69 / 23
Concordia	TT1	10	69 / 13.8
	TT2	12.5	69 / 13.8
Faxinal dos Guedes	TT1	3.125	69 / 23
	TT2	10	69 / 23
Itapiranga	TT1	7.5	69 / 23
	TT2	7.5	69 / 23
Pinhalzinho	TT1	9.375	69 / 23
	TT2	16.67	69 / 23
	TT3	26.67	138 / 23

Table IV.3.3 EXISTING SUBSTATIONS (CELESC) (4/5)

Name	Trans.	Capacity (MVA)	Voltage (kV / kV)
Sao Miguel D'Oeste	TT1	15	69 / 23
	TT2	10	69 / 23
Sao Miguel D'Oeste II	TT1	33.33	138 / 69
Seara	TT1	9.375	69 / 23
	TT2	9.375	69 / 23
Xanxere	TT1	33.33	138 / 69
	TT2	33.33	138 / 69
	TT3	10	69 / 23
	TT4	26.66	138 / 23
	TT5	66.6	138 / 69
Ararangua	TT1	16.67	69 / 13.8
Braco do Norte	TT1	10	69 / 13.8
Criciuma	TT1	26.67	69 / 13.8
	TT2	26.67	69 / 13.8
Ermo	TT1	6.25	69 / 13.8
Forquilhinha	TT1	12.5	69 / 13.8
	TT2	12.5	69 / 13.8
Gravatal	TT1	3.125	69 / 13.8
Icara	TT1	16.67	69 / 13.8
	TT3	6.25	44 / 13.8
Imbituba	TT3	16.67	138 / 13.8
	TT4	16.67	138 / 13.8
	TT5	10	44 / 13.8
Jaguaruna	TT1	6.25	69 / 13.8
Lauro Muller	TT1	10	69 / 13.8
Maracaja	TT1	6.25	69 / 13.8
Sideropolis	TT1	6.25	69 / 13.8
	TT2	6.25	69 / 13.8
Sombrio	TT1	10	69 / 13.8
Tubarao	TT1	26.6	69 / 13.8
	TT2	26.6	69 / 13.8
	TT3	5	44 / 13.8
Tubarao II	TT1	10	69 / 13.8

Table IV.3.3 EXISTING SUBSTATIONS (CELESC) (5/5)

Name	Trans.	Capacity (MVA)	Voltage (kV / kV)
Urussanga	TT1	10	69 / 13.8
	TT2	10	69 / 13.8
	TT3	6.25	69 / 13.8
Azambuja	TT1	3.125	44 / 13.8
Esperanca	TT1	6.25	44 / 13.8
Laguna	TT1	10	44 / 13.8
Nova Veneza	TT1	1	44 / 2.3
Sideropolis Velha	TT1	0.5	44 / 2.3
Palhoca	TT1	26	138 / 13.8
Ilha Centro	TT1	33.3	138 / 13.8
	TT2	33.3	138 / 13.8
Picarras	TT1	26	138 / 13.8
Itajai II	TT1	26	138 / 23
	TT2	26	138 / 13.8
Gaspar	TT1	26	138 / 23
Trombudo Central	TT1	26	138 / 23
Chapeco II	TT1	26	138 / 23
Palmitos	TT1	26	138 / 23
Sao Lourenco D'Oeste	TT1	16	138 / 23

Table IV.4.1 ANNUAL BALANCE OF ELECTRIC ENERGY IN CELESC (1979 - 1989)

(Unit: kWh)

Specifications	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1. Own Generation	367,561,796	446,635,955	407,319,367	413,534,210	482,337,357	404,018,324	332,552,353	281,293,962	411,467,634	375,335,322	385,758,503
1.1 Hydro	367,267,816	446,510,755	407,286,767	413,502,860	482,312,487	404,007,224	332,551,913	281,293,962	411,467,634	375,335,322	385,758,503
1.2 Thermal	293,980	125,200	32,600	31,350	24,870	11,100	440	0	0	0	0
2. Energy Received	2,692,794,105	3,071,754,933	3,350,406,634	3,626,847,459	3,877,355,402	4,489,566,318	5,079,090,790	5,340,419,090	5,766,990,767	6,208,555,667	6,674,854,706
2.1 Electrosul	2,660,581,383	3,048,002,453	3,329,473,906	3,615,488,199	3,868,328,202	4,489,566,318	4,827,021,795	4,687,024,806	4,535,966,870	4,708,000,863	4,651,851,594
2.2 Itaipu	0	0	0	0	0	0	252,068,995	653,394,284	1,231,023,897	1,496,514,504	2,002,628,312
2.3 Hidreletrica Xanxere	23,348,448	20,454,880	20,932,728	11,359,260	9,027,200	0	0	0	0	0	0
2.4 Cia de Papel Chapeco	4,097,000	0	0	0	0	0	0	0	0	0	0
2.5 Copel (PR) - Porto Uniao	4,535,914	3,297,600	0	0	0	0	0	0	0	2,501,100	3,943,200
2.6 Copel (PR) - Itapoa	0	0	0	0	0	0	0	0	0	0	3,788,400
2.7 Ceee (RS)	231,360	0	0	0	0	0	0	0	0	0	0
2.8 Fabrica de Papel Primo Tedesco	0	0	0	0	0	0	0	0	0	1,539,200	12,643,200
3. Energy Required	3,060,355,901	3,518,390,888	3,757,726,001	4,040,381,669	4,359,692,759	4,893,584,642	5,411,643,143	5,621,713,052	6,178,458,401	6,583,890,989	7,060,613,209
4. Energy supply	156,402,998	183,857,744	188,426,726	162,751,951	41,684,703	70,531,831	85,204,356	90,616,666	98,627,350	99,223,674	102,981,432
4.1 Cia Docas de Imbituba	17,058,496	18,893,476	19,263,713	6,586,774	0	0	0	0	0	0	0
4.2 Empresa Forca e Luz Joao Cesa	1,489,548	1,731,948	2,256,551	2,057,376	2,098,320	2,148,600	2,532,072	2,510,496	2,621,856	3,201,312	3,398,496
4.3 Empresa Forca e Luz Ararangua	17,151,080	20,493,750	13,622,568	0	0	0	0	0	0	0	0
4.4 Forca e Luz Criciuma	113,182,632	132,804,828	142,312,556	142,573,450	0	0	0	0	0	0	0
4.5 Forca e Luz Guardense	313,908	0	0	0	0	0	0	0	0	0	0
4.6 Forca e Luz Nova Veneza	654,884	1,018,484	1,107,364	1,156,248	1,342,664	1,394,000	1,583,200	1,688,400	1,943,600	2,185,200	2,385,500
4.7 Forca e Luz Sao Bento	0	0	0	0	0	0	0	0	0	0	0
4.8 Forca e Luz Urussanga	6,552,450	8,915,258	9,863,974	10,378,103	12,261,600	16,313,440	21,451,104	22,960,416	24,110,064	22,497,696	25,192,344
4.9 Hidreletrica Xanxere	0	0	0	0	25,982,119	50,675,791	59,637,980	63,457,354	69,951,830	71,339,466	72,004,992
5. Consumption Total	2,676,177,969	3,149,874,274	3,380,061,559	3,579,526,149	3,993,766,172	4,472,742,119	4,979,502,421	5,181,642,907	5,685,205,225	6,008,591,491	6,456,704,745
5.1 Residential	450,987,677	515,189,978	600,596,205	642,423,998	763,322,924	817,736,973	883,842,455	952,642,306	1,104,761,931	1,188,218,844	1,326,651,373
5.2 Industrial	1,551,169,144	1,827,352,839	1,895,016,379	1,995,513,189	2,155,807,371	2,496,113,014	2,840,939,152	2,947,883,116	3,113,514,044	3,281,996,744	3,506,689,574
5.3 Commercial	320,005,627	364,900,153	378,974,287	386,785,497	441,787,213	463,363,780	472,902,392	466,123,733	537,254,354	555,211,189	593,415,110
5.4 Rural	55,216,742	75,279,404	102,135,761	118,037,486	150,707,100	175,960,052	206,667,634	227,020,792	259,776,249	272,985,549	293,534,735
5.5 Rural Cooperation	106,252,511	135,312,172	152,612,319	168,871,584	170,197,731	187,091,440	213,765,688	239,702,041	266,455,170	273,643,649	291,489,190
5.6 Public Power	59,298,299	73,214,206	78,301,995	70,800,593	75,196,075	79,435,386	89,117,816	84,162,817	99,659,808	115,441,201	116,778,687
5.7 Public Illumination	105,898,954	123,800,496	131,092,533	140,983,679	167,100,603	173,661,382	187,295,976	173,697,543	205,022,568	214,256,009	216,328,040
5.8 Public Service	22,121,204	28,483,152	33,373,194	48,566,014	61,047,024	71,201,265	76,896,278	83,268,865	89,698,387	98,131,414	103,456,385
5.9 Own Use	5,227,811	6,341,874	7,958,886	7,544,109	8,600,131	8,178,827	8,075,030	7,141,694	9,062,714	8,706,892	8,361,651
6. Losses, Diff.	227,774,934	184,658,870	189,237,716	298,103,569	324,241,884	350,310,692	346,936,366	349,453,479	394,625,826	476,075,824	500,927,032
7. Max.Demand (kWh/h)	564,700	643,200	700,800	758,100	824,200	894,800	967,600	1,003,500	1,081,300	1,135,400	1,228,400
8. No. of Clients	477,930	527,656	589,448	670,029	735,064	777,720	819,911	868,834	910,792	960,092	1,013,717
8.1 Residential	375,096	413,154	456,841	504,549	557,091	589,215	620,115	654,448	687,857	727,937	772,528
8.2 Industrial	6,989	7,312	7,764	8,076	8,899	11,319	13,414	17,038	18,490	19,430	20,837
8.3 Commercial	49,348	53,040	57,020	60,578	65,103	65,682	66,307	70,499	73,321	75,837	78,623
8.4 Rural	41,266	48,437	61,434	89,562	96,226	103,043	110,798	116,751	120,372	125,268	129,749
8.5 Public Power	4,857	5,303	5,936	6,368	6,746	7,350	8,095	8,844	9,455	10,205	10,567
8.6 Public Illumination	176	180	185	190	213	221	215	212	247	270	216
8.7 Public Service	198	230	268	412	467	511	541	590	592	644	672
8.8 Own Consumer	0	0	0	294	319	379	426	452	458	501	525
9. No. of Supply Points	19	22	15	15	5	6	6	6	5	5	5
Annual Load Factor (%)	61.87	62.44	61.21	60.84	60.38	62.43	63.85	63.95	65.23	66.20	65.61

Table IV.4.2 TYPICAL DAILY POWER DEMAND OF WHOLE CELESC AND ITAJAI RIVER BASIN

Hour	19/07/89 - Wed. Itajai	CELESC	20/09/89 - Wed. Itajai	CELESC	22/11/89 - Wed. Itajai	CELESC	30/01/90 - Tue. Itajai	CELESC	07/03/90 - Wed. Itajai	CELESC	03/07/90 - Tue. Itajai	CELESC	07/07/90 - Sat. Itajai	CELESC	08/07/90 - Sun. Itajai	CELESC
1	141.7	728.8	139.6	723.9	151.2	805.1	167.9	871.6	153.9	748.5	145.3	707.8	150.2	717.5	78.2	538.5
2	136.7	700.2	137.6	699.7	147.2	779.9	158.9	816.8	146.9	714.4	137.3	663.4	142.2	683.4	76.2	512.9
3	144.7	698.5	135.6	688.8	145.2	766.0	155.9	801.4	144.9	706.4	139.3	664.4	143.2	670.4	71.2	492.1
4	140.7	689.9	138.6	687.3	147.0	757.4	156.9	787.8	146.9	702.4	142.3	663.3	142.2	657.3	70.2	482.5
5	142.7	699.9	139.6	697.0	147.0	767.9	157.9	799.7	148.9	708.4	144.3	678.4	143.2	655.2	68.2	475.5
6	162.7	759.7	156.6	761.8	162.0	817.2	173.9	848.7	165.9	761.1	161.3	743.9	148.2	674.7	63.2	470.5
7	180.4	862.3	172.6	820.3	175.0	872.3	186.9	900.7	180.9	824.1	185.3	848.1	158.2	715.7	65.2	477.6
8	195.4	961.8	183.6	919.2	188.0	969.9	195.9	966.1	192.9	915.7	201.3	974.3	166.2	741.4	66.2	460.3
9	193.4	987.0	182.6	952.2	193.2	1028.7	201.9	1039.5	192.9	960.2	193.3	1000.8	165.2	763.4	65.2	464.8
10	200.5	1004.5	189.6	977.0	197.0	1062.3	212.9	1073.8	205.9	990.8	201.3	1022.8	166.2	771.0	72.2	483.5
11	203.3	1016.2	199.6	1010.7	205.0	1097.3	221.9	1109.6	210.9	1064.3	210.3	1044.2	167.2	769.0	74.2	491.6
12	202.5	984.1	201.6	996.3	210.0	1095.0	222.9	1087.0	215.9	1066.9	210.3	1020.0	167.2	754.8	73.2	490.9
13	175.4	835.4	171.6	847.3	186.2	969.8	199.9	980.3	185.9	928.5	178.3	871.3	150.2	686.0	68.3	464.3
14	187.4	941.7	182.6	930.4	204.2	1066.5	215.9	1088.1	201.9	1030.4	192.3	969.7	111.2	630.9	66.3	462.3
15	200.4	990.0	195.6	980.3	213.4	1131.0	227.9	1145.6	217.9	1092.4	202.3	1020.7	116.2	658.2	68.3	468.5
16	195.4	977.2	193.6	973.5	213.4	1112.8	223.9	1135.1	209.9	1074.8	204.4	1020.8	121.2	665.8	67.3	461.6
17	201.4	986.8	193.6	961.0	212.4	1101.0	220.9	1117.7	208.9	1057.1	206.4	1034.6	126.2	678.5	69.3	467.4
18	206.1	1049.2	187.6	942.5	193.4	1012.3	200.9	1021.7	197.9	1004.8	210.4	1066.1	138.2	792.3	85.3	577.6
19	229.9	1226.0	213.6	1110.9	182.4	971.2	190.9	938.7	195.9	1018.7	239.4	1240.3	165.2	1009.0	120.3	820.0
20	219.9	1138.3	225.6	1182.5	191.4	990.6	189.9	944.5	229.9	1223.2	223.4	1138.3	144.2	904.0	113.3	784.5
21	206.9	1069.2	213.6	1103.6	221.4	1192.2	219.9	1134.4	222.9	1171.2	212.4	1083.7	132.2	823.6	108.3	739.9
22	189.4	989.8	192.6	1016.1	216.4	1166.1	227.9	1205.0	206.9	1103.7	193.3	992.3	118.2	747.0	100.3	684.7
23	165.4	879.6	169.6	907.9	195.2	1047.6	205.9	1088.9	179.9	987.1	172.3	891.2	98.2	671.0	118.3	657.9
24	153.4	798.2	155.6	811.8	172.2	917.3	186.9	988.9	166.9	897.6	155.3	786.6	87.2	599.2	130.3	624.6
Total	4375.7	21974.3	4272.4	21702.0	4469.8	23497.4	4724.6	23891.6	4531.6	22752.7	4461.8	22147.0	3367.8	17439.3	1959.0	13054.0
Aver.	182.3	915.6	178.0	904.3	186.2	979.1	196.9	995.5	188.8	948.0	185.9	922.8	140.3	726.6	81.6	543.9
Max.	229.9	1226.0	225.6	1182.5	221.4	1192.2	227.9	1205.0	229.9	1223.2	239.4	1240.3	167.2	1009.0	130.3	820.0
Load Factor	0.79	0.75	0.79	0.76	0.84	0.82	0.86	0.83	0.82	0.78	0.78	0.74	0.84	0.72	0.63	0.66

Table IV.4.3 MONTHLY PEAK DEMAND IN CELESC (1980 - 1989)

(Unit; MW)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Jan.	567.1	642.2	667.4	749.3	780.2	897.1	890.3	988.3	1,045.5	1,095.7
Feb.	571.8	650.8	673.2	755.3	824.9	892.6	797.8	1,034.3	1,075.2	1,124.8
Mar.	605.3	665.3	714.2	790.7	841.5	933.9	826.8	1,064.3	1,112.125	1,157.8
Apr.	632.0	670.8	717.5	794.0	833.6	941.3	939.0	1,066.8	1,117.508	1,191.8
May	641.8	700.8	746.4	804.0	894.8	966.6	988.3	1,058.5	1,129.961	1,209.5
Jun.	643.2	693.9	755.6	824.2	878.8	967.6	994.2	1,081.3	1,135.4	1,218.9
July	629.8	689.3	758.1	770.8	871.6	949.7	1,003.5	1,051.8	1,111.5	1,228.4
Aug.	621.1	671.0	735.2	772.5	837.3	942.0	980.4	1,037.0	1,083.9	1,225.7
Sep.	618.8	654.1	746.0	773.8	833.9	910.9	963.5	1,017.1	1,088.8	1,185.2
Oct.	632.9	664.2	738.1	799.4	886.8	948.9	994.7	1,040.4	1,080.2	1,215.2
Nov.	636.1	670.7	717.2	800.8	875.4	942.0	988.3	1,037.9	1,075.8	1,194.7
Dec.	634.2	642.5	719.7	778.7	871.1	918.2	977.0	1,019.0	1,080.5	1,165.5
Max	643.2	700.8	758.1	824.2	894.8	967.6	1,003.5	1,081.3	1,135.4	1,228.4

Table IV.5.1 POWER DEMAND FORECAST FOR BRAZIL

(Unit; MWh)

Power System	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
North	7,801.4	9,106.8	11,967.1	13,128.8	14,089.8	15,170.8	15,962.1	17,307.9	18,114.4	20,053.5	21,436.8	22,576.0
Northwest	30,251.0	32,407.8	37,167.5	40,007.4	42,628.8	45,175.4	47,809.7	50,965.9	53,270.6	56,718.9	60,010.3	62,883.9
Southeast	122,646.5	128,483.9	134,544.2	141,204.6	148,331.3	156,264.9	164,353.7	173,299.4	182,048.8	190,856.1	199,926.5	209,073.7
Central	7,999.8	8,827.2	9,712.6	10,624.0	11,761.4	12,772.5	14,122.2	15,433.4	16,567.8	17,777.1	18,899.8	20,160.5
South	26,687.0	27,958.4	30,056.8	32,150.9	34,078.3	36,117.0	38,109.1	40,278.5	42,429.9	44,973.2	47,254.3	49,562.4
Total	195,385.7	206,784.4	223,448.2	237,115.7	250,889.6	265,500.6	280,356.8	297,285.1	312,431.5	330,378.8	347,527.7	364,256.5
Southeast South	149,333.5	156,442.6	164,601.0	173,355.6	182,409.6	192,381.9	202,462.8	213,577.9	224,478.7	235,829.3	247,180.8	258,636.1
Load factor (%) ∠1	65.6	65.8	66.2	66.6	67.1	67.7	68.2	68.6	69.0	69.4	69.8	70.4
Max.demand (MW	25,987	27,141	28,384	29,714	31,033	32,439	33,889	35,541	37,138	38,791	40,425	41,938

Remark;

∠1; Load factors are assumed to be the same values as those of CELESC.

