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Table 3.1. Historical and Projected Energy
Generation and Peak Demand
Luzon Grid

CALENDAR YEAR	T O T A L G R I D		
	ENERGY REQ'T. ^{1/} GWH	PEAK LOAD MW	LOAD FACTOR %
<u>ACTUAL</u>			
1969	6087	1020	68.1
1970	6386	1111	65.6
1971	7048	1205	66.8
1972	7555	1331	64.8
1973	8212	1335	70.2
1974	8240	1379	68.2
1975	9014	1513	68.0
1976	9626	1659	66.2
1977	10357	1709	69.2
1978	11223	1780	71.9
1970-1978 ^{2/}	7.0%	7.0%	
<u>FORECAST</u>			
1979	12010	1960	70.0
1980	12850	2100	70.0
1981	13750	2240	70.0
1982	14710	2400	70.0
1983	15740	2565	70.0
1979-1983 ^{2/}	7.0%	7.6%	
1984	16840	2745	70.0
1985	18020	2940	70.0
1986	19280	3145	70.0
1987	20630	3365	70.0
1988	22075	3600	70.0
1989	23620	3850	70.0
1990	25275	4120	70.0
1984-1990 ^{2/}	7.0%	7.0%	
1979-1990 ^{2/}	7.0%	7.2%	

Table 3.1.

1991	26920	4390	70.0
1992	28670	4670	70.0
1993	30530	4975	70.0
1994	32515	5300	70.0
1995	34630	5645	70.0
1991-1995 ^{2/}	6.5%	6.5%	
1979-1995 ^{2/}	6.8%	6.8%	
1996	36705	5985	70.0
1997	38910	6340	70.0
1998	41245	6725	70.0
1999	43720	7125	70.0
2000	46340	7555	70.0
1999-2000 ^{2/}	6.0%	6.0%	
1979-2000 ^{2/}	6.6%	6.6%	

Note:

- 1/ - Excludes pumping requirements for the Kalayaan pump-storage hydroelectric project.
- 2/ - Average annual compound growth.

Table 3.2. Bulk Substations Forecasted Load (NPC Area)

Substations	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Ballesteros										9.5	10	10.5	11	12	13	14	14
Narvacan	-	-	30	37	43	49	56	64	72	82	93	96	102	109	116	123	132
Bauang		43	22	24	25	27	29	41	44	52	66	81	86	92	98	104	111
Baguio		65	70	77	78	83	91	98	102	108	110	111	117	124	132	141	150
Ambuklao*(Beckel)		30	30														
Mankayan	-	-	-	41	48	50	53	53	54	56	58	58	62	66	70	75	80
Batang-Buhay	-	-	9	9	9	9	10	12	15	20	25	37	40	42	45	48	51
Tuguegarao, Lal-Lo	-	-	9	13	17	19	23	28	30	21	22	20	21	23	24	26	27
Santiago	-	-	13	17	17	19	20	18	19	21	22	24	26	27	29	31	33
Solano	-	-	1	2	3	3	3	3	6	8	9	11	12	12	13	14	15
San Manuel		48	51	35	36	39	42	43	42	44	46	49	52	56	59	63	67
Labrador		-	-	22	25	27	30	33	36	40	44	49	52	56	59	63	67
Botolan		-	9	10	12	14	15	16	17	18	18	19	20	22	23	24	26
Olongapo		93	91	93	94	95	101	102	104	105	106	108	115	122	131	139	148
Prado		24	24	25	26	28	29	31	33	34	36	38	41	43	46	49	52
BTPP		32	33	34	35	36	37	39	40	41	43	44	47	50	53	57	60
EPZA		20	23	27	31	34	36	38	40	41	44	45	48	51	55	58	62
Mexico		83	88	92	94	100	104	111	116	123	131	139	148	158	168	179	191

Table 3.2.

Substations	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Tarlac		28	29	30	31	33	34	36	38	40	42	44	47	50	53	57	60
Cabanatuan		36	41	46	50	57	66	76	89	105	123	146	155	166	177	188	200
Angat (34.5 kW)		(36)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
San Jose (34.5 kV)		40	42	43	45	47	49	50	52	54	56	58	62	66	70	75	80
Kalayaan		-	-	15	16	17	19	20	22	23	25	27	29	31	33	35	37
Caliraya		7	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mak-Ban		18	19	20	21	23	24	25	27	30	32	35	37	40	42	45	48
Dasmariñas		20	23	25	28	30	32	36	39	43	45	50	53	56	60	64	69
Batangas		42	45	49	50	54	58	61	66	72	81	90	96	102	109	116	123
Gumaca		6	7	8	9	9	10	11	12	13	15	15	16	17	18	19	21
Labo		4	4	7	9	9	10	10	11	11	12	12	13	14	15	15	17
Naga		17	18	20	21	23	26	29	31	34	36	40	43	45	48	51	55
Lagaspi		20	22	24	26	24	27	29	32	34	37	41	44	46	50	53	56
NPC Total		676	763	845	899	958	1034	1113	1189	1282.5	1387	1497.5	1595	1698	1809	1926	2052

Table 3.3. Bulk Substations Forecasted Load (MECO Area)

Substation	Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total Load		2100	2240	2400	2565	2745	2940	3145	3365	3600	3850	4120	4390	4670	4975	5300	5645
N P C Load		676	763	845	899	958	1034	1113	1189	1282.5	1387	1497.5	1595	1698	1809	1926	2052
MECO Load		1424	1477	1555	1666	1787	1906	2032	2176	2317.5	2463	2622.5	2795	2972	3166	3374	3593
Sucat group																	
Balibago, Calauan																	
Gardner, Malibay																	
Rockwell, Taguig	513	529	551	591	631	669	713	760	808	861	921	981	1045	1118	1185	1262	
San Jose group																	
Balintawak, Bocaue																	
Malinta, N-Port																	
Novaliches, Sta Mesa																	
Tegen	640	672	709	762	819	875	934	1006	1070.5	1136	1202.5	1283	1362	1446	1548	1648	
Dolores group																	
Dolores, Marikina																	
Rosario, St. Antony																	
Teresa	239	244	257	272	293	313	331	350	373	396	424	451	480	512	545	580	
Malaya group																	
Malaya, Botocan	32	32	33	36	38	43	47	53	58	62	66	71	75	80	85	91	
Tayabas	-	-	5	5	6	6	7	7	8	8	9	9	10	10	11	12	

Table- 4.1.
Luzon Grid Generation Expansion Program
Revised Accelerated
with Tongonan Interconnection
(1980 - 2000)

