III. RIO TUBA MINE

CHAPTER III: RIO TUBA MINE

3.1 History and Future Prospects

The Rio Tuba Mine was developed comparatively recently by the Rio Tuba Nickel Mining Corporation which was set-up as a joint venture by an American company, UOP Co., and Philippine capital in 1969. The Rio Tuba Corp. subsequently began exploration and prospecting for nickel deposits.

In 1971 a feasiblity study on the potential for extraction of 2 million DMT/year conducted by a group of Japanese companies (Pacific Metals Corp., Ltd. Nippon Mining Co., Ltd., and Sumitomo Metal Minig Corp., Ltd.) was completed and the report for the same was finalized in the following year, 1972. As a result, application for 285 new mine lots for the Rio Tuba Corp. was conducted in addition to the 110 mine lots already settled.

In 1973 Pacific Metals Corp. acquired all stocks held by UOP Co., (40% of total stocks) becoming chief stock holder in the Rio Tuba Corp. At the same time, the Japanese Government was requested to conduct a basic design feasibility study for a development plan. Although the original objective of the plan was 1 million DMT of nickel production, this objective was reduced to 500,000 DMT, all destined for export to Japan, by the Technical Committee in response to economic conditions resulting from the Oil Crisis in 1974. In March, 1975, Nippon Steel Corp., Nisshin Steel Co., Ltd., and Nissho Iwai Corp., decided to invest in the Rio Tuba Corp., acquiring 13%, 10% and 10% of shares respectively (Pacific Metals Corp., held the remaining 67%) and promoting further development.

In 1975, with capital investment by the Export-Import Bank of Japan, construction was begun and main mining facilities were completed by December, 1976. At the same time capital for related mine facilities was provided under the JICA grant aid program with which hospital, school and gymnasium facilities for the Rio Tuba Mine employee town site were established. Mine operation commenced from January 1977 and 22,000 WMT of ore were exported to the Pacific Metals factory in Japan by April of the same year.

Operation continued smoothly for several years; however, the effects of world-wide recession caused by the second oil crisis resulted in reduced demand for nickel. Even with the subsequent drop in international nickel prices demand failed to increase (TABLE 3-1). Accordingly, in 1979 the Rio Tuba Corp., recognizing that decreased production was unavoidable (TABLE 3-2), halted use of its diesel powered ore-drier in favor of sunlight drying and export of wet unprocessed ore in order to reduce production costs.

Shipment of wet, unprocessed ore however, entails additional shipping costs (nickel content of shipped ore is only 5%) and electric fees for processing in Japan. This has led the Rio Tuba Corp. and Pacific Metal Corp. to consider establishing a new smelting system at the mine itself with the added objective of increasing local benefits within the Philippines.

Although establishment of smelting facilities is still under study and exact power demands of the same are not yet clear, it is obvious that a large amount of power will be required for operation of the same (total peak load for the mine: about 7,500kW). Accordingly, it is desirable that as much of this power as possible be supplied by less expensive hydropower as part of the Rio Tuba Corp. cost reduction scheme.

The Rio Tuba Mine nickel reserve for potential development as of 1983 amounted to 23 million WMT at the high-quality Guintalungan ore vein alone and with the revival of the international nickel market and continued nickel scarcity, it is likely that the number of mine lots at Rio Tuba will increase and mine operation will continue for several decades hence.

3.2 Electrical Facilities and Power Demand

3.2.1 Electrical Facilities

The Rio Tuba Mine is equiped with three 700kW diesel generators at the plant site, and one 160kW and one 50kW diesel generator at the pier site. The power plant facilities at the plant site were jointly manufactured by Japanese companies in 1976 and are functioning efficiently. There are also about 6.5km of 4.16kV and 230V distribution line strung.