Table IV.5.2 POWER DEMAND FORECAST FOR CELESC

Items		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Consumption	(GWH)													
Residential		1326.7	1482.2	1596.4	1712.8	1833.2	1956.6	2080.6	2206.7	2334.6	2463.6	2598.3	2736.1	2876.8
Industrial		3506.7	3380.0	3400.6	3610.4	3850.0	4100.0	4309.1	4524.6	4750.8	4988.3	5237.7	5499.6	5774.6
Commercial		593.4	640.5	675.4	711.0	748.1	786.1	824.5	863.7	903.5	943.9	986.2	1029.6	1074.0
Rural		585.0	601.7	643.6	685.6	727.6	769.6	811.6	853.7	895.7	937.8	979.9	1022.0	1064.1
Public Ilumi.		216.3	223.2	232.4	241.4	250.6	259.7	268.8	278.0	287.1	296.2	305.3	314.4	323.4
Public Power		116.8	122.2	127.8	133.7	139.7	146.1	152.8	159.7	167.0	174.6	182.5	190.8	199.5
Public Services		103.5	105.0	110.0	117.9	124.2	131.5	139.2	147.5	155.4	163.9	172.8	181.9	190.5
Own Use		8.4	8.5	8.7	8.9	9.1	9.2	9.4	9.6	9.8	9.9	10.1	10.3	10.5
Total	(GWH)	6456.8	6563.4	6794.9	7221.7	7682.4	8158.8	8596.0	9043.4	9503.9	9978.1	10472.7	10984.6	11513.4
Bulk Supply	(GWH)	103.0	109.8	115.2	119.9	125.4	131.1	137.1	143.0	149.2	155.6	162.2	169.2	176.4
Losses and Diff.	(%)	7.1	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Losses and Diff.	(GWH)	500.8	502.3	520.1	552.6	587.7	624.0	657.3	691.5	726.6	762.8	800.5	839.5	879.9
Energy Req.	(GWH)	7060.6	7175.5	7430.2	7894.2	8395.5	8913.9	9390.4	9877.9	10379.7	10896.5	11435.4	11993.4	12569.7
Aver. MW Req.	(MW)	806.0	819.1	848.2	898.7	958.4	1017.6	1072.0	1124.5	1184.9	1243.9	1305.4	1365.4	1434.9
Load Factor	(%)	65.6	65.8	66.2	66.6	67.1	67.7	68.2	68.6	69.0	69.4	69.8	70.4	71.0
Req.Power	(MW)	1228.4	1245.7	1281.8	1348.6	1427.4	1502.2	1570.9	1638.4	1716.1	1791.2	1868.9	1938.3	2019.8

Table IV.6.1 POWER EXPANSION PROGRAM IN SANTA CATARINA

	Enterprise	Commission Date	Name of Plant	Type	Installed Capacity (MW)
1989	ELETROSUL	(Total, Existing)			(Total) 482.0
	CELESC	(Total, Existing)			(Total) 74.3
1990	CELESC	31/05/90	Celso Ramos	H	0.8
	"	31/10/90	Peri	H	3.0
1991	CELESC	31/12/90	Maroin	H	0.9
	ELETROSUL	30/06/91	J. Lacerda IV	T	350
1992	CELESC	31/05/92	Garcia II	H	15
1993	CELESC	31/05/93	Cubatao	H	45
	"	31/11/93	Xanxere	H	20
1995	ELETROSUL	30/06/95	Ita No.1	H	270
	"	30/09/95	Ita No.2	H	270
	"	31/12/95	Ita No.3	H	270
1996	ELETROSUL	31/03/96	Ita No.4	H	270
	"	30/06/96	Ita No.5	H	270
	"	30/09/96	Ita No.6	H	270
1997	ELETROSUL	30/09/97	Campos Novos No.1	H	220
	"	31/12/97	Campos Novos No.2	H	220
1998	ELETROSUL	31/03/98	Campos Novos No.3	H	220
	"	30/06/98	Campos Novos No.4	H	220
	"	31/03/98	Machadinho No.1	H	300
	"	30/06/98	Machadinho No.2	H	300
	"	30/09/98	Machadinho No.3	H	300
	"	31/12/98	Machadinho No.4	H	300
1999	ELETROSUL	30/04/99	Monjolinho No.1	H	36
	"	31/08/99	Monjolinho No.2	H	36
2000 onward			Barra Grande	H	920
			Garibaldi	H	228
			Pai Quere	H	228
			Sao Roque	H	360
			Foz Do Chapeco	H	1,228

Note; H means hydropower plant and T means thermal power plant.

Table IV.6.2 POWER EXPANSION PROGRAM OF SOUTH/SOUTHEAST POWER SYSTEM FOR 1990 TO 2005 PERIOD (1/7)

Name of Plant	Type	Installed Capacity (MW)	Unit No.	Commencement of Operation
(South System)				
Itaipu (60 Hz)	H	9 x 700.0	7/9	Jun /1990
			8/9	Nov /1990
			9/9	Feb /1991
J. Lacerda IV	T	1 x 350.0	1/1	Jun /1991
Jacui	T	1 x 350.0	1/1	Mar /1992
Segredo	H	4 x 315.0	1/4	Sep /1992
			2/4	Dec /1992
			3/4	Mar /1993
			4/4	Jun /1993
Bolivia-Gas	T	6 x 75.0	1/6	Jun /1993
			2/6	Jul /1993
			3/6	Aug /1993
			4/6	Sep /1993
			5/6	Oct /1993
			6/6	Nov /1993
Candiota III - 1	T	1 x 350.0	1/1	Dec /1994
Ita	H	6 x 270.0	1/6	Jun /1995
			2/6	Sep /1995
			3/6	Dec /1995
			4/6	Mar /1996
			5/6	Jun /1996
			6/6	Sep /1996
D. Francisca	H	2 x 62.5	1/2	Sep 1995
			2/2	Dec /1995
Carvao - 50MW	T	4 x 50.0	1/4	Dec /1996
			2/4	Dec /1997
			3/4	Dec /1997
			4/4	Dec /1998
Campos Novos	H	4 x 220.0	1/4	Sep /1997
			2/4	Dec /1997
			3/4	Mar /1998
			4/4	Jun /1998

Note; H: Hydropower plant, T: Thermal plant, N: Nuclear plant

Table IV.6.2 POWER EXPANSION PROGRAM OF SOUTH/SOUTHEAST POWER SYSTEM FOR 1990 TO 2005 PERIOD (2/7)

Name of Plant	Type	Installed Capacity (MW)	Unit No.	Commencement of Operation
Sto. Caxias	H	6 x 250.0	1/6	Sep /1997
			2/6	Dec /1997
			3/6	Mar /1998
			4/6	Jun /1998
Candiota III - 2	T	1 x 350.0	1/1	Dec /1997
Machadinho	H	4 x 300.0	1/4	Mar /1998
			2/4	Jun /1998
			3/4	Sep /1998
			4/4	Dec /1998
Maua	H	2 x 236.0	1/2	Sep /1998
			2/2	Dec /1998
Garabi - 50%	H	6 x 150.0	1/6	Mar /1999
			2/6	Jun /1999
			3/6	Sep /1999
			4/6	Dec /1999
			5/6	Mar /2000
			6/6	Jun /2000
Cebolao	H	2 x 97.0	1/2	Sep /1999
			2/2	Dec /1999
Monjolinho	H	2 x 36.0	1/2	Sep /1999
			2/2	Dec /1999
Candiota III - 3	H	1 x 350.0	1/1	Dec /1999
Carvao - 125MW	T	2 x 125.0	1/2	Dec /1999
			2/2	Dec /2000
Barra Grande	H	4 x 230.0	1/4	Mar /2000
			2/4	Jun /2000
			3/4	Sep /2000
			4/4	Dec /2000
Garibaldi	H	2 x 114.0	1/2	Mar /2000
			2/2	Jun /2000
Sao Jeronimo	H	2 x 222.0	1/2	Jun /2000
			2/2	Sep /2000

Table IV.6.2 POWER EXPANSION PROGRAM OF SOUTH/SOUTHEAST POWER SYSTEM FOR 1990 TO 2005 PERIOD (3/7)

Name of Plant	Type	Installed Capacity (MW)	Unit No.	Commencement of Operation
Pai Quere	H	2 x 144.0	1/2	Sep /2000
			2/2	Dec /2000
Foz Do Chopim	H	2 x 30.0	1/2	Dec /2000
			2/2	Mar /2001
Ilha Grande	H	12 x 110.0	1/12	Mar /2001
			2/12	Jun /2001
			3/12	Sep /2001
			4/12	Dec /2001
			5/12	Mar /2002
			6/12	Jun /2002
			7/12	Sep /2002
			8/12	Dec /2002
			9/12	Mar /2003
			10/12	Jun /2003
			11/12	Sep /2003
			12/12	Dec /2003
Jataizinho	H	3 x 64.0	1/3	May /2001
			2/3	Aug /2001
			3/3	Nov /2001
Tel. Borba	H	2 x 64.0	1/2	Mar /2003
			2/2	Jun /2003
Fundao	H	2 x 77.0	1/2	Jun /2004
			2/2	Sep /2004
(Southeast System)				
Rosana	H	4 x 80.0	2/4	Jan /1990
			3/4	Jul /1990
			4/4	Jan /1991
Taquarucu	H	5 x 101.0	1/5	Feb /1990
			2/5	May /1990
			3/5	Aug /1990
			4/5	Nov /1990
			5/5	Feb /1991
C. Dourada	H	2 x 95.0	1/2	Jun /1990
			2/2	Sep /1990

Table IV.6.2 POWER EXPANSION PROGRAM OF SOUTH/SOUTHEAST POWER SYSTEM FOR 1990 TO 2005 PERIOD (4/7)

Name of Plant	Type	Installed Capacity (MW)	Unit No.	Commencement of Operation
Tres Irmaos	H	4 x 162.0	1/4	Jun /1990
			2/4	Oct /1990
			3/4	Feb /1991
			4/4	Jun /1991
Jaguara	H	6 x 108.0	5/6	Jun /1992
			6/6	Sep /1992
Manso	H	4 x 52.5	1/4	Dec /1993
			2/4	Apr /1994
			3/4	Aug /1994
			4/4	Dec /1994
Igarapava	H	5 x 40.0	1/5	Mar /1994
			2/5	Jun /1994
			3/5	Sep /1994
			4/5	Dec /1994
			5/5	Mar /1995
Santa Branca	H	2 x 24.5	1/2	Mar /1994
			2/2	Jun /1994
Corumba I	H	3 x 125.0	1/3	Apr /1994
			2/3	Aug /1994
			3/3	Dec /1994
Miranda	H	3 x 130.0	1/3	Jun /1994
			2/3	Sep /1994
			3/3	Dec /1994
Nova Ponte	H	3 x 170.0	1/3	Jun /1994
			2/3	Sep /1994
			3/3	Dec /1994
Paulinia - Replan	H	2 x 350.0	1/2	Jun /1994
			2/2	Dec /1994
Serra Da Mesa	H	3 x 400.0	1/3	Apr /1995
			2/3	Aug /1995
			3/3	Dec /1995

Table IV.6.2 POWER EXPANSION PROGRAM OF SOUTH/SOUTHEAST POWER SYSTEM FOR 1990 TO 2005 PERIOD (5/7)

Name of Plant	Type	Installed Capacity (MW)	Unit No.	Commencement of Operation
Porto Primavera	H	18 x 101.0	1/18	May /1995
			2/18	Jul /1995
			3/18	Sep /1995
			4/18	Nov /1995
			5/18	Jan /1996
			6/18	Mar /1996
			7/18	May /1996
			8/18	Jul /1996
			9/18	Sep /1996
			10/18	Nov /1996
			11/18	Jan /1997
			12/18	Mar /1997
			13/18	May /1997
			14/18	Jul /1997
			15/18	Sep /1997
			16/18	Nov /1997
			17/18	Jan /1998
			18/18	Mar /1998
S. J. Campos - Revap	H	1 x 350.0	1/1	Jun /1995
Cana Brava	H	3 x 160.0	1/3	Sep /1995
			2/3	Dec /1995
			3/3	Mar /1996
Simplicio	H	3 x 60.0	1/3	Oct /1995
			2/3	Dec /1995
			3/3	Feb /1996
Angra II	N	1 x 1245.0	1/1	Dec /1995
Igarape II	H	1 x 125.0	1/1	Dec /1995
Queimado	H	2 x 50.0	1/2	Sep /1996
			2/2	Sep /1996
Anta	H	2 x 8.0	1/2	Dec /1996
			2/2	Mar /1997
Sapucaia	H	3 x 100.0	1/3	Dec /1996
			2/3	Mar /1997
			3/3	Jun /1997

Table IV.6.2 POWER EXPANSION PROGRAM OF SOUTH/SOUTHEAST POWER SYSTEM FOR 1990 TO 2005 PERIOD (6/7)

Name of Plant	Type	Installed Capacity (MW)	Unit No.	Commencement of Operation
C. Magalhaes	H	4 x 55.0	1/4	Mar /1997
			2/4	Jun /1997
			3/4	Sep /1997
			4/4	Dec /1997
Formoso	H	3 x 113.3	1/3	Mar /1997
			2/3	Jun /1997
			3/3	Sep /1997
Itaocara	H	3 x 70.0	1/3	Mar /1997
			2/3	Jun /1997
			3/3	Sep /1997
Serra Do Facao	H	3 x 70.0	1/3	Mar /1997
			2/3	Jun /1997
			3/3	Sep /1997
Bocaina	H	3 x 55.0	1/3	Mar /1998
			2/3	Jun /1998
			3/3	Sep /1998
Picada	H	2 x 50.0	1/2	Mar /1998
			2/2	Jun /1998
Rosal	H	2 x 29.0	1/2	Mar /1998
			2/2	Jun /1998
Angra III	N	1 x 1245.0	1/1	Sep /1998
Franca Amaral	H	2 x 16.0	1/2	Sep /1998
			2/2	Dec /1998
Foz Bezerra	H	2 x 100.0	1/2	Mar /1999
			2/2	Jun /1999
Capim Branco	H	3 x 200.0	1/3	Jun /1999
			2/3	Sep /1999
			3/3	Dec /1999
Irape	H	3 x 140.0	1/3	Jun /1999
			2/3	Sep /1999
			3/3	Dec /1999
Sobragi	H	2 x 55.0	1/2	Jun /1999
			2/2	Sep /1999

Table IV.6.2 POWER EXPANSION PROGRAM OF SOUTH/SOUTHEAST POWER SYSTEM FOR 1990 TO 2005 PERIOD (7/7)

Name of Plant	Type	Installed Capacity (MW)	Unit No.	Commencement of Operation
Barra Do Peixe	H	4 x 112.5	1/4	Sep /1999
			2/4	Jan /2000
			3/4	May /2000
			4/4	Sep /2000
Corumba II	H	2 x 117.5	1/2	Sep /1999
			2/2	Dec /1999
Mirador	H	2 x 53.0	1/2	Mar /2000
			2/2	Jun /2000
Paulistas	H	2 x 30.0	1/2	Mar /2000
			2/2	Jun /2000
Peixe	H	4 x 278.0	1/4	Mar /2000
			2/4	Jun /2000
			3/4	Sep /2000
			4/4	Dec /2000
Funil	H	2 x 82.0	1/2	Jun /2000
			2/2	Sep /2000
Quartel	H	2 x 50.0	1/2	Jun /2000
			2/2	Sep /2000