YEAR OF COMM.	PLANT ADDITION	INSTALLED CAPACITY (MW)					TOTAL	DEPEND. CAP.	PEAK DEMAND	RES. CAP.	% RES.	AVAIL-ABLE ENERGY (GWH)	ENERGY CAPABILITY AND REQUIREMENT (GWH)				SUR-PLUS (DEF.)			
		HYDRO	GEO	COAL THER.	NUCL	OIL THER.							HYDRO	GEO	COAL THER.	NUCL		OIL THER.	TOTAL	GENE-RATION LEVEL
1979	Existing Plant	541	220			2230	2991	2660	1960	70	4	2491	2050	959		13871	16880	12010	4870	
79/1	Tiwi (1 x 55)										397									
79/3	Tiwi 2 (1 x 55)										397									
79/8	Mak-Ban 1 (1 x 55)										397									
79/11	Mak-Ban 2 (1x55)										397									
80/3	Tiwi 3 (1 x 55)	541	440			2155	3136	2815	2100	85	4	397	2050	2283		13571	17904	12850	5054	
80/5	Tiwi 4 (1 x 55)										397									
80/10	Mak-Ban 3 (1 x 55)										397									
80/12	Mak-Ban 4 (1 x 55)										397									
1981	Masiway (1 x 12)	553	440			2155	3148	2826	2240	(44)	-	48	2098	3176		13571	18845	13750	5095	
1982	Kalayaan #1 (1x150)	853	550			2155	3558	3226	2400	196	8	150	2373	3671		14769	20813	15080	5733	
82/3	Kalayaan #2 (1x150)										150									
82/4	Tiwi 5 (1 x 55)										397									
82/7	Tiwi 6 (1 x 55)										397									
1983	Magat 1-4 (4 x 90)	1213	550			2155	3918	3496	2565	301	12	1103	3501	3970		14769	22240	16140	6100	
1984	Coal Thermal I (300)	1213	550	300		2155	4218	3766	2745	391	14	1989	3501	3970	1989	14769	24229	17240	6989	
1985	Coal Thermal II (300)	1393	1345	600	620	2155	6113	5536	2940	1666	57	1989	3501	9748	3978	1684	14769	33680	18420	15260
	Magat 5 & 6 (180)																			
	PNPP 1 (620)										3910									
	Manito 1-2 (110)										794									
	Tiwi 7-10 (220)										1588									
	Mak-Ban 5-6 (110)										794									
	Daklan Geo. (55)										397									
	Tongonan (300)	1393	1345	600	620	2155	6113	5536	3145	1461	46	2205	3501	9748	3978	3367	14769	35363	19680	15683
1986																				
1987		1393	1345	600	620	2155	6113	5536	3365	1241	37		3501	9748	3978	3639	14769	35635	21030	14605
1988	Gened 1-6 (600)	1993	1345	600	620	2155	6713	5998	3600	1468	41	1153	4654	9748	3978	3856	14769	37005	22475	14530
1989		1993	1345	600	620	2155	6713	5998	3850	1218	32		4654	9748	3978	3910	14769	37059	24020	13039
1990		1993	1345	600	620	2155	6713	5998	4120	948	23		4654	9748	3978	3910	14769	37059	25675	11384

Table 4.1.

YEAR OF COMM.	PLANT ADDITION	INSTALLED CAPACITY (MW)					TOTAL	DEPEND. CAP.	PEAK DEMAND	RES. CAP.	% RES.	AVAIL-ABLE ENERGY (GWH)	ENERGY CAPABILITY AND REQUIREMENT (GWH)					GENE-RATION LEVEL PLUS (DEF.)	
		HYDRO	GEO	COAL THER.	NUCL	OIL THER.							HYDRO	GEO	SYSTEM CAPABILITY		TOTAL		
															COAL THER.	NUCL			OIL THER.
1991	Manito 3-4 (110)	1993	1455	600	620	2155	6823	4390	778	18	794	4654	10342	3978	3910	14769	37853	27320	10533
1992	San Roque (390) Tiwi 11-12 (110)	2383	1565	600	620	2155	7323	4670	920	20	1157	5811	11336	3978	3910	14769	39804	29070	10734
1993	Coal Ther III (300)	2383	1565	900	620	2155	7623	4975	885	18	1989	5811	11336	5967	3910	14769	41793	30930	10863
1994	Chico IV (360) Mak-Ban 7-8 (110)	2743	1675	900	620	2155	8093	5300	951	18	804	6615	12130	5967	3910	14769	43391	32915	10476
1995	Agos Kanan (280) Diguon (350)	3373	1675	900	620	2155	8723	5645	1048	19	815	8402	12130	5967	3910	14769	45178	35030	10148
1996	Chico II (250) Daklan 2-3 (110)	3623	1785	900	620	2155	9083	5985	1005	17	1050	9452	12924	5967	3910	14769	47022	37105	9917
1997	Coal Ther IV (300) Cabingatan (140) Manito 5-6 (110)	3763	1895	1200	620	2155	9633	8403	1133	18	1989	9979	13718	7956	3910	14769	50332	39310	11022
1998	Chico III (120) Amburayan (100) Manito 7-8 (110) Tongonan (110)	3983	2115	1200	620	2155	10073	8758	1103	16	266	10937	15306	7956	3910	14769	52878	41645	11233
1999	Coal Ther V (600) Dagsan (120)	4103	2115	1800	620	2155	10793	9398	1343	19	3978	11352	15306	11934	3910	14769	57271	44120	13151
2000	Abuan (100) Gadang (150) Iligan (210)	4563	2115	1800	620	2155	11253	9761	1276	17	382	12735	15306	11934	3910	14769	58654	46740	11914
											603								

Table- 4.2. Luzon Grid KW Balance (1979-2000)