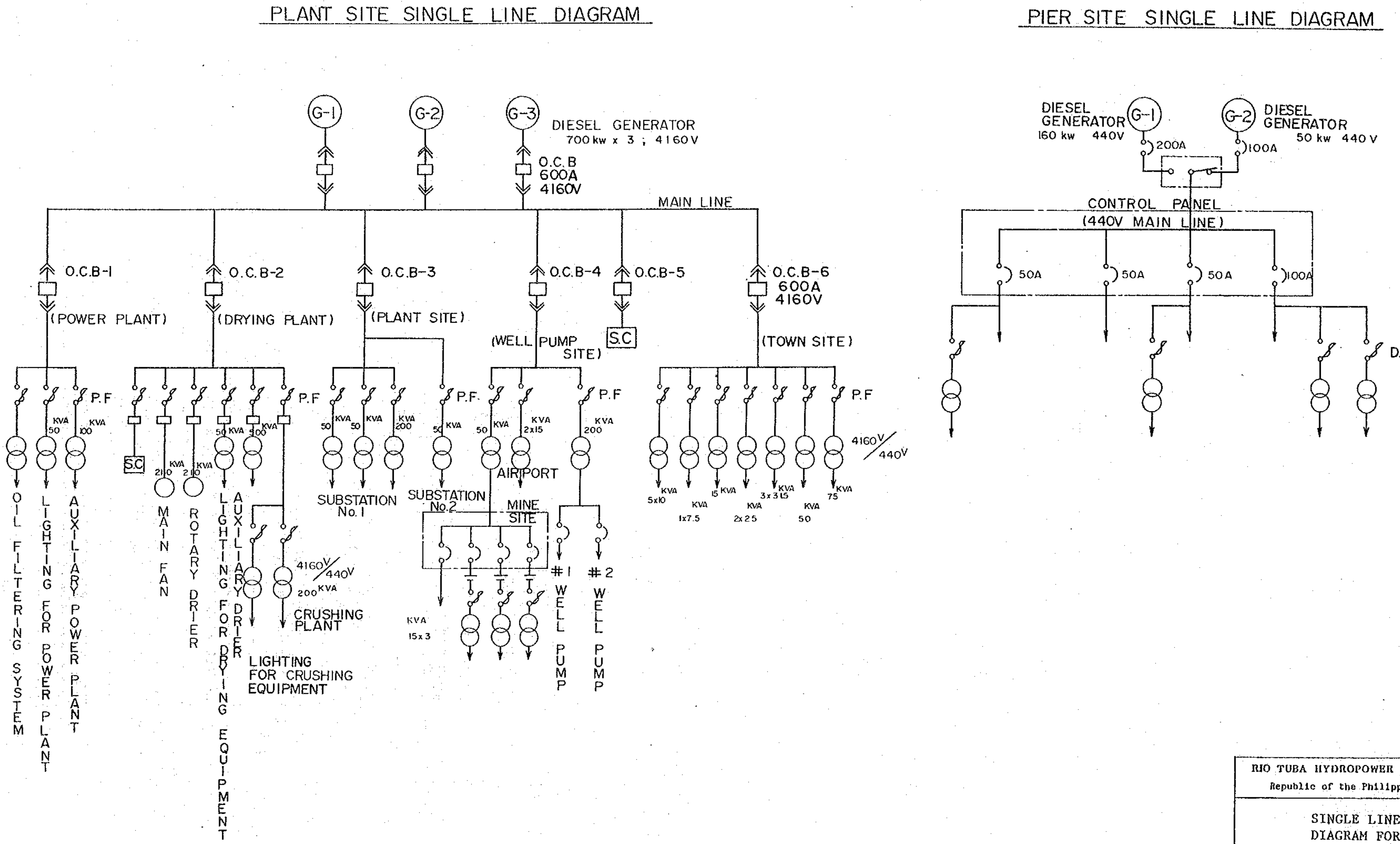
Operation and maintenance of the above facilities is performed by a total of 32 workers (not including managerial staff) in 3 shifts.

Overhaul of the generators takes place once in every 3,000 operation hours, and the most recent overhaul was conducted from Sept. to Oct. 1983 which makes the total operating hours to date 27,000. In general, maintenance and equipment condition is good and repairs are performed with adequate technical skill. A single line diagram for the plant and pier site is presented in FIG. 3-1. The electrical systems of the 2 sites however, are as yet unconnected.

3.2.2 Power Supply Conditions

Since Rio Tuba Mine commenced operation in 1977, efforts have been made to reduce production costs. Energy-saving sunlight drying was adopted in 1979 for example in place of the drier facility and the heat source for the latter was converted from electricity to heavy crude oil in 1982. As a result, peak load was drastically reduced from approximately 1,100kW to about 310kW, and generator operation was limited to the use of only 1 unit among the 3 existing units. In addition diesel fuel was changed from light to heavy crude oil further reducing power supply costs. Power supply conditions at the Rio Tuba Mine are presented in FIG. 3-2, while a recent example of the daily load curve is as shown in FIG. 3-3.