FIGURES

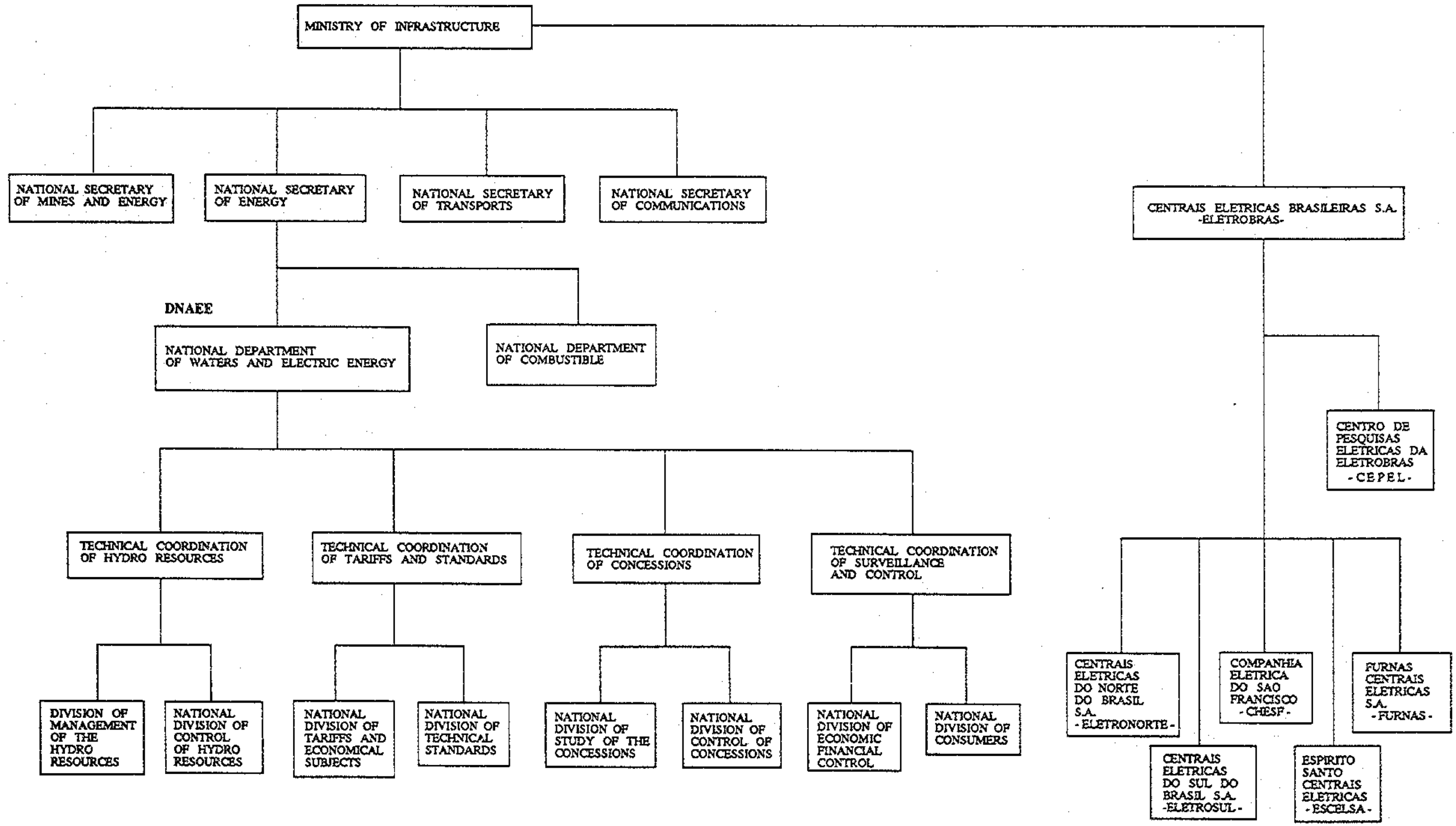

Fig.IV.2.1 ORGANIZATION CHART OF POWER INDUSTRIES IN BRAZIL

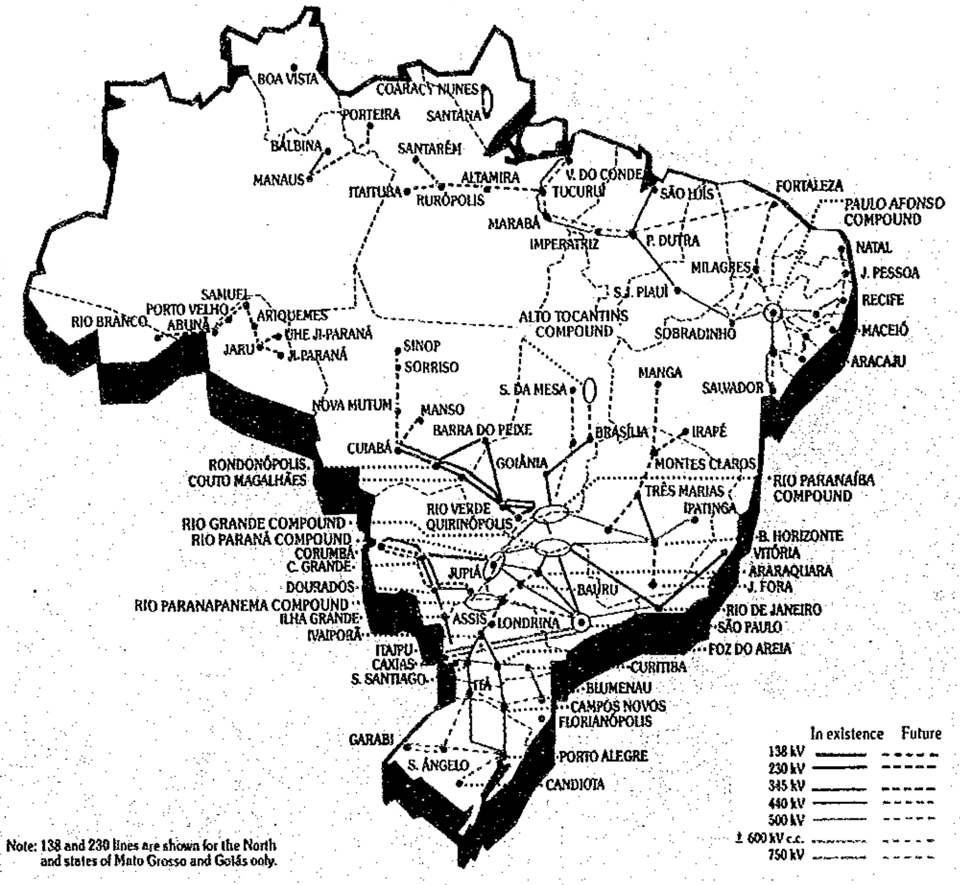

Fig. IV.3.1 MAJOR TRANSMISSION LINES OF BRAZIL

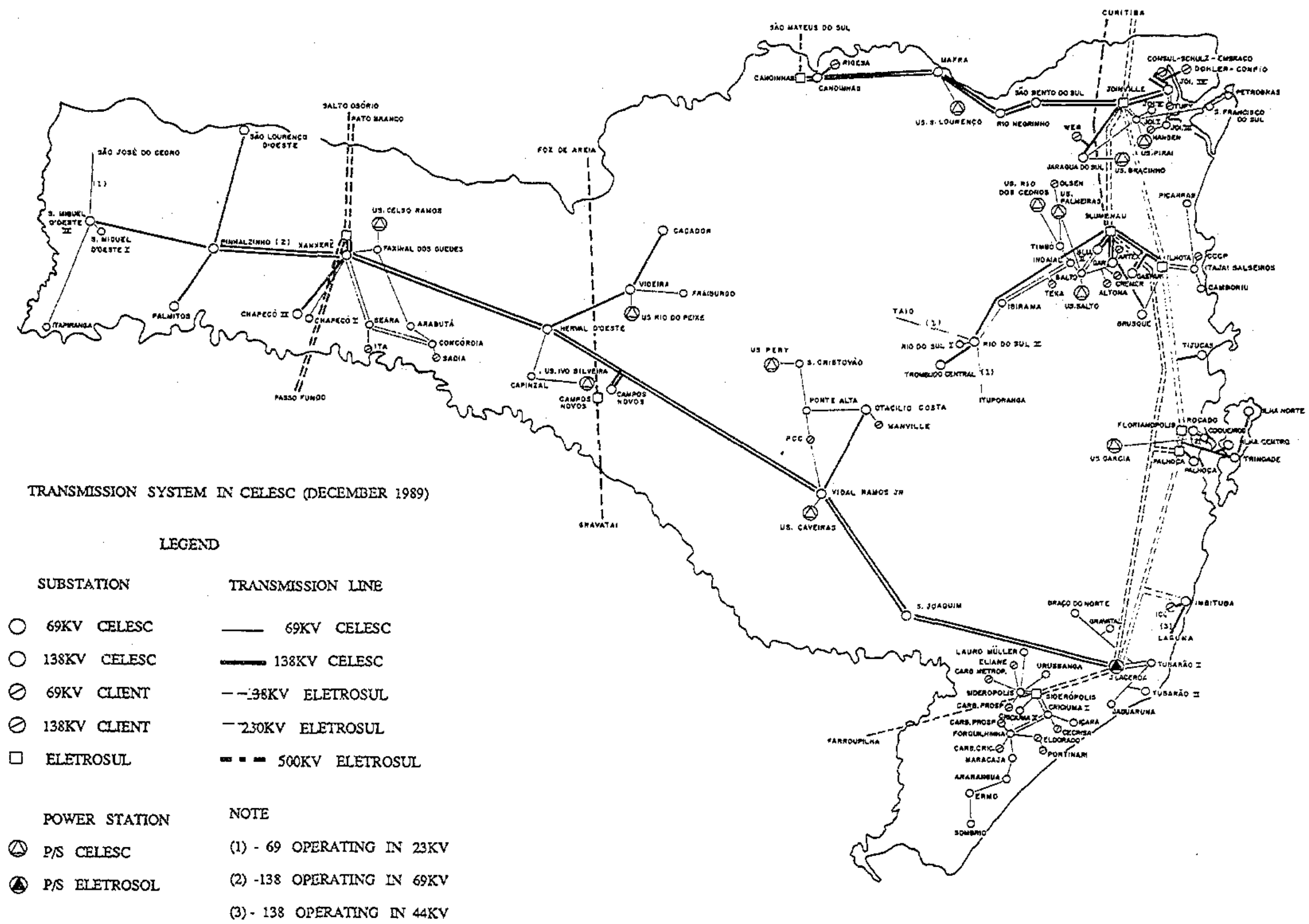

Fig. IV.3.2 TRANSMISSION SYSTEM IN CELESC

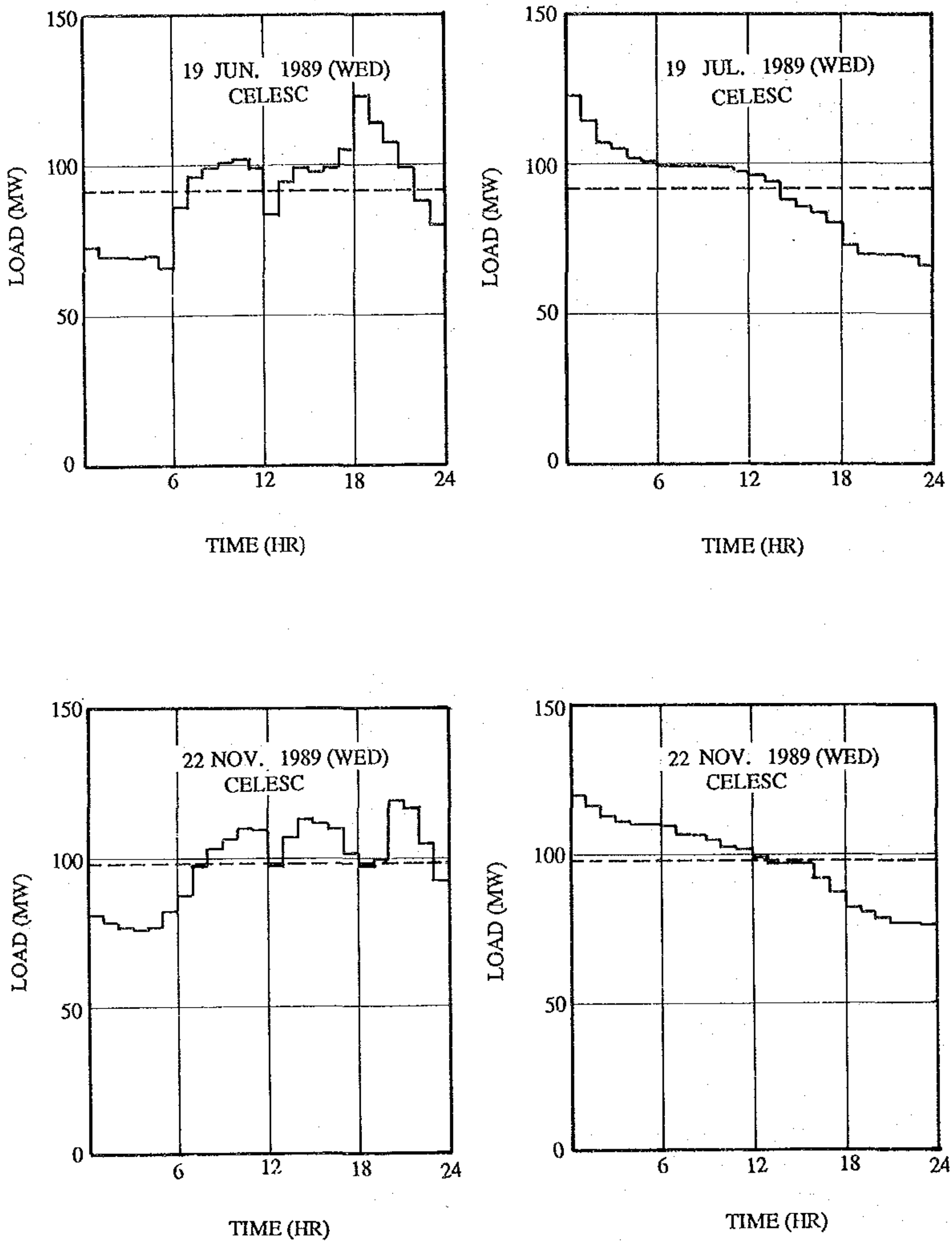

Fig.IV.4.1 DAILY LOAD AND LOAD DURATION CURVES (1/3)

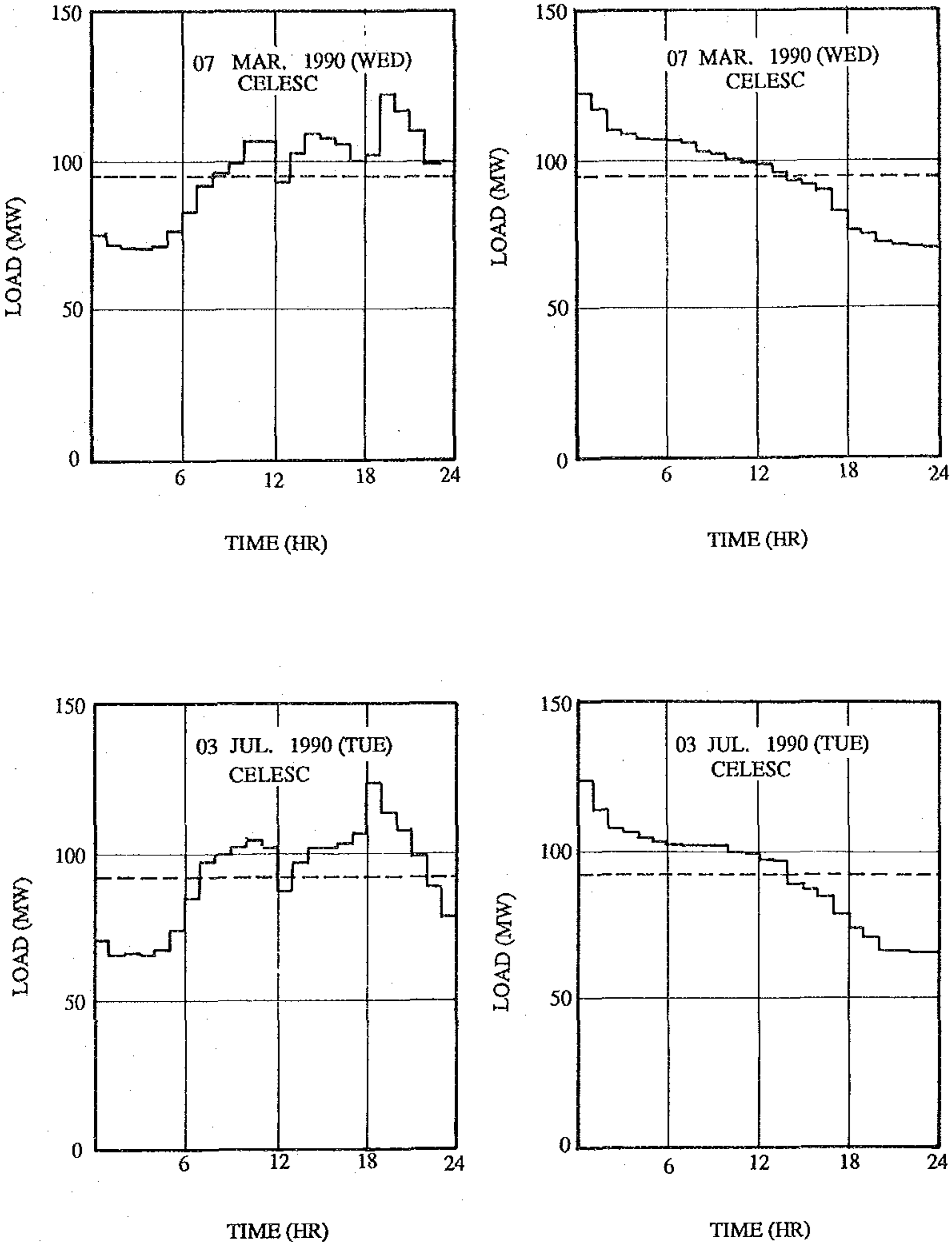

Fig.IV.4.1 DAILY LOAD AND LOAD DURATION CURVES (2/3)