Unit: MW

CY	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
INSTALLED CAPACITY																							
HYDRO	541	541	553	553	913	913	1093	1093	1093	1693	1693	1693	1693	2083	2083	2443	3073	3323	3463	3683	3803	4263	
PUMP HYDRO				300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
GEOTHERMAL	220	440	440	550	550	550	1345	1345	1345	1345	1345	1345	1455	1565	1565	1675	1675	1785	1895	2115	2115	2115	2115
COAL FIRED THERMAL						300	600	600	600	600	600	600	600	600	900	900	900	900	1200	1200	1200	1800	1800
NUCLEAR							620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620
OIL FIRED THERMAL	2230	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155
TOTAL	2991	3136	3148	3558	3918	4218	6113	6113	6113	6713	6713	6713	6823	7323	7623	8093	8723	9089	9633	10073	10793	11253	11253
DEPENDABLE CAPACITY	2660	2815	2826	3226	3496	3766	5536	5536	5536	5998	5998	5998	6098	6520	6790	7181	7623	7920	8403	8758	9398	9761	9761
PEAK DEMAND	1960	2100	2240	2400	2565	2745	2940	3145	3365	3600	3850	4120	4390	4670	4975	5300	5645	5985	6340	6725	7125	7555	7555
RESERVE (1)	700	715	586	826	931	1021	2596	2391	2171	2398	2148	1878	1708	1850	1815	1881	1978	1935	2063	2033	2273	2206	2206
RESERVE (2)	360	375	246	486	591	681	2006	1801	1581	1808	1558	1288	1118	1260	1225	1291	1388	1345	1473	1443	1683	1616	1616
RESERVE (3)	70	85	(44)	196	301	391	1666	1461	1241	1468	1218	948	778	920	885	951	1048	1005	1133	1103	1343	1276	1276

Reserve (1) = Dependable capacity (minus) Peak Demand.

Reserve (2) = Reserve 1 (minus) largest unit under maintenance.

Reserve (3) = Reserve 2 (minus) largest unit on line being outage.

Table- 4.3. Luzon Grid KWH Balance (1979-2000)

Unit: 10⁶ KWH

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HYDRO	2050	2050	2098	2098	3201	3201	3201	3201	3201	4354	4354	4354	4354	5511	5511	6315	8102	9152	9679	10637	11052	12435
PUMP HYDRO				275	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
GEOTHERMAL	959	2283	3176	3671	3970	3970	9748	9748	9748	9748	9748	9748	10542	11336	11336	12130	12130	12924	13718	15306	15306	15306
COAL FIRED THERMAL						1989	3978	3978	3978	3978	3978	3978	3978	3978	5967	5967	5967	5967	7956	7956	11934	11934
NUCLEAR							1684	3367	3639	3856	3910	3910	3910	3910	3910	3910	3910	3910	3910	3910	3910	3910
OIL FIRED THERMAL	13871	13571	13571	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769	14769
T O T A L	16880	17904	18845	20813	22240	24229	33680	35363	35635	37005	37059	37059	37853	39804	41793	43391	45178	47022	50332	52878	57271	58656
REQUIRED ENERGY	12010	12850	13750	14710	15740	16840	18020	19280	20630	22075	23620	25275	26920	28670	30530	32515	34630	36705	38910	41245	43720	46340
PUMPING ENERGY				370	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
SURPLUS	4870	5054	5095	5733	6100	6989	15260	15683	14605	14530	13039	11384	10533	10734	10863	10476	10148	9917	11022	11233	13151	11914

Table- 4.4. Luzon Grid
Average 30 Yrs Hydrologic Data
of Existing and Proposed Hydro Projects
(Source: Project Development)

NAME OF PLANT	QUARTERLY CAP. (MW)				CAPABILITY (MW)		DEPENDABLE CAPACITY (MW)
	1ST	2ND	3RD	4TH	MAX. / ¹	MIN. / ²	
Caliraya (36)	32.3	32.1	32.1	32.3	32.3	32.1	32.1
Ambuklao (75)	64.3	50.9	57.3	67.3	67.3	50.9	50.9
Binga (100)	90.0	85.1	87.0	90.0	90.0	85.1	85.1
Angat (218)	188.3	157.7	150.0	176.9	188.3	150.0	150.0
Pantabangan (100)	77.6	67.4	75.7	87.3	87.3	67.4	67.4
Botocan (17)	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Masiway (12)	10.8	10.8	10.8	10.8	10.8	10.8	10.8
Magat (360)	313.7	270.6	307.9	315.0	315.0	270.6	270.6
Magat (180)							180.0
San Roque (260)	219.2	191.6	197.6	228.1	228.1	191.6	191.6
San Roque (130)							130.0
Gened (600)	528.3	487.8	461.7	490.5	528.3	461.7	461.7
Kanan (280)	250.0	240.0	221.9	231.5	250.0	221.9	221.9
Chico IV (360)	321.4	290.6	305.2	349.5	349.5	290.6	290.6
Chico II (250)	216.1	197.0	204.7	220.3	220.3	197.0	197.0
Tabu (110)	99.0	92.6	77.3	99.0	99.0	77.3	77.3
Cabingatan (140)	123.1	112.6	112.2	121.9	123.1	112.6	112.6
Chico III (120)	108.0	103.1	78.7	89.2	108.0	78.7	78.7
Abuan (100)	87.9	82.8	78.4	83.1	87.9	78.4	78.4
Dakgan (120)	100.3	100.9	100.7	106.8	106.8	100.3	100.3
Amburayan (100)	82.4	75.6	81.5	88.7	88.7	75.6	75.6
Ilagan (210)	183.2	175.9	168.9	175.5	183.2	168.9	168.9
Gadeng (150)	132.2	116.2	116.1	130.0	132.2	116.1	116.1
Tanudan (140)	119.1	110.3	114.6	125.7	125.7	110.3	110.3
Diduyon (350)	-	-	-	-	-	-	220.0

NOTE: The above are Synthetic Data generated by Lahmeyer as there is no available data for planning purposes.

/1 Max. capability for hydro means capacity the plant can deliver at high or favorable reservoir condition.

/2 Minimum capability means capacity the plant can deliver at low or worst reservoir condition defined as dependable capacity.

Table- 4.5. Thermal Plants
Plant Capacity Data

<u>NAME OF PLANT</u>	<u>NO. OF SETS</u>	<u>INSTALLED CAPACITY (MW)</u>	<u>CAPABILITY MAX.</u>	<u>(MW) MIN.</u>	<u>DEPENDABLE CAPACITY (MW)</u>
Rockwell 1-5	5	125	75	25	75
Rockwell 6-8	3	180	150	54	150
Tegen 1 & 2	2	200	190	60	190
Bataan 1	1	75	72	22	72
Bataan 2	1	150	143	45	143
Gardner 1	1	150	140	45	140
Gardner 2	1	200	180	60	180
Snyder 1	1	200	190	60	190
Snyder 2	1	300	290	90	290
Malaya 1	1	300	290	90	290
Malaya 2	1	350	340	105	340
<u>GEOHERMAL</u>					
Tiwi 1-6	6	330	300	270	300
Geo. 1 x 55	1	55	50	45	50
<u>NUCLEAR</u>					
PNPP 1	1	620	590	197	590
<u>COAL</u>					
Coal Thermal I	1	300	270	90	270
<u>PUMPED HYDRO</u>					
Kalayaan 1 & 2	2	300	300	300	300

* Maximum and Minimum capability is the operating level at which the plant can be operated economically for thermal plant max. capability is the dependable capacity.