FIG. 3-1



RIO TUBA HYDROPOWER PROJECT Republic of the Philippines
SINGLE LINE DIAGRAM FOR PLANT AND PIER SITE
JAPAN INTERNATIONAL COOPERATION AGENCY
DWG.NO. SHEET OF

FIG. 3-2 **ENERGY SUPPLY CONDITIONS AT RIO TUBA MINE**

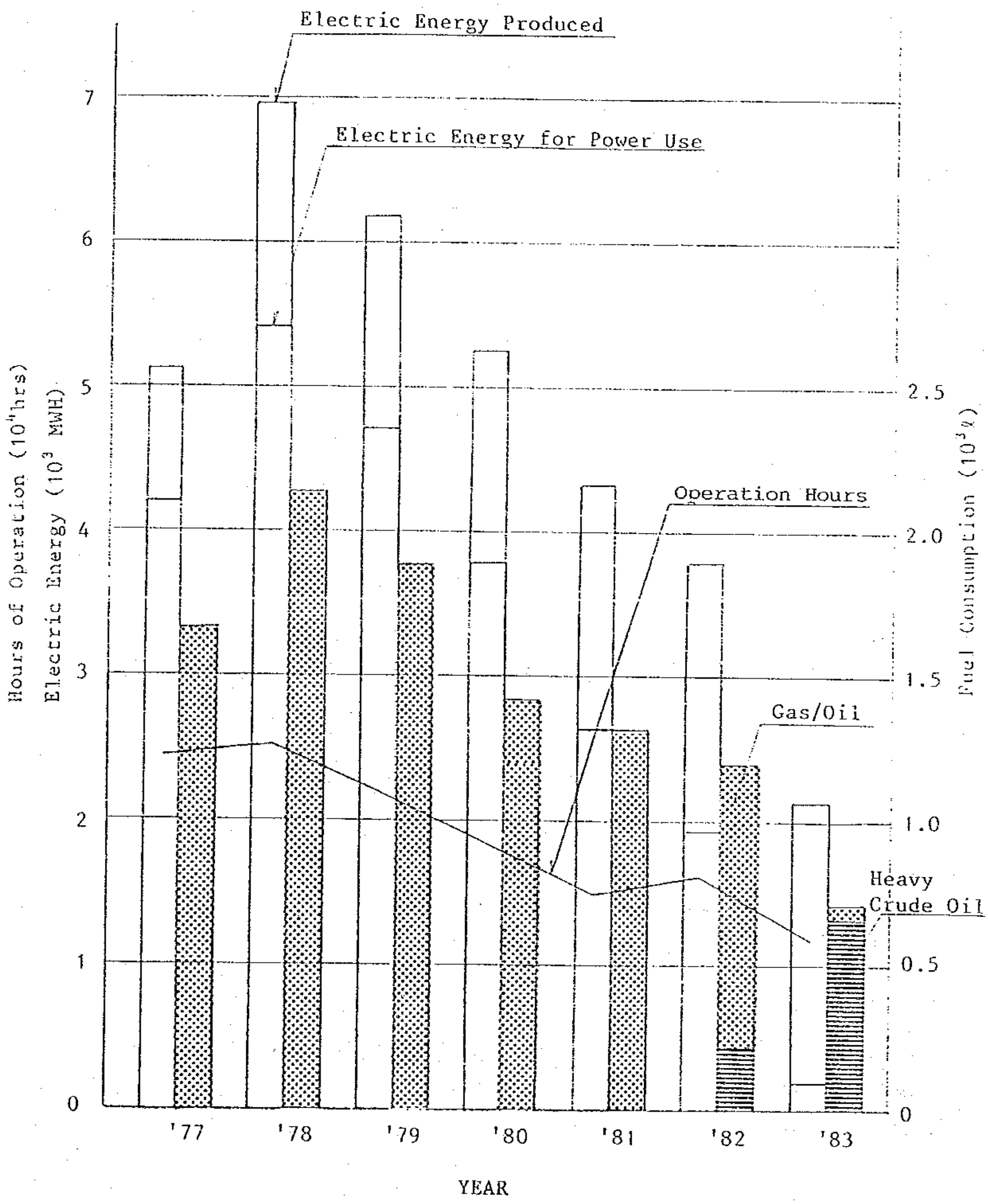


FIG. 3-3 DAILY LOAD CURVE (JAN 30, 1984)