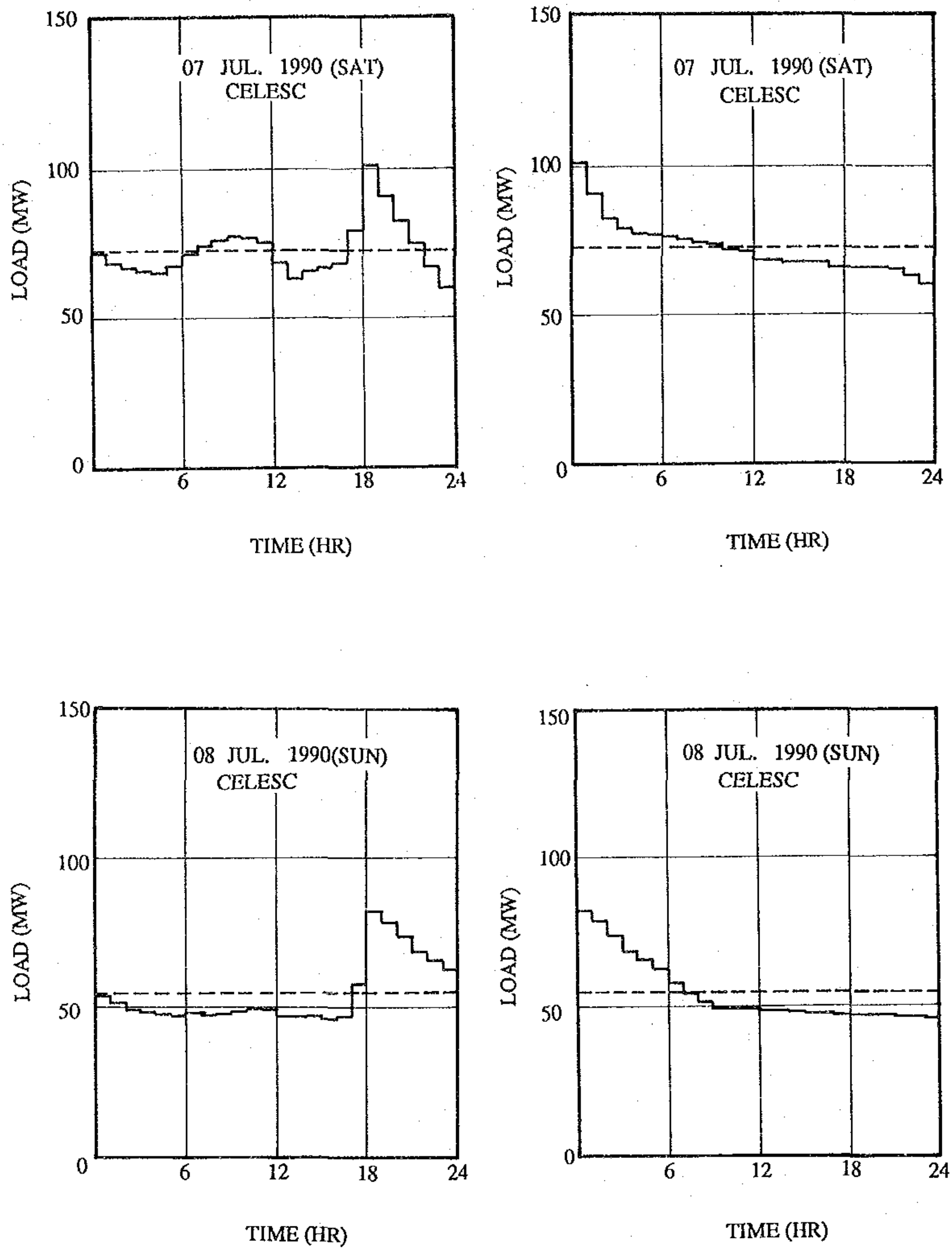

Fig.IV.4.1 DAILY LOAD AND LOAD DURATION CURVES (3/3)

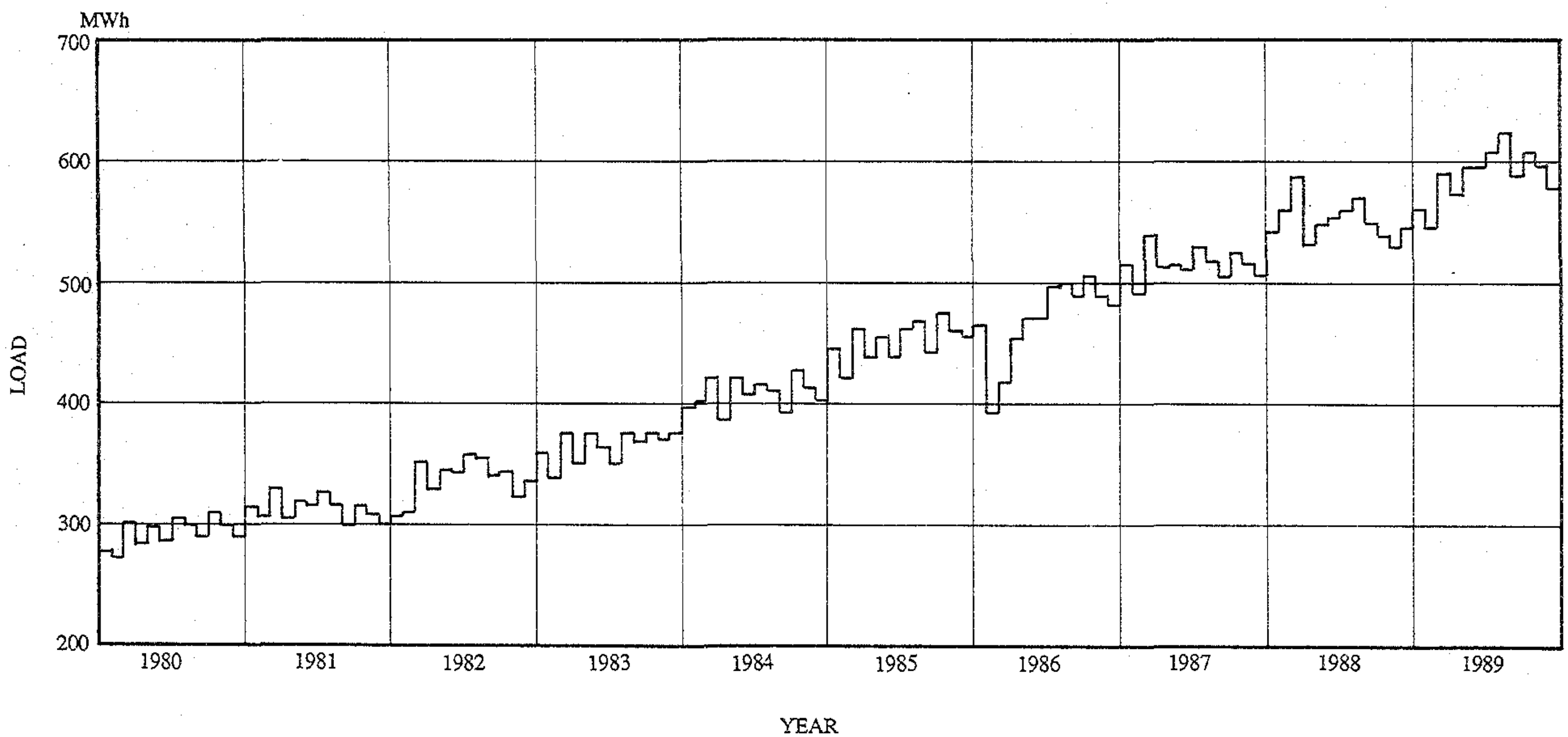

Fig.IV.4.2 ANNUAL LOAD CURVE OF CELESC (1980-1989)

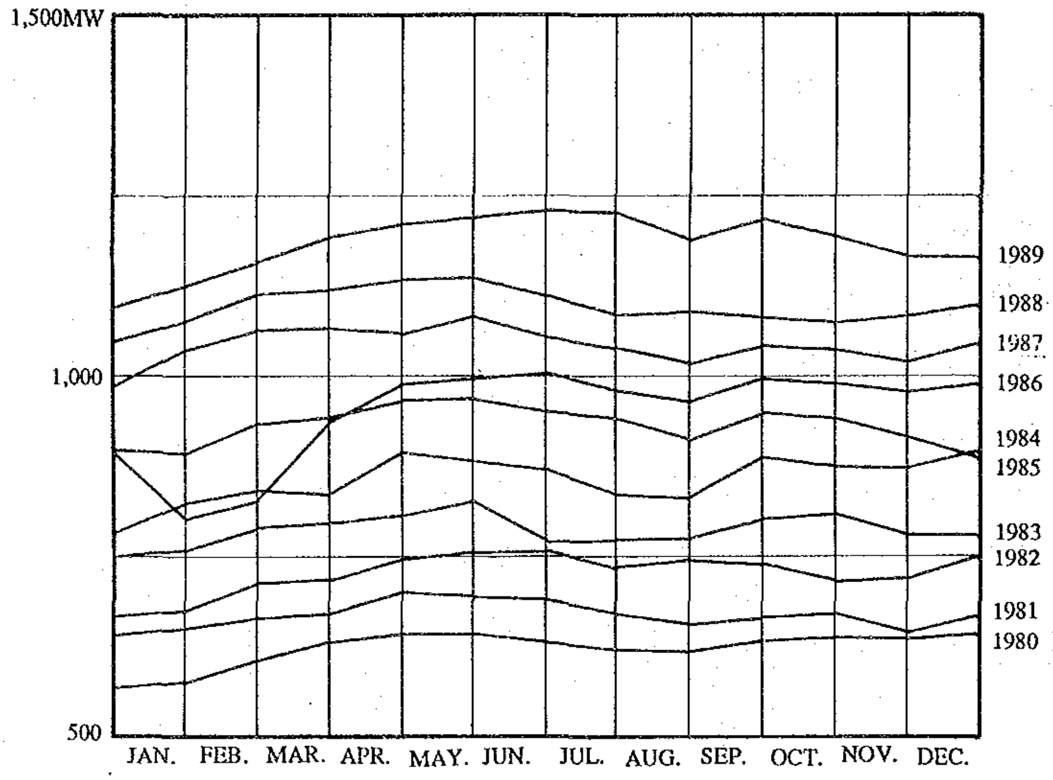

Fig. IV.4.3 CHANGE OF MONTHLY PEAK DEMAND IN CELESC, 1980-1989

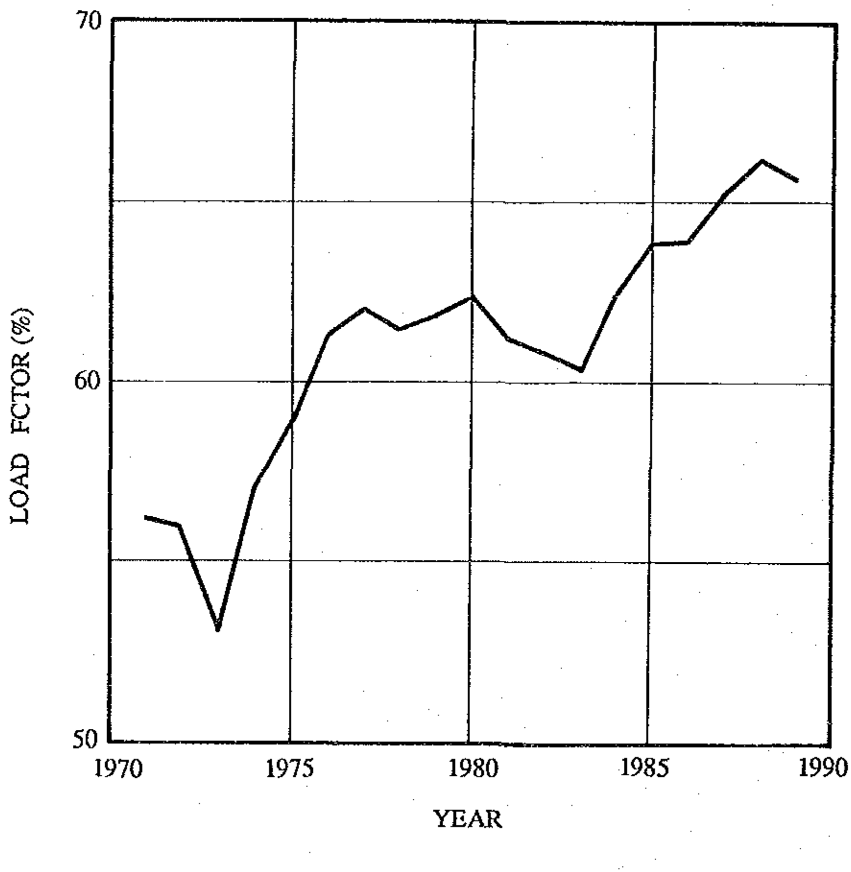

Fig.IV.4.4 CHANGE OF ANNUAL LOAD FACTOR IN CELESC (1970-1989)

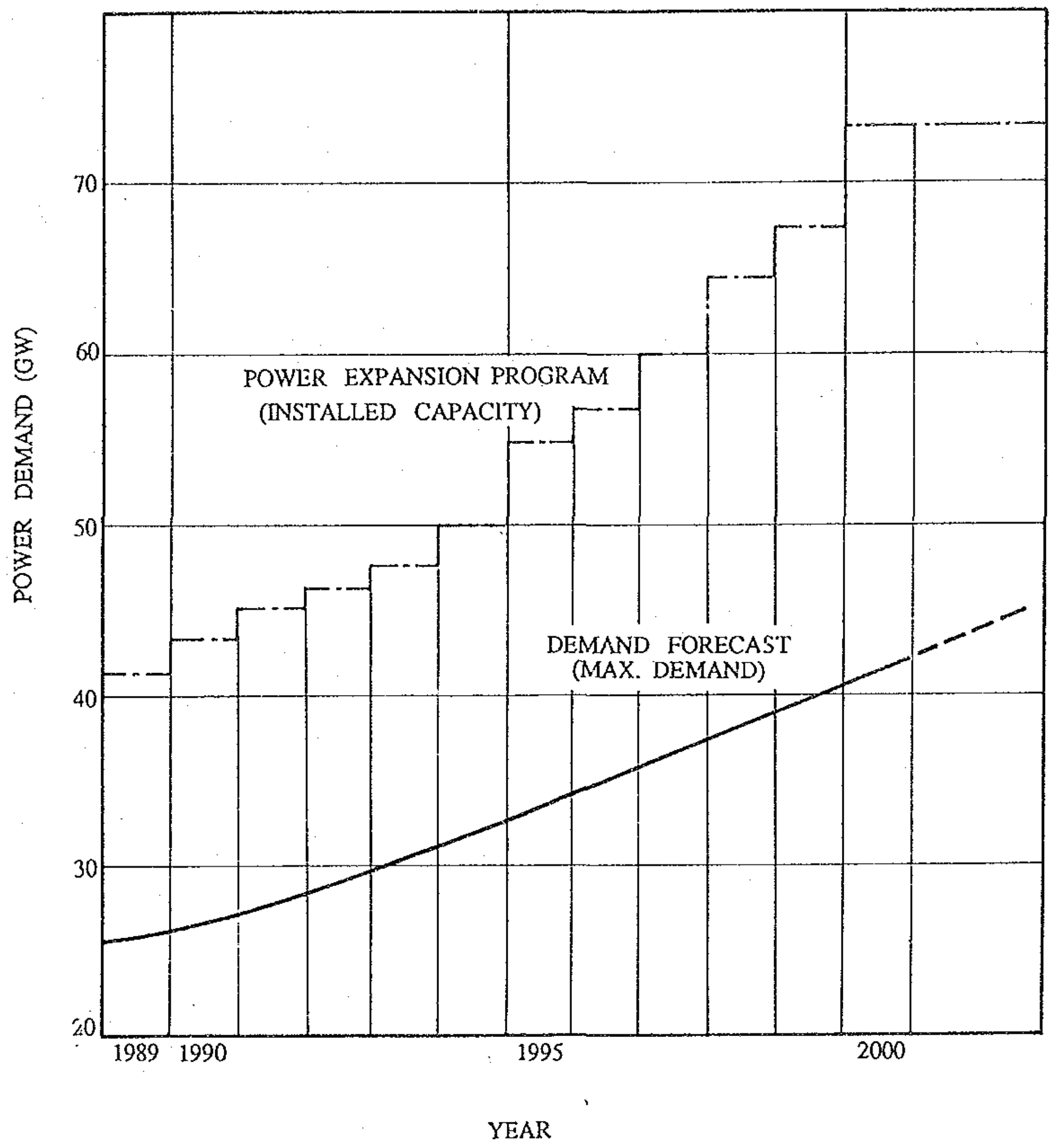

Fig. IV.6.1 POWER DEMAND FORECAST AND POWER SUPPLY CURVE (SOUTH/SOUTHEAST SYSTEM)