Table 5.1.

Existing EHV System and 2nd Voltage in World

unit : kV

Nations	EHV (A)	2nd Voltage (B)	Ratio (A)/(B)	Note
U.S.A.	345	138 154	2.5 2.24	*1 Very long trans- mission line (> 600 km) *2 Future Surround Paris planning
	500	220	2.27	
	765	345	2.22	
Canada	730 *1	220	3.32	
	500	220	2.27	
U.K.	400	275	1.45	
France	730 *2	220	3.32	
	400	220	1.82	
Other European	400	220	1.82	
Japan	500	275	1.82	
		220	2.27	

Table- 6.1. Relevant Parameters of Transmission Lines

(per circuit)

Voltage (kV)	No. of Circuits	Line Size (MCM)	Max. Current (Amp.)	Max. Capacity (MVA)	Kvarc per km	% for km on 100 MVA base positive sequence	
						Resistance	Reactance
230	1	1 - 795	900	358.5	168.28	0.01619	0.09679
230	2	1 - 795	900	358.5	175.10	0.01619	0.09314
230	2	2 - 795	1,800	717.0	227.30	0.00809	0.07093
230	2	4 - 795	3,600	1,434.1	269.64	0.00405	0.05927
500	2	4 - 795	3,600	3,117.6	1,197.22	0.00086	0.01334
115	1	1 - 795	900	179.3	45.78	0.06474	0.35676 *1
115	1	1 - 795	900	179.3	47.67	0.06474	0.3431 *2
115	1	2 - 795	1,800	358.5	64.45	0.03237	0.2428 *2

Note: *1. Tower

*2. Pole

Table- 6.2. Relevant Parameters of Generator and Step-up Transformer

Existing Plants

Name	MW	MVA	X'd(%)	X''d(%)	H	TrB.MVA	TrB.Imp. (%)	Note
Mak-Ban	55.0	69.0	24.00	18.00	4.0	68.75	15.83	% value are per unit own base
Tiwi	55.0	69.0	26.86	21.02	4.0	41.4	10.10	
Malaya	650.0	828.0	29.49	23.47	2.8	812.0	24.31	21 kV - 230 kV
							10.38	117 kV - 230 kV
							12.69	21 kV - 117 kV
Gardner	350.0	433.0	25.78	18.71	3.5	362.0	9.42	
Snyder	500.0	615.0	32.22	23.02	3.5	602.0	13.44	Geothermals are unit capacity
Tegen	200.0	256.0	19.00	15.00	3.4	250.0	9.90	
Bataan	225.0	281.0	23.40	18.10	3.45	300.0	9.50	Other plants are total capacity
Pantabangan	100.0	111.0	27.00	20.00	3.4	128.0	13.63	
Ambuklao	75.0	83.4	31.00	22.00	3.2	64.0	16.97	
Binga	100.0	112.2	31.00	21.60	2.9	132.0	13.60	
Argat	200.0	222.0	22.00	15.50	2.9	244.0	29.68	

Table-6.3. Relevant Parameters of Generator and Step-up Transformer

Future Plants

Name	MW	MVA	X'D (%)	X''D (%)	H	Tr.B MVA	Tr.B Imp. (%)	Note
Geothermal	55.0	69.0	26.86	21.02	4.0	41.4	10.1	Same value at Tiwi
C F T H	300.0	370.0	32.00	24.00	3.0	400.0	15.0	
P N P P	620.0	800.0	39.33	28.22	4.5	768.0	15.0	
Kalayaan	300.0	333.0	30.00	22.00	4.0	340.0	15.0	
Magat	540.0	600.0	30.00	22.00	4.0	690.0	15.0	
Gened	600.0	690.0	30.00	22.00	4.5	768.0	15.0	
San Roque	390.0	433.0	30.00	22.00	4.0	500.0	15.0	
Chico IV	360.0	400.0	30.00	22.00	4.0	460.0	15.0	
Agos Kanan	280.0	311.0	30.00	22.00	4.0	360.0	15.0	
Chico II	250.0	278.0	30.00	22.00	4.0	320.0	15.0	
Other future Hydro	-	MW÷0.9	30.00	22.00	4.0	MW÷0.9 x 1.15	15.0	

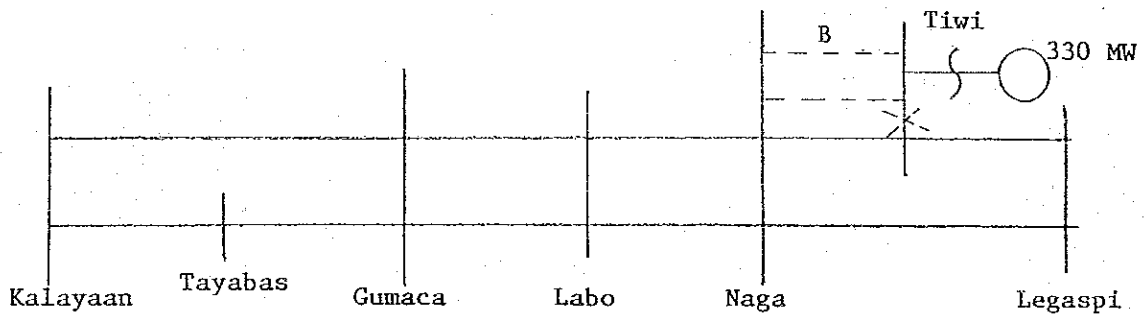
Table-6.4. Relevant Parameters of Step Down Transformer

Voltage	Capacity	Impedance
230 kV/115 kV	300 MVA	11.5%
230 kV/115 kV	100 MVA	11.3%
500 kV/230 kV	300 MVA	14%
500 kV/230 kV	150 MVA	14%
500 kV/115 kV	300 MVA	16%

Table 7.1. Result of Transient Stability Calculation
(Year 1982)

Case	Fault Point	Opened line	Max. δ & time	Max. δ point	Judgement
A	Tiwi	Naga - Tiwi	$>180^\circ$ 45s	Tiwi	unstable
	Naga	Naga - Labo l cct	92.6° 27s	Tiwi	stable
	Gumaca	Gumaca - Tayabas	79.6° 24s	Tiwi	stable
B	Tiwi	Naga - Tiwi l cct	85.5° 24s	Tiwi	stable