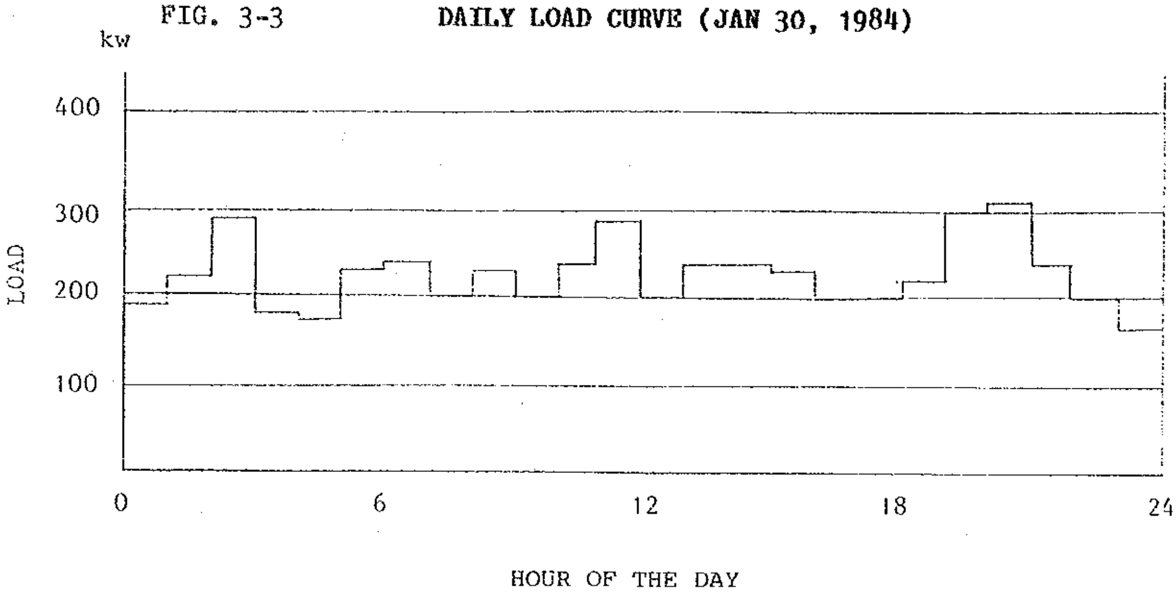


TABLE 3-1 **INTERNATIONAL NICKEL PRICE FLUCTUATIONS**

Year	INCO (¢/1b) (a)	Canadian Producer Price ($/MT) (b)	Commerical Market Price ($/MT) (c)
1975	207.3	4,570	4,155
1976	225.3	4,970	4,573
1977	241.0	5,200	4,579
1978	-	4,610	4,254
1979	280.5	5,990	5,642
1980	342.9	7,530	6,783
1981	345.0	7,560	6,736
1982	320.0	7,055	5,132
1983	320.0	7,053	4,802
1984*	-	7,273	5,510
1985*	-	7,494	6,171
1990*	-	11,708	-
1995*	-	17,965	-

Source: (a) Mining Manual 1983
(b), (c) Commodity Price, World Bank, 1984 Jan.

TABLE 3-2 **CHANGES IN PRODUCTION, SALES AND FINANCIAL CONDITIONS OF RIO TUBA MINING CORP.**

Item \ Year	1977	1978	1979	1980	1981	1982	1983
Amount Produced	472,198	644,443	759,839	675,223	542,737	474,506	421,004
Amount Sold	375,735	661,997	729,367	601,449	631,421	431,112	437,036
Turnover	8,130	9,843	13,543	17,958	16,251	9,897	6,340
Net Profit before Taxes	128	2,330	1,924	3,297	114	950	278

IV. POWER AND ENERGY DEMAND FORECAST

CHAPTER IV POWER AND ENERGY DEMAND FORECAST

4.1 Objectives of Load Forecast

The 3,800kW maximum capacity hydropower plant to be constructed on the Tamlang River will supply the Rio Tuba Mine through a 34.5kV transmission line 44km in length. A certain portion of the same will also be used to supply electricity to rural communities along the transmission line route which are not presently electrified, thus contributing to the rural electrification program and improvement of rural life.