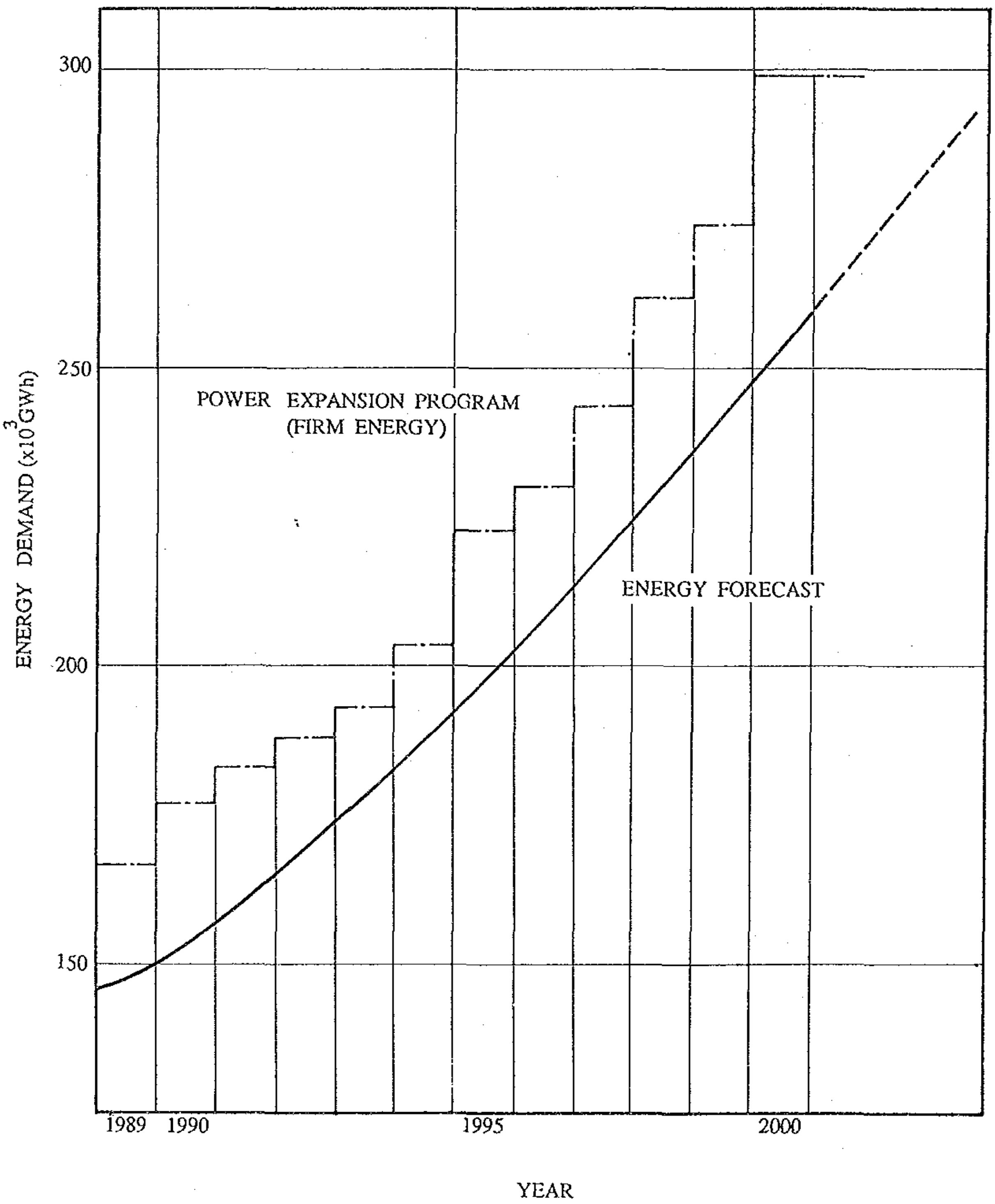

Fig. IV.6.2 ENERGY DEMAND FORECAST AND ENERGY SUPPLY CURVE
(SOUTH/SOUTHEAST SYSTEM)

ANNEX V

ENVIRONMENTAL STUDY

ANNEX V. ENVIRONMENTAL STUDY

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

This Initial Environmental Examination (IEE) covers the sixteen potential hydropower sites which have been identified from map study. Its purpose has been to identify potential impacts and to evaluate their significance in order to clarify those environmental items for which further study is needed in the Environmental Impact Study (EIS) which is scheduled to be carried on two or three selected sites during the next stage.

2. PRESENT ENVIRONMENTAL CONDITIONS IN THE ITAJAI RIVER BASIN

2.1 Natural Environment

2.1.1 Topography

The Itajai river basin with a catchment area of about 15,220 km^2 is located in the northeastern part of state of Santa Catarina. The basin is situated between 26°20' and 27°50' of south latitude and 48°40' and 50°20' of west longitude and extends about 150 km north to south and 155 km east to west. It is bounded to the west and south by the Canoas river basin and to the north by the Negro river basin. The eastern part of the basin faces the Atlantic Ocean at Itajai city.

2.1.2 Climate

The climate is subtropical except on the coast. There are no clear divisions between dry and wet seasons. The period from June to August corresponds to winter and the period from December to March to summer. There are spring and autumn seasons between these periods. The annual mean temperature is about 21°C with 25.3°C as the maximum temperature in January and 17°C as the minimum temperature in July and August. The mean annual rainfall is 1,400 mm ranging from 1,000 mm to 1,600 mm. The rainfall is heavier in the north than in the south. The average relative humidity is 80%. The annual mean discharge in the Itajai river at Indaial gauge which is centrally located is 220 m^3/sec.

2.1.3 Mineral resources

According to statistical information on mineral resources in 1987, 7 types of the minerals are produced in the basin area; slate, sand, clay, calcareous rock, gold, stamp stone and granite rock. Among them, about 70% of the slate and all of the gold are produced in Trombudo Central and Gaspar regions respectively.

2.1.4 Soil

The soil in the Itajai river basin is classified into the following 8 types;

- Glei Pouco Humico distofico (HGPD);
- Podozolico Vermelho-Amarelo alico (PVa);
- Podozolico Vermelho-Amarelo Lastossolico alico (PVLa);
- Solos Litolicos eutroficos (Re);
- Cambissolo alico (Ca);
- Cambissolo distrofico (Cd);
- Cambissolo Humico alico (CHa);
- Cambissolo Brano Humico alico (CBHa).

HGPD type soil is developed on low land along the Itajai river. PVa type soil is a podogolized yellowish red soil which widely extends in the low land in the southern part of Itajai city. Ca and Cd type soils are spread over most of the mountainous area. They are good soil from the viewpoint of physical characteristics (thickness, soil properties and drainage) and well utilized for agriculture. The other types of soil except foregoing type soils distribute only in the limited area of the basin.

2.1.5 Vegetation

The vegetation map of the Itajai river basin shows that low land and the low hilly area along the Itajai river are well utilized for agriculture and pasture.

The hilly area and highland in the middle and upstream reaches are covered with natural forest and secondary forest influenced by human activity. The majority of forests up to about EL600 m consist of secondary forest and afforestation. This is the prevalent type of forest in the basin area. At higher altitudes, natural vegetation is observed, but its area is limited. These natural forests are mainly comprised of sub-tropical evergreen hard woods. Most of this type of forest comprises Sloanea guianensis, Alchorena trip linervia Eutropea aduris, Octotea cathariensis, Ocotea pretosa and Aspidoperma olvaceum.

2.1.6 Water resources

The Itajai river basin has abundant water resources not only in the Itajai main stream but also in its tributaries. The annual mean river discharge at Indaial which is located on the Itajai main stream at about the center of the basin is about 220 m^3/sec and varies between about 150 m^3/sec in April and about 255 m^3/sec in February.

2.1.7 Wildlife

No information on wildlife in the Itajai river basin is available. A record of the birds in the state of Santa Catarina however lists 544 species, 75 families and 22 orders of birds. This list includes some species which are prohibited to transfer. These are Rhea Americana, Phoenicopterus ruber, Coscoroba, Cygnus melancorypus, Pipile jacutinga and Amazona vinacea.

A report on the hydropower project of Cubatao which is located in the northern part of the state of Santa Catarina states that 36 species of mammals, 9 species of amphibians, 13 species of reptiles, and 20 species of fish are living in the targeted basin. This information was based on field investigation and information collected from inhabitants and published references. Among those species listed in this data, there are some species which are included in the list of the Washington treaty such as Tupinambis sp., Caiman latirostris, Felis concolor, Felis pardalis, Tapirus terrestris and Panthera onca. Judging from this information; it may be said that since the Cubatao river basin is close to the Itajai river basin, some of these species will live in the Itajai river basin. However, details of actual status of distribution and habitat of these species are unknown at present.

2.2 Social Environment

2.2.1 Immigration history

In the latter half of the seventeenth century, immigration was initiated to the coast of Santa Catarina, and at the end of same century immigrants from Sao Viente of San Paulo founded the colony of San Francisco (Florianopolis). After this, they spread over the plateau aiming at ranching of cattle.

Meanwhile immigration from the Açorianas Islands (Territory of Portugal) commenced in 1748 - 1756. These immigrants joined to those from Sao Viente. In nineteenth century, immigration from Germany and Italy was commenced. German immigrants who were officially authorized by the Brazilian Government founded a colony in San Pedro of Alcantara and in Joinville in 1829. In 1850, Dr. Herman Blumenau created Blumenau city in the valley of the Itajai river. This city has played an important role in motivation the creation of a series of colonies.

2.2.2 Environmental administration

Environmental administration was specified by decree No. 6,938 of August 31, 1981 which regulates national policy on the environment, deterioration of the environment, sources of pollution, and natural resources. This decree was reinforced by decree No. 88,351 in June 4 1983. This decree was also reinforced decree of No. 6,602 of April 27, 1981 which regulates establishment of ecological stations and environmental protection areas.

An application for approval to implementation of a project has to be submitted to the national committee on the environment (CONAMA). In the state of Santa Catarina, urban development and environment (SEDUMA) is the authorized administration office. Under this organization the Foundation for Technological Assistance for the Environment (FATMA) was established in 1975 for investigating the distribution of air, water, landscape and ecology of animals likely to be affected by implementation of development plans and for giving administrative advise for various type of environment.

2.2.3 Land use

The census of agriculture in 1980 by IBGE shows that about 60% of the basin area is utilized for agriculture for crop land (20%), pasture land (19%) and forest land (20%). The remaining 40% of the basin which is not utilized, is unsuitable for agricultural activity and not identified. The residential area occupies only one % of the basin area.

Agricultural land is being developed alongside the Itajai river and its tributaries. The forest land is distributed in hilly and mountain areas but mostly as secondary forest.

2.2.4 Industry

It has been estimated that the GRDP in Santa Catarina in 1980 was Cr$400 million comprising Cr$185 million in the services sector, Cr$151 million in the industrial sector and Cr$64 million in the agricultural sector.

The basin area of the Itajai river occupies only about 16% of the state area but major municipalities in the basin play an important role in industrial activities especially in such industries as textiles, clothing, shoes and women articles, food products and lumber.

2.2.5 Spatial structure

There are 46 municipalities within the Itajai river basin. They have developed along the Itajai and its tributaries and are connected by state and national roads. Among these municipalities, those with populations of more than 10,000 are Blumenau, Gaspar, Itajai, Indaial, Timbo, Benedito Novo and Brusque,

2.2.6 Use of water resources

The water from the Itajai and its tributaries has been drawn for municipal and industrial uses. The municipal water supply has been carried out by the water supply company (CASAN), the foundation of public health service (FSESP) and the municipal water and sewage service (SAMAE). These enterprises supply the water for 39 municipalities, and about 79% of the urban population receives the water supply service. The average water consumption is less than 200 l per capita in the majority of municipal populations.

There are 635 factories in the basin which utilize the water. The total water consumption is estimated at 1,900 l/sec.

2.2.7 Tourism

In the Itajai river basin, there are many touristic places and facilities inside and outside of the major cities such as Blumenau, Trombudo Central, Ibirama, Gaspar, Rio do Sul, Timbo, Itajai, Botuvera, etc. Many tourists are visiting such cities throughout the year but no accurate number of tourists is known at present.

2.2.8 Historical and archaecological assets

From the site inspection and information from inhabitants, it seems that there are no notable historical or archaecological assets in the vicinity of the identified 16 hydropower potential sites.

3. INITIAL ENVIRONMENTAL EXAMINATION

3.1 *Methodology of Examination*

The Initial Environmental Examination (IEE) for the identified 16 hydropower potential sites was carried out by means of check lists comprising items for natural and social environmental impacts due to project realization.

The environmental examination was evaluated by means of extent of impact as defined in the followings;

- A ; Degree of impact would be significant
- B ; Degree of impact would be moderate
- C ; Degree of impact would be relatively small
- D ; Impact is unknown but study is needed
- X ; There would be no influences

The extent of impact for the respective items evaluated by the above definition was listed for relative comparison. Based on these results, environmental management was studied.

3.2 Evaluation of Natural Environmental Impacts

3.2.1 Impacts on land

(1) Sedimentation and its downstream effects

The results of the hydrological studies showed that the sediment yield in the basin was about 100 m^3/km^2/year or 0.1 mm/year. Since the sediment load in the reservoir for run-of-river type schemes will be flushed out by the gated spillway, there are no impacts on the river downstream. In the case of a reservoir type scheme, part of the sediment load will be deposited in the reservoir and due to this sediment deposition, degradation of river bed downstream may take place.

The degree of sediment deposition in the reservoir will be assessed by means of trap efficiency (T.E), which is defined by T as a ratio of gross storage volume in the reservoir to annual inflow. T for respective reservoir type schemes and their T.E were estimated as follows;

Name of scheme	T	T.E (%)
Barra da Pratinha	0.28	95
Barra das Pombas	1.59	98
Timbo	0.06	80
Doutor Pedrimho	0.55	96
Trombudo Central (1)	0.92	98
Trombudo Central (2)	2.32	98
Botuvera	0.33	95

The degree of sediment deposit in the reservoir increases as the figure of the trap efficiency increases. Thus the impact on the river downstream was defined by the following criteria;

- A ; T.E is more than 90%
- B ; T.E is the range between 90% and 50%
- C ; T.E is less than 50%.

Consequently, the identified reservoir type schemes except Timbo scheme were evaluated as A. The Timbo scheme was evaluated as B.

(2) Impact on soil erosion

It is presumed that new settlement areas to accommodate the inhabitant in the submerged reservoir area will be provided in the catchment area of the identified hydropower potential sites and that soil erosion will take place due to deforestation or reclamation of new farm land in the settlement area. Since it is considered that the degree of soil erosion increases in proportion to the extent of inhabitant owned farm lands, the impact on soil erosion was evaluated by the following criteria.;

- A ; Acreage of farm land is more than 5 km^2
- B ; Acreage of farm land is in the range between 1 and 5 km^2
- C ; Acreage of farm land is less than 1 km^2.

The acreage of the farm land area in the submerged area was estimated as shown in Table V.3.1 and the result of evaluation by the above criteria is given in Table V.3.1.

3.2.2 Impact on river environment

Since the reservoir type schemes are planned so as to avoid submergence of large townships in the upstream of the envisaged hydropower potential sites, it is presumed that sewage from the city areas will flow directly into the reservoirs and consequently the problem of eutrophication will take place.

The possibility of eutrophication depends on two parameters, namely, extent of the content of phosphate and nitrogen and ratio of annual inflow to gross storage volume in the reservoir (P). Since it is considered that the extent of content of phosphate and nitrogen is in proportion to the population of townships upstream, the populations of the townships upstream of the envisaged reservoir type scheme sites were investigated as follows;

Scheme	Name of townships	Population (person)
Barra da Pratinha	—	—
Barra das Pombas	—	—
Timbo	Benedito Novo	3,800
Doutor Pedrinho	—	—
Trombudo Central (1)	Braco do Trombudo	1,000
Trombudo Central (2)	Agrolandia	1,300
Botuvera	—	—

Degree of possibility of eutrophication due to P is defined as follows;

- A ; $P < 1$; There is possibility
- B ; $1 < P < 10$; There is slight possibility
- C ; $P > 10$; There is no possibility

The parameter, P and the degree of possibility for the respective reservoir types were estimated as follows;

Scheme	P	Degree
Barra da Pratinha	3.6	B
Barra das Pombas	0.6	A
Timbo	16	C
Doutor Pedrinho	1.8	B
Trombudo Central (1)	1.1	B
Trombudo Central (2)	0.4	A
Botuvera	3	B

Comparing with these parameters and number of population, degree of possibility of eutrophication was evaluated as A for Trombudo Central (1) and (2) schemes, B for Timbo and Barra das Pombas schemes and C for Doutor Pedrinho, Barra da Pratonha and Botuvera schemes.