System Outline

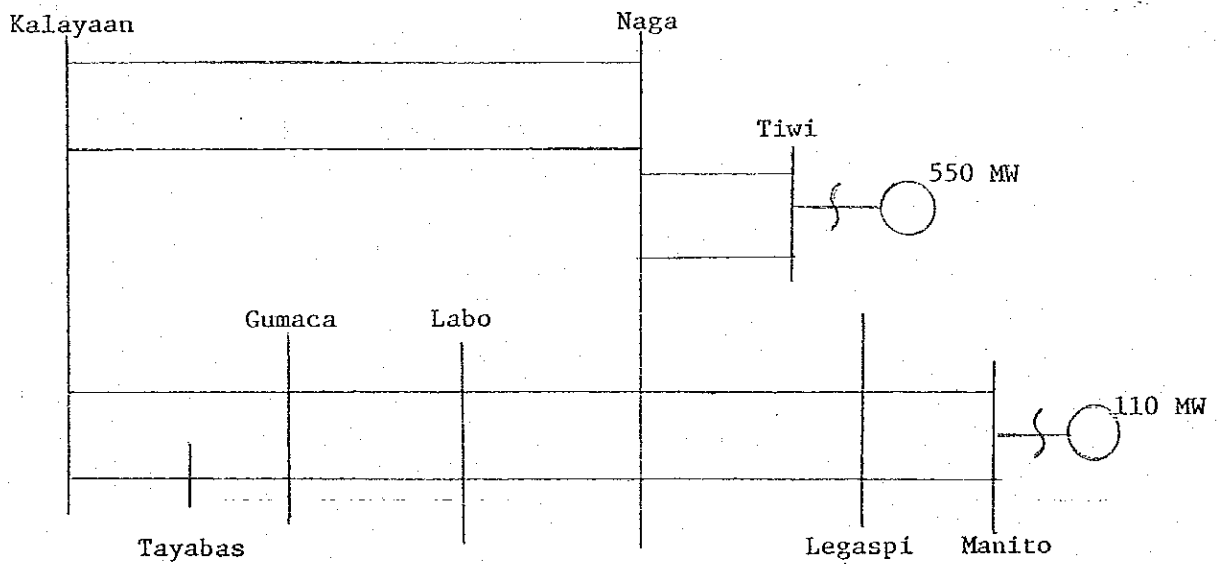


———— Case A Tiwi 330 MW
 - - - - Case B (additional to Case A) Tiwi 330 MW

Table 7.2. Result of Transient Stability Calculation
(Year 1985)

Case	Fault Point	Opened line	Max. δ & time	Max. δ Point	Judgement
C	Naga	Naga - Kalayaan 1 cct	68.2° 24 μ	Tiwi	stable

System Outline

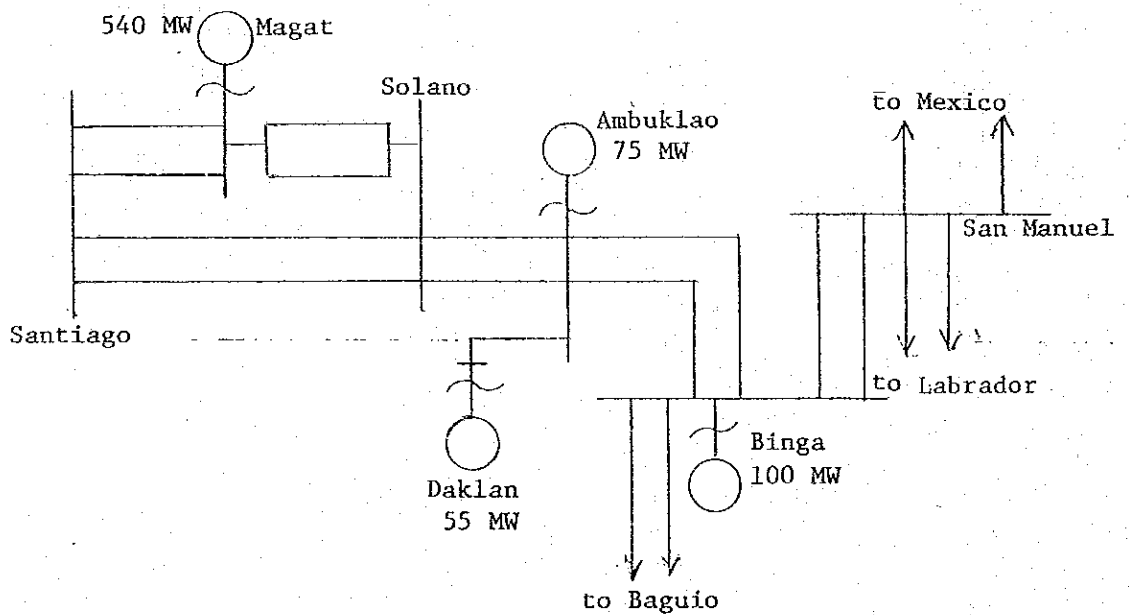


— Case C Tiwi 550 MW, Manito 110 MW; total 660 MW

Table 7.3. Result of Transient Stability Calculation
(Year 1985)

Case	Fault Point	Opened line	Max. δ & time	Max. δ point	Judgement
D	Solano	Solano - Ambuklao 1 cct	113.3° 36 _s	Magat	stable
	Ambuklao	ditto	118.1° 42 _s	Magat	stable
	ditto	Ambuklao - Binga 1 cct	93.1° 27 _s	Magat	stable
	Binga	ditto	92.8° 27 _s	Magat	stable
	Magat	Magat - Solano	105.3° 27 _s	Magat	stable

System Outline

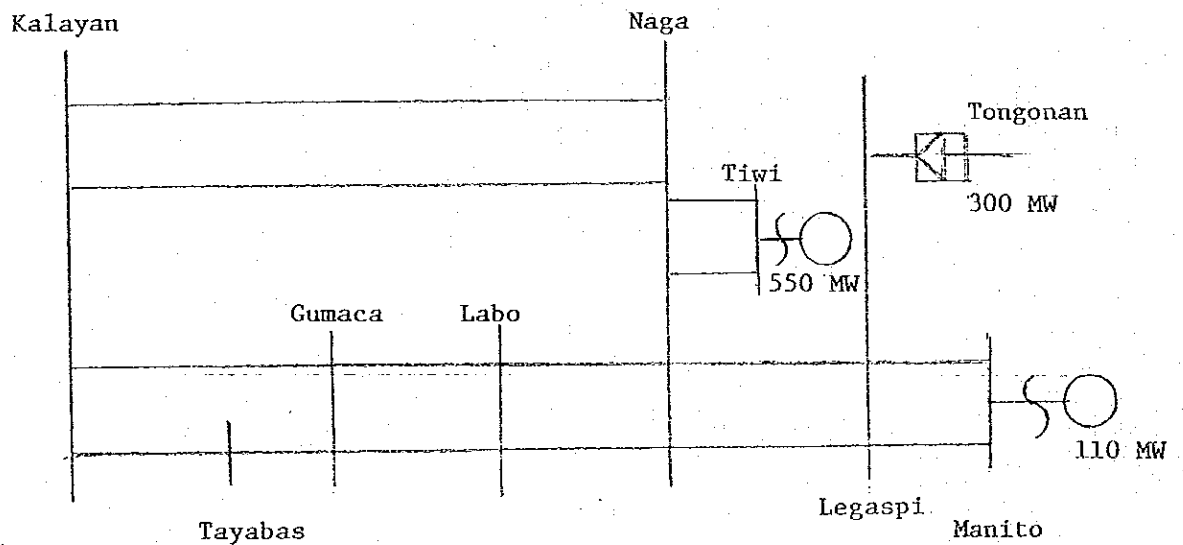


Case D Magat 540 MW, Ambuklao 75 MW, Binga 100 MW,
Daklan 55 MW; total 770 MW

Table 7.4. Result of Transient Stability Calculation
(Year 1986)

Case	Fault Point	Opened line	Max. $\Delta\delta$ & time	Max. $\Delta\delta$ point	Judgement
E	Naga	Naga - Kalayaan 1 cct	99.6° 33~	Tiwi	stable

System Outline

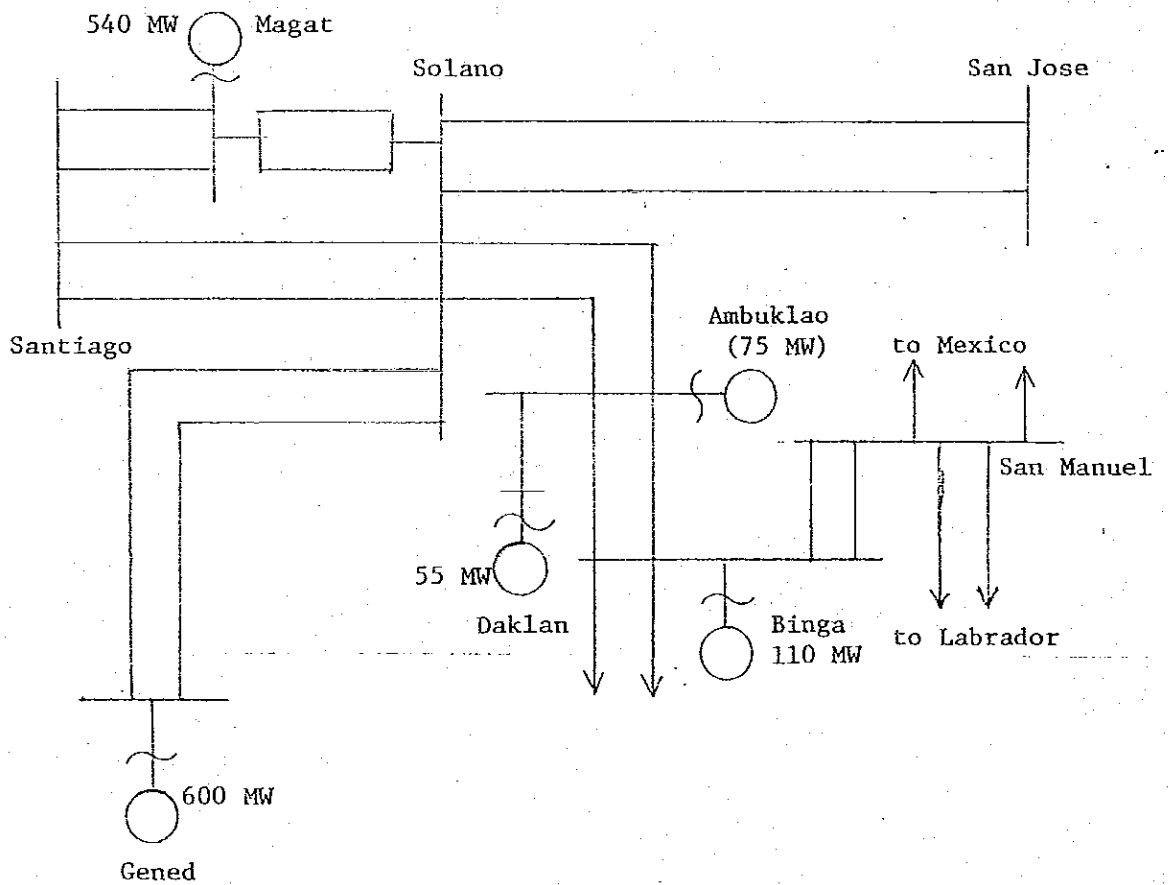


Case E Tiwi 550 MW, Manito 110 MW
Tongonan 300 MW; total 960 MW

Table 7.5. Result of Transient Stability Calculation
(Year 1988)

Case	Fault Point	Opened line	Max. δ & time	Max. δ point	Judgement
F	Gened	Gened - Solano 1 cct	$>180^\circ$ 33a	Gened	unstable