3.2.3 Impact on Vegetation

The realization of a hydropower scheme will bring about a decrease in area of forest in the basin area and consequently will exert an influence on the regional economy due to reduction of productivity of the forest. To evaluate the impact on the vegetation due to implementation of the hydropower scheme, the area of forest to be submerged was estimated as shown in Table V.3.1. Since the impact on vegetation is proportionate to the extent of the submerged area, the impact on vegetation was evaluated by the following criteria;

- A ; Area of forest is more than 5 km^2
- B ; Area of forest is in the range between 1 and 5 km^2
- C ; Area of forest is less than 1 km^2.

The area of the forest in the submerged area and the result of evaluation by these criteria are given in Table V.3.1.

3.2.4 Impact on wildlife

A record of the birds in Santa Catarina shows that there are precious species such as Phoenicopterus ruber, Coscoroba, Cygnus melancorypus, Pipile jacutinga and Amazona vinacea. These species live in riverine areas with a relatively wide river surface area. Since there are no such wide river surface areas in the area of the identified schemes, it was presumed that these species do not exist at the identified hydropower potential sites.

While, it has been reported in Cubatao hydropower project that precious species of wildlife such as Tupinambis sp., Caiman latirostris, Felis concolor, Felis pardalis, Tapirus terrestris and Panthra onca generally live in the mountainous area with forest and grass land. Among the identified schemes, Barra da Pratinha, Barra das Pombas, Doutor Pedrinho and Botuvera scheme sites are located in the mountainous area. Thus, these schemes were evaluated as D.

3.3 Evaluation of Social Environmental Impact

3.3.1 Effect on population

The realization of the hydropower schemes will bring about the disturbance of inhabitants from the conceivable submerged area and consequently will exert an influence on the activity of the regional economy and on regional planning. These influences will become serious as the number of people increases. Also, the degree of difficulty in acquiring the land will increase in proportion to the population to be removed. Accordingly, the effect on the change of population distribution in the region was evaluated by means of the extent of the population to be shifted and the following criteria were set out;

- A ; Number of population is more than 1,000
- B ; Number of population is in the range between 500 and 1,000
- C ; Number of population is less than 500

The number of houses in the submerged area was estimated based on topographic maps at a scale of 1 : 50,000. The number of households was estimated based on the socio-economic data. The number of houses and population in the submerged area thus estimated and the result of the evaluation by these criteria are given in Table V.3.2.

3.3.2 Effect on industry

(1) Effect on agriculture

Since the agricultural land is generally located on low land near the river, it is anticipated that submergence of agricultural land will take place due to realization of the hydropower scheme. It is also presumed that many inhabitants will depend for their living on agriculture and forestry in the mountainous area.

Since there are no data showing the ratio of agricultural area to the total submerged area, it was estimated from the results of site inspection and topographic maps as shown in Table V.3.1. The effects on agriculture are defined as follows;

- A ; Area of agricultural land is more than 5 km^2.
- B ; Area of agricultural land is in the range between 1 and 5 km^2
- C ; Area of agricultural land is less than 1 km^2.

The result of evaluation is given in Table V.3.1. This table shows that the majority of the schemes have the submerged agricultural land of less than one km^2. The effect on agriculture for Trombudo Central (1) and (2) schemes was evaluated as A due to their large submerged agricultural area.

(2) Effect on inland fishery

With the change in the river environment when a river changes a reservoir in case of reservoir type scheme, the fish fauna is anticipated to change to lacustrine fauna. The data on fish fauna in the Itajai river basin are not available but it is considered that the existing fish species would be able to adapt to the new environment. It was clarified, however, that there are no inhabitants depending for their livelihood on inland fishery in the identified hydropower potential sites. It was judged that there would be no influence on inland fishery.

(3) Effect on secondary industry

According to statistical information of mineral resources in 1987, about 70% of the slate and 30% of the decorative granite for total product in the state are produced in the regions of Trombudo Central and Benedito Novo respectively.

Due to the realization of the hydropower scheme in these regions, possibility of exploitation of these resources may be lost due to their submergence. Although no data on the exact location of these resource are available, and no exploration is being implemented at present, the effect on the secondary industry for Trombudo Central (1) and (2) schemes was evaluated as A. *Since the area of the submerged land for Benedito Novo scheme is only* 0.18 km^2, the effect was evaluated as C.

3.3.3 Effect on use of water resources

It was confirmed in the site reconnaissance that there are no intake facilities for irrigation and municipal water use in the conceivable submerged area for the identified hydropower potential sites. Since there is very little river water use in the Itajai and its tributaries, there will be no effect on water use even if the river discharge condition is varied by the reservoir type scheme.

3.3.4 Effect on traffic

Due to realization of the hydropower scheme, national and state roads will be submerged. These roads are connected with major cities and play an important role in the basin economy. The effect on traffic will depend on the traffic volume and length of road to be relocated. However, since the record of traffic volume is not available, the effect on the traffic was evaluated by means of the length of road and number of bridge to be submerged.

The length of the existing roads and number of the bridge in the submerged area for the respective identified schemes were assessed based on the topographic map at a scale of 1:50,000. The result of the assessment is given in Table V.3.3. The effect on traffic is defined as follows;

- A ; Total length of road to be submerged is more than 10 km
- B ; Total length of road to be submerged is less than 10 km, besides, there are bridge to be submerged.
- C ; There are roads and bridges to be submerged.

The results of evaluation by the above criteria are given in Table V.3.3.

3.3.5 Effect on landscape

The dam height for all of the run-of-river type schemes is less than 20 m and their submerged area is very small. Thus it will be no influence on the landscape even after the implementation of these schemes.

Since majority of the reservoir type schemes are planned in the mountainous area which is covered with forest, it was presumed that the population in the reservoir area is relatively small. Thus it is considered that there will be no changes to human life due to changes of landscape. However, a relatively large scale reservoir was planned for Trombudo Central (1) and (2) schemes, and variation of the landscape due to construction of a dam and relocation of the existing roads is conceivable. Since such variation may affect human life to some extent, the effect on landscape for these two schemes was evaluated as C.

3.3.6 Effect on historical and archaecological assets

It was presumed by field reconnaissance and information from inhabitants that there are no historical or archaecological assets at any of the identified hydropower potential sites.

3.4 Overall Evaluation

Initial Environmental Examination (IEE) of the 16 identified hydropower potential sites was carried out and the results are listed in Table V.3.4. The overall evaluation for the various schemes is as follows;

(i) Salto Pilao (1) and (2) schemes

These schemes are run-of-river type and there are no serious environmental problems.

(ii) Ibirama and Subida schemes

Since a national road has been provided along the left bank of the damsites, relocation of road is needed due to dam construction. It will exert on effect on regional economy and bring about inconvenience for land transportation. Except for this effect, there are no environmental effects.

(iii) Ascurra scheme

Although this scheme is run-of-river type, a relatively large scale reservoir area will be needed. Since there are houses, forests and farm lands in the reservoir area, problem of relocation of houses and effect on forest are conceivable. Also relocation of road will be needed. Thus effect on the land transportation is pointed out.

(iv) Indaial scheme

This scheme is located near Indaial city and national and state roads have been provided along both left and right banks of the damsite. The impact on traffic is pointed out.

(v) Dalbergia scheme

This scheme is a run-of-river type and there are no serious environmental problems.

(vi) Barra da Pratinha scheme

Since a dam of about 80 m high is planned, and there will be large extent forest area and existing road in the submerged area, impacts on vegetation and traffic are pointed out.

(vii) Barra das Pombas scheme

Since a large scale reservoir will be created in the mountaineous area and there are forest area, farm land and existing road in the submerged area, the impacts on vegetation, agriculture, traffic and wildlife are pointed out.

(viii) Timbo scheme

This scheme is a reservoir type but the reservoir area is relatively small due to the relatively steep river bed slope. However, since a national road has been provided along the left bank of the damsite, the effect on traffic is pointed out.

(ix) Benedito Novo and Alto Benedito Novo schemes

These schemes are run-of-river type and there are no serious environmental problems.

(x) Doutor Pedrinho scheme

This scheme is a reservoir type but its submerged area is relatively small due to the steep river bed slope. However, there will be an impact on traffic due to submergence of the existing road along the valley.

(xi) Trombudo Central (1) and (2) schemes

These schemes are a reservoir type, which are located near the urban area. There are houses, existing roads and farm lands in the submerged area. Consequently the impacts of removal of houses, traffic and agriculture, and the problem of eutrophication in the reservoir are pointed out.

(xii) Botuvera scheme

This scheme is a reservoir type which is located in the mountainous area. The submerged area is occupied by forest area and the existing road has been provided along the valley in the submerged area. Thus, there will be impacts on vegetation, wildlife and traffic.

4. SUMMARY OF BENEFICIAL AND ADVERSE EFFECTS

4.1 Beneficial Effects

The realization of the hydropower scheme will have several beneficial effects such as supply of electric power, water supply for irrigation, municipal and industrial water and creation of recreation sites. Besides activation of the regional economy due to creation of job opportunities, purchase of construction materials and services to tourism will be conceivable as an incidental benefits.

While, appearance of aquatic fauna and flora due to creation of reservoir will be anticipated. Such effect will only be conceivable at the large scale reservoirs for Barra das Pombas, and Trombudo Central (1) and (2) schemes. By creation of reservoirs, favourable effect on wildlife and vegetation will be expected for Barra da Pratinha, Barra das Pombas, Doutor Pedrinho and Botuvera schemes. In the case of run-of-river schemes, utilization as camping facilities will be conceivable.

4.2 Adverse Effects

The realization of the hydropower scheme will bring about some socially adverse effects to human life directly such as disturbance of inhabitants and reduction of farm land. Also, deterioration of the living environment, variation of landscape and submergence of historical assets will take place during the construction of project.

Also, several natural adverse effects will be anticipated. These will be diminishing or reduction of wildlife and vegetation in the submerged area, effects on aquatic fauna and flora due to river division and the resultant ecological variation. In addition, entry of organic material into the reservoir, and the resultant eutrophication, occurrence of muddy water during construction and its long duration, etc will be conceivable. For reservoir type schemes such as Trombudo Central (1) and (2), removal of many houses, submergence of the existing road and farm land are anticipated. The impacts on wildlife and ecology will be conspicuous for Barra das Pombas and Boturera schemes.

5. MANAGEMENT OF ENVIRONMENTAL IMPACT

5.1 Enhancement of Beneficial Effects

The multipurpose use of reservoirs for water utilization and flood control in addition to power generation will become possible for reservoir type schemes. To enhance these effects, it will be necessary to facilitate regional activation by means of a land use plan, water utilization plan and arrangement of the traffic network. For reservoir type schemes such as Barra da Pratinha, Barra das Pombas, Doutor Pedrinho and Botuvera, which are located in the mountainous area, these can be utilized as tourism resources by arranging forest resources near the reservoir area. Besides, measures to protect and increase the birds and aquatic fauna, due to creation of the reservoir, will be benefit the tourist industry. For run-of-river schemes, regional arrangements associated with recreation and utilization of the lake will create beneficial effects.

5.2 Measures to Minimize Adverse Effects

Since the construction of dam projects cause changes in the natural and social environments, it will be necessary to contemplate conservation measures to minimize the adverse effects.

For the reservoir type schemes of Trombudo Central (1) and (2), large areas of new farm land in the area to be shifted will have to be provided. In this case, it will be necessary to avoid deforestation and the possibility of soil erosion. Also, for the majority of reservoir type schemes, large scale relocation of existing roads is needed. These require measures for protection of side slopes of the road embankment and conservation of landscape by afforestation. Ecological changes due to deforestation may take place for the schemes of Barra das Pombas and Botuvera which are located in the mountainous area. Although it is unavoidable to reduce the acreage of forest due to submergence by dam construction, it will be necessary to avoid deforestation to protect forest resources and to promote reforestation in the vicinity. Also, investigation of precious fauna and flora will be needed.

5.3 Management of Environment

Management of the environment in the Itajai river basin is the responsibility of the state government (FATMA) under the guidance of the Federal Government. However, since the present environmental management in the basin is insufficient condition, further arrangement of regulations and decrees for environmental conservation and inspection will be needed. Besides, aggressive conservation of environment by development agencies should be promoted based on detailed management plans.

5.4 Further Study

It was shown in the study on hydropower potential inventory that the promising schemes which will be proposed for pre-feasibility study in the second stage are all run-of-river type. For these schemes, no significant environmental problems have been identified in this study.

In carrying out more detailed environmental study in the second stage for these schemes, Environmental Impact Study (EIS) should be performed for the following items;

(1) Natural Environmental Survey

The natural environmental survey should be carried out based on site survey in the approximate submerged area determined on maps at a scale of 1:50,000 and available data for natural resources to be obtained from governmental offices concerned. The survey items are follows;

(i) Submergence of mineral resources.

(ii) Submergence of historical and archeological assets in the submerged area.

(iii) Kind and acreage of vegetation in the submerged area.

(iv) Kind and number of wildlife in the submerged area.

(v) Kind and methods of water resources use.

(vi) River water quality.

(2) Social Environmental Survey

The social environmental survey should be carried out based on site survey in the approximate submerged area determined on maps at a scale of 1:50,000 and available data for population, land use and other related socio-economy to be obtained from governmental offices concerned. The survey items are as follows:

(i) The houses and their types (ex, Grade I, Grade II, Grade III) in the area to be submerged, and in areas for power stations and construction roads.

(ii) Households and number of population to be removed from the submerged area.

(iii) The area, ownership and kind of land use of areas to be compensated due to implementation of the project

(iv) Kind, location and acreage of public facilities (school, church, office) to be removed.

(v) Kind of right for water use and fishery in the submerged area.

(vi) Kind, area, and number of employee of the factory in the compensation area.

(vii) Length, width and kind of road (national or provincial) to be removed.

(viii) Kind and number of property to be lost (wells, trees, cattle, etc.) and valuation.

TABLES

Tale V.3.1 LAND USE IN THE SUBMERGED AREA

No.	Name of Scheme	Forest (1) (sq.km)	Agricultural Area (2) (sq.km)		Others (sq.km)	Total (sq.km)	Evaluation for	
			Farm land	Pasture			(1)	(2)
1.	Salto Pilao (1)	10 0.12	15 0.18	65 0.78	10 0.12	1.2	C	C
2.	Salto Pilao (2)	10 0.12	15 0.18	65 0.78	10 0.12	1.2	C	C
3.	Ibirama	20 0.10	15 0.08	50 0.25	15 0.08	0.5	C	C
4.	Subida	40 0.08	20 0.04	25 0.05	15 0.03	0.2	C	C
5.	Ascurra	20 1.40	25 1.75	45 3.15	10 0.70	7.0	B	B
6.	Indaial	15 0.03	20 0.04	45 0.09	20 0.04	0.2	C	C
7.	Dalbergia	80 0.32	10 0.04	5 0.02	5 0.02	0.4	C	C
8.	Barra da Pratinha	80 5.04	0 0	15 0.95	5 0.31	6.3	A	C
9.	Barra das Pombas	90 19.17	0 0	10 2.13	0 0	21.3	A	B
10.	Timbo	30 0.30	10 0.10	50 0.50	10 0.10	1.0	C	C
11.	Benedito Novo	70 0.07	0 0	20 0.02	10 0.01	0.1	C	C
12.	Alto Benedito Novo	40 0.04	10 0.01	40 0.04	10 0.01	0.1	C	C
13.	Doutor Pedrinho	60 1.13	5 0.10	30 0.57	5 0.10	1.9	B	C
14.	Trombudo Central (1)	30 3.84	10 1.28	45 5.76	15 1.92	12.8	B	A
15.	Trombudo Central (2)	20 1.92	15 1.44	45 4.32	20 1.92	9.6	B	A
16.	Botuvera	80 2.47	5 0.16	10 0.31	5 0.16	3.1	B	C

Note:

(1) Water surface area is excluded from submerged area.

(2) Upper figures show percentages ; lower figures show area in sq. km.

Table V.3.2 RELATIONSHIP BETWEEN SUBMERGED AREA AND ASSUMED NUMBER OF HOUSE AND POPULATION

Identified Schemes	Scheme Name	River Name	Type of Power Schemes	Drainage Area (sq.km)	Submerged Area (sq.km) /1	Assumed Number of House	Assumed Number of Population	Evaluation for Population
1.	Salto Pilao (1)	Itajai	ROR	5,597	4.65 (1.2)	74	340	C
2.	Salto Pilao (2)	Itajai	ROR	5,597	4.65 (1.2)	74	340	C
3.	Ibirama	Itajai	ROR	9,041	0.75 (0.5)	10	46	C
4.	Subida	Itajai	ROR	9,147	0.6 (0.2)	28	128	C
5.	Ascurra	Itajai	ROR	9,586	8 (7.0)	123	565	B
6.	Indaial	Itajai	ROR	11,493	0.9 (0.2)	15	69	C
7.	Dalbergia	Itajai do Norte	ROR	3,212	1.1 (0.4)	6	27	C
8.	Barra da Pratinha	Itajai do Norte	RES	1,405	6.3	37	170	C
9.	Barra das Pombas	Itajai do Norte	RES	979	21.3	21	96	C
10.	Timbo	Benedito	RES	765	1	50	230	C
11.	Benedito Novo	Benedito	ROR	586	0.18 (0.1)	4	18	C
12.	Alto Benedito Novo	Benedito	ROR	473	0.17 (0.1)	6	27	C
13.	Doutor Pedrinho	Benedito	RES	161	1.9	13	59	C
14.	Trombudo Central (1)	Trombudo	RES	293	12.8	183	841	B
15.	Trombudo Central (2)	Trombudo	RES	117	9.6	188	865	B
16.	Botuvera	Itajai Mirim	RES	625	3.1	38	174	C

/1: Figures in bracket show acreage excluding water surface area.