System Outline

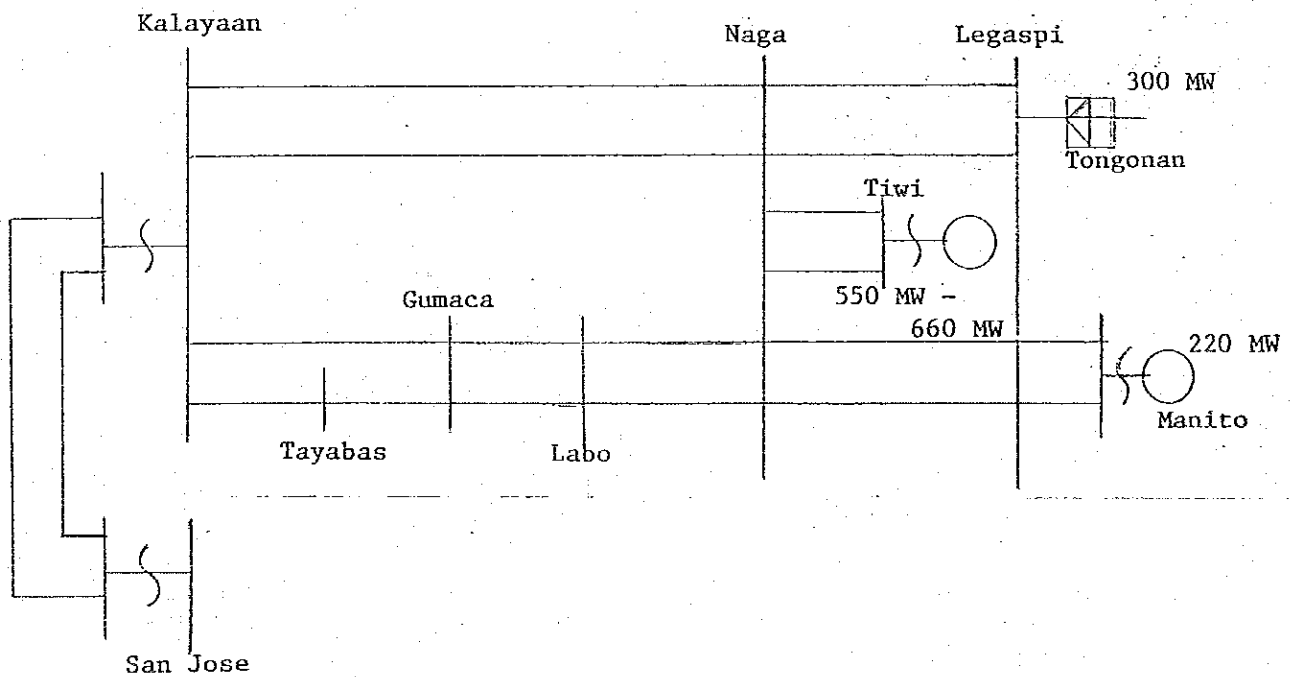


Case F Magat 540 MW, Ambuklao 75 MW, Binga 100 MW,
Daklan 55 MW, Gened 600 MW; total 1,370 MW

Table 7.6. Result of Transient Stability Calculation
(Year 1991, 1992)

Case	Fault Point	Opened line	Max. δ & time	Max. δ point	Judgement
G-I	Naga	Kalayaan - Naga 1. cct	97.1° 33 ^o	Tiwi	stable
G-II	ditto	ditto	>180° 57 ^o	Tiwi	unstable

System Outline



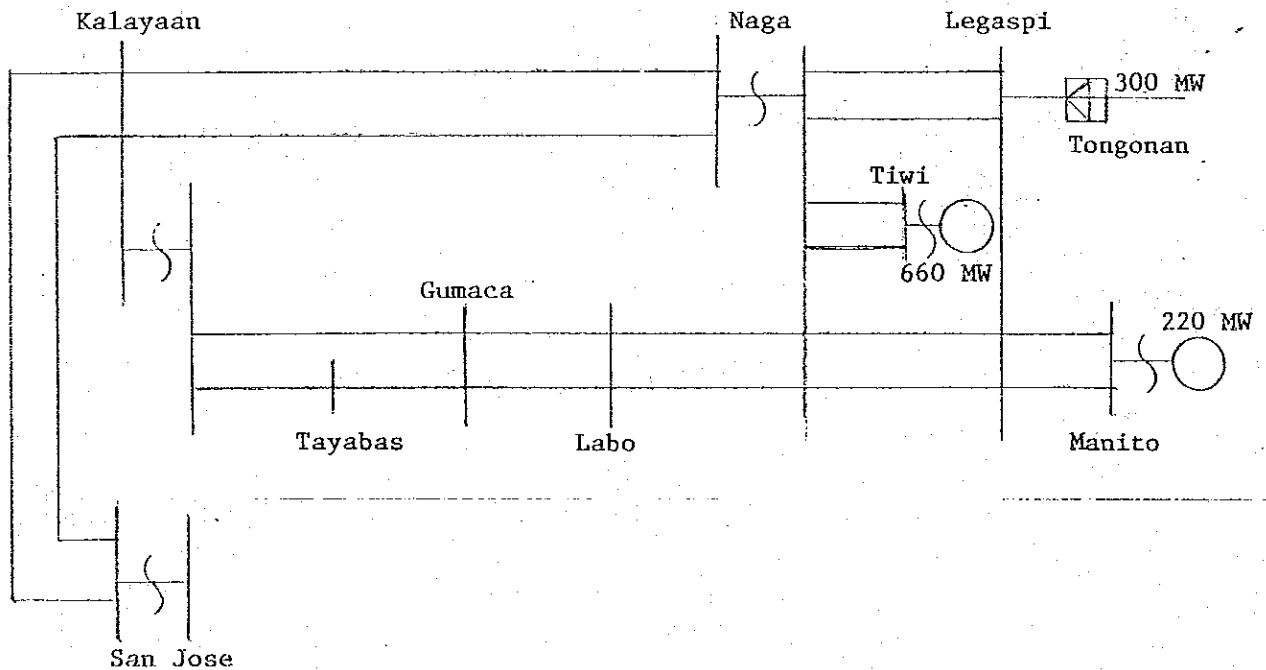
Case G-I (1991) Tiwi 550 MW, Manito 220 MW, Tongonan 300 MW;
Total 1,070 MW

Case G-II (1992) Tiwi 660 MW, Manito 220 MW, Tongonan 300 MW;
Total 1,180 MW

Table 7.7. Result of Transient Stability Calculation
(Year 1995)

Case	Fault point	Opened line	Max. δ & time	Max. δ point	Judgement
H	Naga	Kalayaan - Naga Line	58.8° 18s	Tiwi	stable
	Kalayaan	ditto	51.7° 15s	Tiwi	stable

System Outline

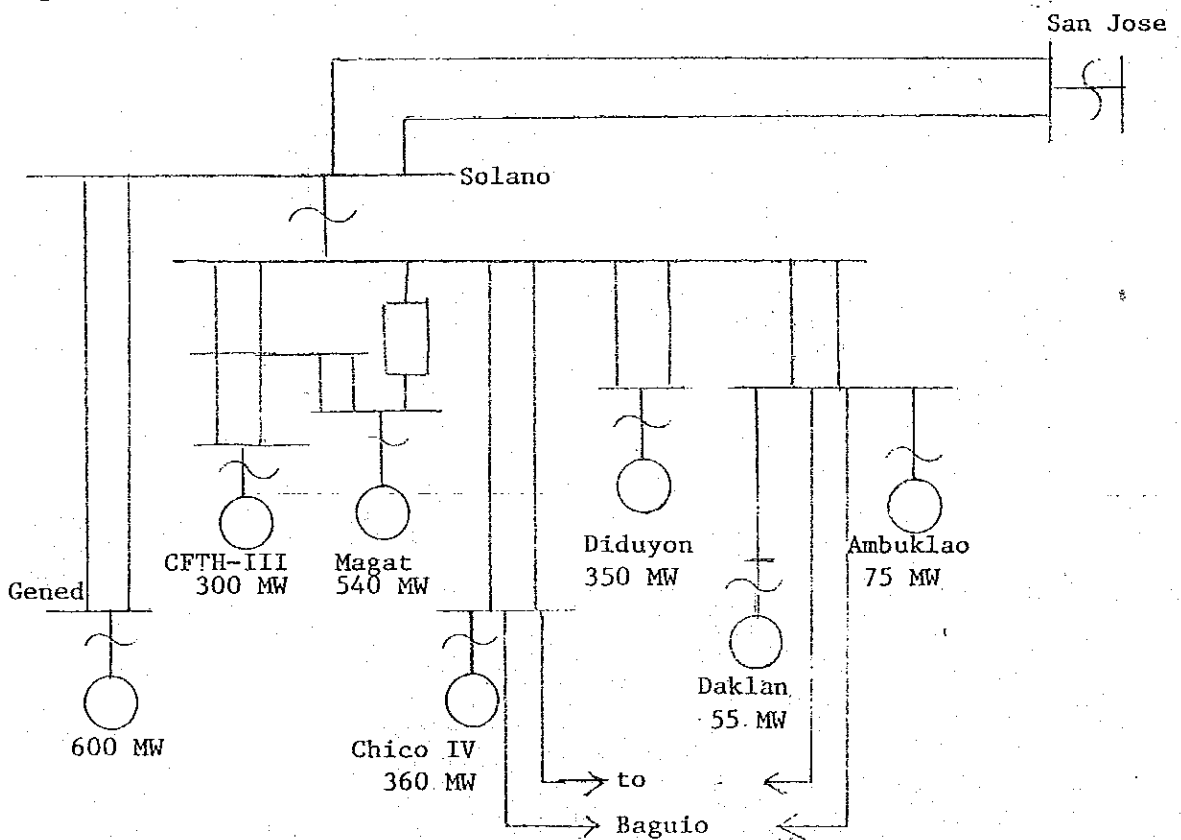


Case H Tiwi 660 MW, Manito 220 MW, Tongonan 300 MW;
Total 1,180 MW

Table 7.8. Result of Transient Stability Calculation
(Year 1995)

Case	Fault point	Opened line	Max. δ & time	Max. δ point	Judgement
K-I	Solano	Solano - San Jose 1. cct	95.1° 30 _{ms}	Magat	stable
K-II	Gened	Gened - Solano 1 cct	67.7° 21 _{ms}	Gened	stable
	Solano	ditto	72.7° 24 _{ms}	Magat	stable
	ditto	Solano - San Jose 1 cct	101.5° 45 _{ms}	CFTH-III	stable

System Outline



Case K - I Southern Luzon 500 kV operation

Case K-II Southern Luzon 230 kV operation

Gened 600 MW, CFTH-III 300 MW, Chico IV 360 MW, Magat 540 MW, Diduyon 350 MW, Daklan 55 MW, Ambuklao 75 MW; Total 2,280 MW

Table 8.1. Luzon Grid EHV Expansion Schedule

Year of Comm.	Northern System		Central System		Southern System	
	Transmission Line	Substation	Transmission Line	Substation	Transmission Line	Substation
1982	-	-	Malaya-Kalayaan 27 km 230 kV 2 x 4 - 795 MCM	-	Naga-Tiwi 60 km 230 kV 2 x 2 - 795 MCM	230 kV PCB Naga 3
1985	Ambuklao-Daklan 17 km 230 kV 1 x 1 - 795 MCM	230 kV PCB Ambuklao 1 Daklan 1	-	230 kV PCB Kelayaan 3	Kalayaan-Naga 237 km 500 kV design 2 x 4 - 795 MCM Legaspi-Manito 43 km 230 kV 2 x 2 - 795 MCM	230 kV PCB Naga 3 Legaspi 3 Manito 3
1986	-	-	San Jose-Kalayaan 97 km 500 kV design 2 x 4 - 795 MCM	230 kV PCB San Jose 3 Kalayaan 3	Naga-Legaspi 71 km 500 kV design 2 x 4 - 795 MCM	230 kV PCB Naga 3 Legaspi 3
1988	Gened-Solano-San Jose 452 km 500 kV 2 x 4 - 795 MCM	500 kV/230 kV 300 MVA Tr B. Solano 2 500 kV PCB Gened 3 Solano 9 230 kV PCB Solano 3 ShR. Solano 700 MVAR	San Jose-Kalayaan 97 km 500 kV operation	500 kV/230 kV 300 MVA Tr B. San Jose 3 Kalayaan 1 500 kV PCB San Jose 11 Kalayaan 5 230 kV PCB San Jose 2 ShR. San Jose 180 MVAR	-	-
1992	San Roque-San Manuel 9 km 230 kV 2 x 1 - 795 MCM	230 kV PCB San Roque 3 San Manuel 3	-	500 kV/230 kV 300 MVA Tr B. Kalayaan 1 500 kV/115 kV 300 MVA Tr B. San Jose 2 500 kV PCB San Jose 3 115 kV PCB San Jose 3 ShR. Kalayaan 550 MVAR	Kalayaan-Naga 237 km 500 kV operation	500 kV/230 kV 300 MVA Tr B. Naga 3 500 kV PCB Naga 8 230 kV PCB Naga 2
1993	CFTH-III-Santiago 36 km 230 kV 2 x 2 - 795 MCM	230 kV PCB CFTH-III 3 Santiago 3	-	-	-	-
1994	Chico IV-Solano 107 km 230 kV 2 x 2 - 795 MCM	500 kV/230 kV 300 MVA Tr B. Solano 1 500 kV PCB Solano 2	-	500 kV/115 kV 300 MVA Tr B. San Jose 1 500 kV PCB San Jose 1	-	-

Year of Comm.	Northern System		Central System		Southern System	
	Transmission Line	Substation	Transmission Line	Substation	Transmission Line	Substation
1994		230 kv PCB Chico IV Solano	-	115 kv PCB San Jose	-	-
1995	Diduyon-Solano 45 km 230 kv 2 x 1 - 795 MCM	500 kv/230 kv 300 MVA Tr B. Solano 500 kv PCB Solano 230 kv PCB Diduyon Solano	-	-	-	-

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