Table V.3.3 EXISTING ROADS AND BRIDGES IN THE SUBMERGED AREA

Identified Schemes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Assumed distance of state road (km)	2.0	2.0	4.0			4.5	2.5	28.0	18.0	8.5	1.0		8.0	11.0	13.2	7.8
Assumed distance of national road (km)			1.0	2.0	2.5	1.5										
Assumed nos of bridges (State road, nos)	2	2	4		1	4	1		10		1	1				
Assumed nos of bridges (Federal road, nos)			1	1												
	C	C	B	B	B	B	C	A	A	B	C	X	B	A	A	B

Table V.3.4 ENVIRONMENTAL EXAMINATION

Item of Check List		Evaluation for Identified Schemes															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Natural Environment	Sedimentation and its downstream effect	x	x	x	x	x	x	x	A	A	B	x	x	A	A	A	A
	Impact on soil erosion	C	C	C	C	B	C	C	C	B	C	C	C	C	A	A	C
	Impact on river environment	x	x	x	x	x	x	x	C	B	B	x	x	C	A	A	C
	Impact on vegetation	C	C	C	C	B	C	C	A	A	C	C	C	B	B	B	B
	Impact on wildlife	x	x	x	x	x	x	x	D	D	x	x	x	D	x	x	D
Social Environment	Effect on population	C	C	C	C	B	C	C	C	C	C	C	C	C	B	B	C
	Effect on agriculture	C	C	C	C	B	C	C	C	B	C	C	C	C	A	A	C
	Effect on inland fishery	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Effect on secondary industory	x	x	x	x	x	x	x	x	x	x	C	x	x	A	A	x
	Effect on use of water resources	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Effect on traffic	C	C	B	B	B	B	C	A	A	B	C	x	B	A	A	B
	Effect on landscape	x	x	x	x	x	x	x	x	x	x	x	x	x	C	C	x
	Effect on historical and archaecological assets	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Note:
A : Degree of impact is significant.
B : Degree of impact is moderate.
C : Degree of impact is relatively small.
D : Impact is unknown but study is needed.
x : There are no influence

ANNEX VI

STUDY ON HYDRO-ELECTRIC POWER POTENTIAL INVENTORY

ANNEX VI. STUDY ON HYDROELECTRIC POWER POTENTIAL INVENTORY

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

ATTACHMENT

1. INTRODUCTION

The supply of electric power in Brazil is regulated by the Ministry of Infrastructure which administers the National Department for Water and Electric Power (DNAEE) and the holding company of the power sector (ELETROBRAS) in order to orient and implement a nationwide policy for the energy sector.

The DNAEE grants concessions to utilities for building plants and dams on water course. ELETRÓBRAS is responsible for planning, financing and coordinating the expansion and operation of the Brazilian power system. It controls four regional utilities; ELETRONORTE in the northern region, CHESF in the northeastern region, FURNAS in the center west/southeastern region and ELETROSUL in the southern region. These regional utilities are responsible for executing federal policy within their geographical areas. They own and operate generating systems and inter-regional transmission lines.

In each of the regions, there are also state utilities, which are usually controlled by the state government, and responsible for part of the generation, transmission and distribution within each state. CELESC is a Santa Catarina government owned electric company which is responsible for power supply in the state of Santa Catarina.

The power consumption by category in Santa Catarina in 1987 is as follows:

- Residential	1104	GWh
- Industrial	3113	GWh
- Commercial	537	GWh
- Rural	526	GWh
- Public Services and Ilumination	394	GWh
- Internal Consumption	9	GWh
TOTAL	5683	GWh

CELESC generates electric power by its 12 owned power plants and supplied 375 GWh of power energy in 1988, which is about 7 % of the power demand, the remaining power demand being supplied by power from ELETROSUL, ITAIPU Binational and other power supply sources.

ELETROSUL supplies electric power to four states in the south region, namely, Rio Grande do Sul, Santa Catarina, Paraná and Mato Grosso do Sul. The power supply network of ELETROSUL is interconnected with the southeastern region. If electric power exceeding the demand in the south region is available, ELETROSUL sells such excess power to the southeastern region, and if the situation is reversed, FURNAS supplies power from the southeastern region to the southern region.

CELESC disburses more than 50% of its budget for power supply from ELETROSUL, but intends to reduce this proportion to 20% by developing its own hydropower projects.

In line with this policy, CELESC intends to develop the hydroelectric power projects in the Itajai river basin which has the highest power market areas in the state.

Hydroelectric power development planning in 1966 was concentrated on at a rapid river stretch downstream of Rio do Sul, and this was reviewed in 1974 and 1979. However, no hydropower potential survey has been carried out for the whole Itajai river basin.

For implementation of this study, the Federal Government of Brazil requested the technical assistance of the Government of Japan. In December 1989, JICA entered into an agreement with CELESC to carry out the present study on hydropower potential in the Itajai river basin.

The study was performed in two stages. The present initial stage has been an inventory study of the potential hydropower of the Itajai river basin. The second stage will be the pre-feasibility study of schemes selected from among the inventory study in the initial stage.

This report presents the results of the inventory study in the initial stage and describes the following items:

- Study process and approach
- Previous study on hydropower development
- Identification of hydropower potential sites
- Power output calculations
- Basic design and preliminary cost estimates
- Hydropower project inventory
- First and second screenings of identified schemes
- Preparation of master plan program

2. STUDY PROCESS AND APPROACH

2.1 General Study Flow

For preparation of the inventory of potential hydropower sites, the following studies were undertaken:

(i) Basic data collection and their review
(ii) Map study and site reconnaissance
(iii) Hydropower calculations and preliminary cost estimates
(iv) Establishment of the inventory of hydropower sites, and
(v) Selection of promising hydropower projects.

For formulation of the power development plan, the following works were performed;

(vi) Preparation of the basic layout design
(vii) Cost estimate (2nd)
(viii) Establishment of catalogue of promising hydropower projects and second screening
(ix) Formulation of power development plan

The general work flow showing the above procedure is shown in Fig VI.2.1.

2.2 Basic Concepts of the Study

2.2.1 Basic criteria and assumptions

Basic criteria and assumptions applied to this study were as follows;

(i) Power scale

No definite limitation was set out for the power scale to be developed since the river discharge and catchment areas in the basin - wide study were relatively small.

(ii) Concept for other water uses

No water resources development has yet been promoted in the Itajai river basin except for some small scale hydropower plants situated along the Benedito river upstream of Timbo.

There are several weirs and pumping stations along the Itajai river and its tributaries for municipal and industrial uses. Their intake is only 10 to 150 l/sec except for 550 l/sec for municipal water use from the Itajai Mirim river. The irrigation area for paddy and sugar cane cultivation in the Itajai river basin was estimated at about 35,000 ha, for which the irrigation water has been taken from small tributaries. It is considered, therefore, that these present water uses will have no influence on use of the river even if the hydropower development is realized and that the hydropower potential study should proceed regardless of other water uses.

(iii) Concept for regulating effect of flood by dam

In this hydropower potential study, two types development were contemplated, namely, run-of-river type and reservoir type development taking into account the topographic characteristics of the Itajai river basin. For the run-of-river type scheme, it is considered that there would be no flood control effect by weir since only low weirs will be constructed for daily regulation of flow to cope with daily peak load and flood flows down without regulation by weir. For the reservoir type scheme, floods may be regulated by means of flood capacity in the reservoir in case of a large scale reservoir type. This flood control effect will be examined for reservoir type schemes which remain after final screening.

2.2.2 Identification of hydropower sites

The identification of potential hydropower sites was carried out based on topographic maps at a scale of 1:50,000 with a contour interval of 20 m, and maps at a scale of 1:10,000 with a contour interval of 10 m.

The data extracted from the map are location, water level to be specified, reservoir capacity, river cross section, waterway length, information on transmission lines, access roads and other technical findings.

2.2.3 Cost study

Based on the cost information provided by several previous project reports, unit costs for each facility necessary for hydropower schemes were examined and adequate unit costs were assessed.

2.2.4 Power output calculation and preliminary cost estimate

Based on the hydrological and topographical data obtained through the survey and study, power output calculations were carried out for each identified hydropower potential site to obtain such output information as installed capacity, annual energy, and scheme feature for development alternatives.

Preliminary cost estimate were made for all the identified schemes for power development, transmission lines and access roads and such indirect costs as engineering and administration costs as well as physical contingencies. The work quantities necessary for cost estimation were obtained by simplified formulae.

2.2.5 Inventory of hydropower sites

The project features of the hydropower schemes obtained through power output calculations and cost estimates were stored in the inventory of hydropower sites.

2.2.6 First screening evaluation

The first screening evaluation was to select promising projects out of the schemes identified and stored in the inventory of hydropower sites. The evaluation of each hydropower scheme was made by comparing with unit cost of power energy obtained through the study and the marginal cost of expanding energy in the system, which has been specified by criteria of ELETROBRAS.

2.3 Preparation of Master Plan Program

For the selected hydropower schemes which passed the first screening, a second screening evaluation was performed as the basis for formulation of the proposed power development master program.

2.3.1 Preparation of basic layout plan

A layout plan was prepared for each selected scheme based on the optimized development plan formulated in the first screening.

2.3.2 Second screening evaluation

The second cost estimate was carried out using data on work quantities obtained from the basic layout drawing and unit cost assessed in the foregoing. This cost estimate was more detailed one than the preliminary one which was estimated by simplified formulae.

For the selected schemes, the second screening evaluation was carried out in the same manner as applied to the first screening evaluation. In this case, technical review of the schemes was made on such items as technical aspect, constraints to construction and sociological and environmental aspects. In this screening, power development schemes were selected for pre-feasibility study to be carried out in the following stage.

2.3.3 Preparation of master plan program

For the selected power development schemes, a master program showing annual disbursement schedule and time schedule for project implementation was prepared considering the relations between marginal cost of the expanded energy of the system and period to be developed.

3. PREVIOUS STUDY ON HYDROPOWER DEVELOPMENT

3.1 Existing Plants

CELESC operates 12 power plants in the State of Santa Catarina. Of these, the following 3 plants are under operation in the Itajai river basin.

Name of Power Station	Name of River	Installed Capacity (MW)	Commission Year
Palmeiras	Benedito	17.6	1964
Cedros	Benedito	7.6	1949
Salto	Itajai	6.3	1914
Total		31.5	

The Palmeiras and Cedros power stations are located on a tributary of the Benedito river, about 41km upstream of its conference with the Itajai river. The Salto power station is situated just upstream of the center of Blumenau city. The Palmeiras and Cedros power stations are reservoir type with waterways. These two power plant generates daily power divided into 6 types depending on the water level of their respective reservoirs. The Salto power station is a run-of-river type.

3.2 Previous Study on Hydropower Development

In 1966 hydropower development planning was performed concentrating on a rapid river stretch downstream of Rio do Sul. The recommendations of this and subsequent reviews in 1974 and 1977 may be summarized as follows:

Studied year	Installed Capacity (MW)	Construction Cost (10^6 US$)	Cost Index (US$/kW)
Jan/1966	355	44.7	95
Aug/1974	360	48.4	134
Jan/1977	331	248.6	951
Jan/1977	92*	106.2	1154

* In case without diversion of Canoas river

This plan was, however, not realized due to the following reasons;

(i) The right to construction of power plant and generation of power supply was granted to all power companies by decree through DNAEE at the time of study in 1966. Accordingly planning of hydropower development was promoted by CELESC. Since the regional company (ELETROSUL) had not been established at that time. ELETROSUL was established in 1968 with the right to construction of power plant and generation. Thus, since 1968 CELESC has only had the right to distribute power energy .

(ii) Even so, CELESC has encountered difficulties in obtaining funds to improve the existing transmission and distribution systems.

4. IDENTIFICATION OF POTENTIAL HYDROPOWER SITES

4.1 General

The identification of potential hydropower sites (herein called the "map study") was carried out based on the topographic maps at a scale of 1:50,000 with a contour interval of 20 m, maps at a scale of 1:10,000 with a contour interval of 10 m and longitudinal profiles of river stretches as shown in pocket attached on the back cover.

4.2 Type of Power Development

The types of power development assumed in this map study were broadly of two types, namely, (i) Reservoir type development and (ii) Run-of-river type development. Each type has several variations as follows:

(1) Reservoir type development

(i) Single dam scheme
(ii) Dam + waterway scheme
(iii) Reservoir scheme with saddle dam (s)
(iv) Reservoir scheme with inter-basin water transfer intake (s)

(2) Run-of-river type development

(i) Run-of-river scheme with single intake
(ii) Run-of-river scheme with inter-basin water transfer intake (s)
(iii) Run-of-river scheme with regulating pondage

As a result of the map study, development types identified are (i) for the reservoir type development and (iii) for the run-of-river type development.

4.3 Method and Criteria for Map Study

Uniform criteria for the map study were established to ensure consistency. The criteria for map planning are given in Table VI.4.1. The following were the criteria and guidelines applied to the map study.

4.3.1. Selection/Identification of sites

The selection/identification of the sites was performed taking into account various factors as follows;

(1) Dam (reservoir) type scheme;

The site should be selected in a narrow gorge or at place of closed topography with steep banks. The gradient of river profile upstream of the envisaged site should be reasonably gentle, preferably with an open plane topography in the upper area to have a larger reservoir capacity.

(2) Run-of-river type scheme

The scheme consists of a diversion dam (weir) and a tunnel waterway to take water to a power station. The scheme is conceived in river stretches of steep gradient (basically steeper than 1/60) or in place where the equivalent head is available.

For both types schemes, it is essential to avoid submergence of a large town or city by the development.

4.3.2 Power scale

No definite limitation was set out for the power scale to be developed since river discharges and catchment areas in the basin-wide study were relatively small.

4.3.3 Preliminary estimation of power output and energy

The potential power output and energy at the site were estimated on an approximate basis in the map study. For this purpose, catchment area and approximate head were estimated based on the maps at a scale of 1:50,000 and 1:10,000, and river discharge at the site was calculated based on the discharge record of a nearby existing gauge and with reference to rainfall data in the catchment area.

4.3.4 General development plan

After the identification of potential hydropower sites, a preliminary general plan was prepared for each scheme and plotted on the topographic maps at a scale of 1:50,000. In many cases, several alternative ideas were conceivable in formulating the development plan such as alternative dam axes and alternative power house locations. In this phase of the study, only the site which was considered to be the most suitable based on the result of site reconnaissance was chosen and listed for estimating the hydropower potential at each site.

The general development plans plotted on the maps comprise (i) axis of dam/weir (ii) location of head tank/surge tank (iii) waterway route and (iv) location of the power station.

4.4 Geological Assessment of Schemes

Engineering geological assessment of dam, intake weir, waterway and power house for the identified sites was carried out by means of a field survey with surface inspection but without exploratory borings and also by geological map study. The results of the geological assessments are given in Table II.4.1, ANNEX II, GEOLOGICAL INVESTIGATION .

4.5 Schemes Identified from Map Study

As a result of the map study for the whole Itajai river basin, 16 hydropower potential sites were identified in total as listed in Table VI.4.2. They comprise 9 run-of-river type schemes and 7 reservoir type schemes. The locations of the identified schemes are shown in Fig.VI.4.1.

Utilization of Norte dam as a seasonal base load power station was not contemplated for the following reason;

The meteo-hydrological data for the Norte river show that there is no clear definition of dry and wet seasons from the view point of rainfall and there is a possibility of floods in any month of the year. This means that it is impossible to fill the reservoir to generate power even if the hydropower scheme upstream of the Norte dam is economically feasible and constant river flow used for power generation in the upstream power station flows into the Norte reservoir.

5. POWER OUTPUT CALCULATION

5.1. General

For each hydropower site indicated by the map study, power output and energy were calculated based on the criteria specified by ELETROBRAS. Through this calculation, various alternatives of development scale were examined to determine the optimal development scale of each site in combination with the preliminary cost estimate. Each of the identified sites was assumed to be independent of the other schemes.

5.2. Criteria Established by ELETROBRAS

In order to formulating the hydropower development plan, the power supply system of ELETROSUL, which supplies more than 90 % of the power consumed in Santa Catarina state through CELESC, should be taken into account. The power system of south region is interconnected with the power supply system of the southeastern region, and both systems are mainly composed of hydropower plants (87 % of total installed capacity). This implies that power generation largely depends on hydrological conditions in the region. Accordingly ELETROBRAS established the followings criteria :

(1) For the inventory study, the firm energy will be approximated to the average energy generated during the critical hydrological period in the interconnected system.

(2) The critical hydrological period in the interconnected system is defined as the period from April 1949 to November 1956 as illustrated in Fig.VI.5.1, in which the ordinate is the total monthly power output (MW) equivalent to reservoir storage for all the existing hydropower plants and promising hydropower projects in the interconnected system and abscissa shows the period from 1931 to 1982.

(3) The guaranteed energy is defined as the mean energy generated in the plant during the critical period of the 1,000-year synthetic flow plus a proportional part of the power deficit in the system, and it is expressed as follows;

$$Eq = Gi + Gi \times Ds/Gs,$$

$$Ds = Os - Gs$$

where; Eq ; Guaranteed energy (MW)

Gi ; Medium energy generated in the critical period (MW)

Ds ; Medium deficit of the system in the critical period (MW)

Gs ; Medium energy generated in the system in the critical period (MW)

Os ; Supply of energy in the system (MW)

According to the power calculation in the interconnected system by ELETROSUL, the relation between firm energy based on the critical period and mean energy probably occurring less than 5% based on 1,000-year synthetic flow is calculated as shown in Fig.VI.5.2. Based on this figure, the guaranteed energy can be defined as 90% of the firm energy.

(4) The economic viability of a hydropower project in the interconnected system is analysed by comparing the "unit cost of guaranteed energy" of the project with the "marginal cost of expanded energy".

The unit cost of guaranteed energy is obtained by following expression:

$$CUEG = \frac{CIA - 8{,}760 \cdot CRES \cdot ES - 1{,}000 \cdot CMP \cdot PG}{8{,}760 \cdot EG}$$

where; CUEG ; Unit cost of energy guaranteed in US$/MWh

CIA ; Annual equivalent cost, in US$; corresponds to the total investment cost multiplied by capital recovery factor for a useful life of 50 years at 10% per annum (0.1009)

CRES ; Reference cost of secondary energy, in US$/MWh; is considered to be fuel cost of 10 US$/MWh; which is estimated as the cost of weighted mean of fuel for coal, gas, oil and nuclear

ES ; Secondary energy, in MW

CMP ; Marginal cost of peak, in US$/MW

PG ; Guaranteed peak of power plant, in MW

EG ; Guaranteed energy, in MW on an average

In this expression, the marginal cost of peak, CMP is regarded as null for the following reason;

The power supply in the interconnected systems of the south and southeastern regions will be composed mainly of the majority of hydropower plants and several thermal plants. Power generation is, therefore, subject to hydrological conditions in the system area. According to the past power output record, the power energy does not always increase compared with extent of power installation, in other words, it may be said that there is at present excess power capacity. In view of these conditions, the marginal cost of peak is regarded as nil.

The marginal cost of expanded energy of the system, which actually represents a composition of unit cost of guaranteed energy is presented for every five years as follows:

Five - Year Period	Marginal Cost of Expanded Energy (US$/MWh)
1991 - 1995	34
1996 - 2000	36
2001 - 2005	43
2006 - 2010	53
2011 onward	64

Details of the marginal cost theory are explained in Chapter 5, *ANNEX III*, SOCIO-ECONOMY.

5.3 Development Scale Alternatives

5.3.1 Run-of-river development

For the run-of-river development scheme, the location and altitude of both the head pond and power house have to be determined to use the topographical advantages of the site to their maximum extent. Basically no fundamental alteration with regard to the topographical features of the scheme are conceivable because the head available in the river stretch is almost fixed.

The alternative development plans considered herein are, therefore, based on variation of maximum plant discharge. Several alternatives were examined by varying the development ratio which is defined as follows :

$$DR(i) = \frac{\text{Average turbinable flow } (m^3/s)}{\text{Maximum plant discharge } (m^3/s)}$$

$$= 1.0,\ 0.9,\ 0.8\ \ldots$$

In general, five to six cases were examined as the discharge alternatives. Fig.VI.5.3 shows the graphical indication of DR (i) illustrated on a flow duration curve.

5.3.2 Reservoir development

The development scale of the reservoir type schemes was examined for variation of reservoir capacity. Several reservoir development scales in terms of active storage capacity were examined. For each reservoir capacity alternative, the following 5 cases were also examined by varying the reservoir full supply level (F.S.L.) as variable parameter;

	Alternative F.S.L.	Minimum operating level (MOL)
1.	Topographically max F.S.L.	Drawdowned level at effective storage
2.	At 3/4 intermediate height between 1 and 5	Same as above
3.	At 1/2 intermediate height between 1 and 5	Same as above
4.	At 1/4 intermediate height between 1 and 5	Same as above
5.	Lowest FSL corresponding to a given storage above MOL	Lowest minimum MOL above sediment level

To determine the optimum reservoir development scale and dam height, it was assumed for each reservoir scheme that the ratio of firm discharge to peak discharge world be 0.5.

5.4 Power Calculation Criteria

To proceed with the power output calculation for each individual scheme, plant discharge, operating level and head was calculated by use of the criteria which are summarized in Table IV.5.1. These criteria were applied on a uniform basis to all the schemes. Table IV.5.1 also shows the equation for calculating the firm output and energy, installed power capacity and guaranteed energy.

5.5 Power Output Calculation

The power output calculation was made for all of 16 schemes by applying the criteria set out in Section 5.4. The results are given in ATTACHMENT in this ANNEX.

6. BASIC DESIGN AND PRELIMINARY COST ESTIMATE

6.1 General

In order to evaluate the identified 16 schemes through the first screening, the basic dimensions of major structures of the schemes were determined based on the empirical design criteria. Based on the results of this basic design, preliminary costs were estimated using the unit prices for similar projects which have been or are being implemented by CELESC.

6.2 Basic Design Criteria

6.2.1 Dams and waterways

(1) Dams

Two types development, namely run-of-river type and reservoir type are contemplated in this hydropower potential study. For run-of-river type development a concrete dam with a gated spillway was assumed to be adopted because there is topographically no space to provide a spillway beside the damsite on any run-of-river type schemes. The reservoir sediment level was set at the spillway crest. To secure the intake depth and required storage volume above this sediment level, gated spillways were planned. For securing dam safely 200-year probable floods were applied. A trapezoidal shaped dam with a vertical upstream face, 1 : 1.05 for downstream slope, and a crest width of 4.5 m was assumed. The freeboard above flood water level was taken to be 2 m.

For the reservoir type schemes, a rockfill type dam was adopted. A trapezoidal shaped dam with a 1 : 2.5 upstream slope, 1 : 2 downstream slope and crest width of 10 m was adopted. A freeboard above full supply level was taken to be 6 m.

(2) River diversion

A pressure tunnel type was assumed for diversion of river water. The inside diameter of the tunnel was calculated by the following equation;

$$D = 0.24 \times Qd^{0.5}$$

where;	D	;	Inside diameter of diversion tunnel (m)
	Qd	;	Design flood discharge for river diversion (m3/s)

(3) Headrace tunnel

A pressure type headrace tunnel was assumed. The inside diameter of the headrace tunnel was calculated by the following equation;

$$D = 1.05\ Qp^{0.372}$$

where;	D	;	Inside diameter of headrace tunnel (m)
	Qp	;	Maximum plant discharge (m^3/s)

The minimum diameter of the headrace tunnel was fixed at 2.5 m, and if the diameter exceeded 8 m, two or three lanes were considered.

Since the cover thickness of the hilly area along the waterway for Indaial run-of-river type scheme is less than 2.5 times the diameter of the headrace tunnel, a non-pressure type channel was assumed. In this case a concrete lined trapezoidal shaped channel with side slopes of 1 : 1 and an average channel slope of 1 : 1,000 was applied. Freeboard of 0.3 m was adopted.

(4) Penstock line

An underground inclined pressure shaft was considered as the typical layout of the penstock line. The slope of the inclined shaft was assumed to be 50°. Fig VI.6.1 is the pressure shaft profile assumed in this study. The inside diameter of the steel liner pressure shaft is calculated by the following equation;

$$D = 1.125\ (Qp^{3/7}/H^{1/7}) + 0.494$$

where;	D	;	Inside diameter of pressure shaft (m)
	Qp	;	Maximum plant discharge (m^3/s)
	H	;	Static head (m)

The minimum diameter was fixed at 1.8 m, and if the diameter exceeds 8 m, two or three lanes were considered.

(5) Surge tank

A simple type surge tank was assumed, and its inside diameter was assumed to be 4 times of that of the headrace tunnel.

6.2.2 Transmission line

The transmission line was assumed to connect the power house to an existing substation located near the project site. The transmission line route was selected based on the following criteria;

(i) The line route was selected along the proposed access road and/or the existing public roads.

(ii) If there are no existing roads, the line route was selected along the river valley to avoid crossing of the mountain range.

The shortest route to the existing substation was determined based on 1/50,000 topographic maps.

6.3 Preliminary Cost Estimate

6.3.1 General

The work quantities for major structures were estimated by applying empirical formula. The unit prices for each segment of the works were derived from cost data for similar projects which had been studied by CELESC.

6.3.2 Preliminary cost estimate

Table VI.6.1 shows the empirical formula to estimate the work quantities of such major structures as dams, waterways, power house generating equipment, transmission line, etc. Table VI.6.2 shows the unit prices applied to this study, which were derived by converting the recent cost data to the price level in 1990. Based on the work quantities and unit prices thus obtained, the construction cost for the identified 16 schemes was estimated as shown in ATTACHMENT of this ANNEX.

7. HYDROPOWER PROJECT INVENTORY

7.1 Inventory of Hydropower Potential including Alternative Plans

Based on the power output calculation and preliminary cost estimates for the 16 potential hydropower sites identified, an inventory of hydropower potential for 16 schemes including alternative plans by varying the development scale for the run-of-river scheme and changing reservoir development scale for the reservoir type was prepared as shown in ATTACHMENT of this ANNEX.

7.2 Inventory of Hydropower Potential for Optimum Scale

7.2.1 Evaluation index

To determine the optimum scale of the hydropower development for the various identified schemes, unit cost of the guaranteed energy was calculated as an evaluation index. The calculation formula for the unit cost of the guaranteed energy is as follows;

$$CUEG = \frac{CIA - 8{,}760 \cdot CRES \cdot ES - 1{,}000 \cdot CMP \cdot PG}{8{,}760 \cdot EG}$$

Where;	CUEG	;	Unit cost of energy guaranteed in US$/MWh; hereinafter called "Unit Cost of Generation"
	CIA	;	Annual equivalent cost, in US$; corresponds to the total investment cost multiplied by capital recovery factor for a useful life of 50 years at 10% per annum (0.1009)
	CRES	;	Reference cost of secondary energy, in US$/MWh; is considered to be fuel cost of 10 US$/MWh; which is estimated as the cost of weighted mean of fuel for coal, gas, oil and nuclear
	ES	;	Secondary energy, in MW
	CMP	;	Marginal cost of peak, in US$/MW
	PG	;	Guaranteed peak of power plant, in MW
	EG	;	Guaranteed energy, in MW on an average

7.2.2 Optimum development scale

Based on the evaluation index stated in the foregoing section, the optimum development scale for run-of-river and reservoir type schemes for all of the identified schemes was selected from among several alternative plans. The optimum development scale thus selected is given in Table VI.7.1. The total power potential in terms of the installed capacity in the Itajai river basin was estimated to be about 238 MW.

The inventory of optimum scale for the identified schemes contains the following information;

(i) Scheme identification information
- Name of river basin and stream
- Scheme No, name of scheme, location

(ii) Hydrological and topographic information
- Average runoff
- Stream gauge correlated
- Catchment area

(iii) Scheme information
- Type of development
- Reservoir/pondage capacity
- Development scale; firm discharge and max plant discharge
- Dam/weir height, volume, crest length and elevation
- Waterway length diameter and number
- Length of transmission line
- Length of access road

(iv) Power information
- F.S.L. and T.W.L.
- Operating level and head
- Installed capacity and firm power
- Firm, guaranteed and secondary energy

(v) Preliminary cost information

- Total construction cost
- Cost per kW
- Cost per MWh
- Unit cost of guaranteed energy

(vi) Other information

- Submerged area
- Submerged houses
- Submerged farm lands
- Roads to be relocated
- Bridges to be replaced

8 FIRST SCREENING OF IDENTIFIED SCHEMES

8.1 Screening Criteria

The first screening was carried out by comparing the unit cost of the guaranteed energy estimated by the generated power energy and preliminary cost for the respective schemes, and the marginal cost of the expanded energy of the system which was assessed by ELETROBRAS.

The marginal cost of the expanded energy of the system was estimated for every five years, and it ranges from US$34/MWh in 1991-1995 period to US$64/MWh in 2011 onward. Thus a hydropower scheme with an extremely high unit cost of the guaranteed energy, and which deviates from the upper range of the marginal cost (approximately, less than US$70/MWh) was eliminated in the first screening.

8.2 Schemes Passed First Screening Evaluation

The five schemes which passed the first screening are all run-of-river type. The names of the selected schemes and their features are as follows;

Name of scheme	Installed capacity (MW)	Annual energy (GWh)	Guaranteed energy (GWh)	Total construction cost (Mil.US$)	Unit cost of guaranteed energy (US$/MWh)
Salto Pilao (1)	117.8	721.3	649.1	114.6	16.7
Salto Pilao (2)	67.1	470	423	80.7	18.5
Dalbergia	15.9	97.5	87.7	58.5	65.7
Benedito Novo	12.5	65.7	59.1	26.1	42.5
Alto Benedito Novo	12.9	56.7	51	36.0	69.2

9. SECOND SCREENING OF PROMISING SCHEMES

9.1 General

In order to select the hydropower schemes to be taken up for the pre-feasibility study in the following stage, second screening was performed for five schemes which passed the first screening. To obtain the cost information necessary for the second screening, general layout of five hydropower schemes was prepared based on the topographic maps at a scale of 1:50,000. The work quantity of the major components of the power facilities was estimated based on the prepared layout plan. The cost required for the second screening evaluation was estimated by multiplying the obtained work quantities by the unit costs used in the first screening. The second screening evaluation was performed in the same manner as applied to the first screening evaluation.

9.2 Basic Design

Major dimensions of the power facilities were designed to estimate work quantity and project cost. In this section, type of structure, its function, design criteria, calculation method and so on are presented.

9.2.1 Dam

Since the hydropower schemes which passed the first screening are all run-of-river type with a regulation pondage, about 15 to 20 m high dam has been planned. The geological conditions of these damsites are excellent or good. But there is topographically no space to provide the spillway beside the damsite. Then a concrete gravity dam type with gated spillway was planned.

Considering the geological condition, the dam section as stated in the followings was adopted;

- Upstream slope of dam	;	Vertical
- Downstream slope of dam	;	1:1.0
- Crest width of dam	;	4.5 m
- Freeboard above FWL	;	2 m

9.2.2 Spillway

The gated spillway has two functions, to spill the design flood for dam safety, and to keep the water level of the pondage for power generation.

In this study, the spillway crest was initially determined to maintain the intaking depth below the normal water level for power generation. The flood discharge with 200-year recurrence was adopted as the design flood for the spillway. The required width of the spillway was calculated by the following equation;

$$B = \frac{Q}{CH^{3/2}}$$

where ;	B	;	Effective overflow width (m)
	Q	;	Design flood (m^3/sec)
	C	;	Coefficient of overflow discharge ; 1.9
	H	;	Overflow depth at crest (m)

9.2.3 Headrace tunnel

A pressure type headrace tunnel was applied to the headrace waterway for all the run-of-river type schemes. The alignment of the waterway was decided based on the topographic maps at a scale of 1:50,000 with a contour interval of 20 m.

A circular type was applied as the tunnel section, and its diameter was calculated using the following equation;

$$D = 1.05\ Op^{0.372}$$

where ;	D	;	Inside diameter of the headrace tunnel (m)
	Op	;	Maximum plant discharge (m^3/sec)

The lining thickness of the tunnel was calculated by the following equation;

$$T = 0.125D$$

where ;	T	;	Lining thickness (m)
	D	;	Inside diameter of tunnel (m)

Since the geological condition along the tunnel route for all the schemes has been presumed to be excellent or good except for the upstream route for Benedito Novo scheme, the lining thickness obtained by this equation was applied for cost estimate. For about 200 m long upstream tunnel route for Banedito Novo scheme, thickness of the lining was increased by 50%.

9.2.4. Surge tank

Among several types of the surge tanks, a simple type surge tank was applied to all the schemes. The height and diameter of the surge tank were calculated by the following equations;

$$Ds = 4\ Dt$$

$$Hs = Hd+4Ht+2Dt+1$$

where ;	Ds	;	Diameter of tank shaft (m)
	Dt	;	Diameter of headrace tunnel (m)
	Hs	;	Height of surge tank (m)
	Hd	;	Drawdown depth of reservoir (m)
	Ht	;	Surging depths (m)
			$=0.36\ Qp^{1/3}x[(LxI)^{1/2}+(LxI)^{1/3}]$
	Qp	;	Maximum plant discharge (m^3/sec)
	L	;	Tunnel length (m)
	I	;	Hydraulic gradient of headrace tunnel

It was presumed that the height of the surge tank for all of the schemes would be in the range of 20 to 50 m. Considering the stability of the surge tank structure with such height, the surge tank was designed so as to be below the ground surface without protruding above the ground surface.

The lining thickness of the surge tank was calculated by the following equation;

$$t = 1.2 - 0.8/D1/2$$

where ;	t	;	Lining thickness (m)
	D	;	Diameter of surge tank (m)