In consideration of the above overall objectives, load forecast was focused on the following:

a) power demand forecast in communities to be newly electrified and determination of power distribution to PALECO and the Rio Tuba Mine;

b) use of a few case studies regarding Rio Tuba Mine energy demand for formulation of the smelting process presently under study.

4.2 Study of Domestic Power Supply

4.2.1 Present Conditions

Brookes Point town is located about 15km northeast of the hydropower project site in Brookes Point Municipality. The population of the same is about 6,000, one of the largest population centers in the Project area. PALECO commenced supply of electricity in the area in March 1982 and a total of 11 rural communities are presently served by the same. Electrification conditions in Brookes Point Municipality are as presented in 2.4.4 above.

PALECO has 2 diesel generators supplying electricity to the above; a 300kW generator manufactured in 1945 and a 150kW generator made in 1969. In addition, connection of the PALECO power systems between Brookes Point, Naraa, Aborlan, and Quezon, is expected to be completed by 1988, the year in which the proposed Tamlang River Hydropower Project is scheduled to begin operation. All communities south of Brookes Point town to the Rio Tuba Mine are presently without electrical power supply.

4.2.2 Residential Power Demand

An interview survey was conducted in 12 rural communities (barangays) in Bataraza Municipality to determine the relationship between such factors as power demand, income, and fuel consumption among low, middle, and high income households. Survey results revealed that 1.6-18ℓ of kerosine are consumed, and 14-158 pesos are expended monthly for lighting with an average monthly consumption of 3ℓ at 26.4 pesos. In addition approximately 60% of households spend 15 pesos/month on dry-cell batteries for radios. The majority of people expressed the desire to become recipients of any future power supply scheme and further, as the lowest PALECO electricity rate is presently 31.1 pesos for up to 12kWh, capability of payment was deemed generally sufficient. At present, PALECO bears the cost of both wattmeter installation and line extension up to 45m from the distribution line (45m x number of household applicants). This policy greatly facilitates electrification for rural residents.

4.2.3 Load Forecast for Residential Power Supply

Load forecast for residential power demand was made for each rural community in the area according to the following conditions.

(1) Communities eligible for power supply are:

Brookes Point Municipality (South of Brookes Point Town)	Bataraza Municipality	
Tubtub	Inogbong	Colandanum
Oringoring	Bataraza	Rio Tuba
Tagperara	Bonobono	Ocayan
Saraza	Malihod	Iwahig
Samariniana	Bulalacao	Igangigang
Salogon	Tarusan	Sarong
Malis	Sandoval	

(2) Load forecast was made for a period of 20 years commencing with envisaged power plant start-up in April 1988.

(3) Household power demand forecasts were made on the following premises:

a) Population increase was estimated for each community in consideration of past population increase rate, infrastructure development by PIADP, and migration trends resulting from electrification, etc.;

b) Household number was calculated as population divided by average number of persons was per household. According to the census conducted in 1980, the average number of persons per household was 5.2 and 4.7 in Brookes Point and Bataraza municipalities respectively;

c) Date for available of electric service in each barangay was estimated by distance from transmission lines, size of community, etc.;

d) Initial electrification rate was estimated for each community with a 10% growth rate in the first 2 years and uniform growth thereafter. The above figures were determined in consideration of the difficulties involved in supplying individual households and small, isolated mountain communities.

e) The number of electrified households was obtained by the multiplication of the electrification rate and the number of households;

f) Electrical appliances were estimated for each income level, and initial average peak load of 80W per household with a 4% growth rate was assumed; and,

g) A load factor of 30% was determined by estimation of residential power supply usage.

(4) Demand for commercial use, public buildings, street lights, and small scale industry was estimated from number of users and peak load per user.

a) Number of users was assumed as 5% of number of residental user households.

b) Peak load per user was estimated at 170W and peak load growth rate at 5%.

c) Load factor was estimated as 35% based on usage conditions.

(5) Demand for north of and including Brookes Point town will be about 800kW by the time of hydropower plant start-up according to the PALECO program, while, at the same time, the equivalent of 450kW of power output from the existing PALECO diesel generator at Brookes Point town will be supplemented by the hydropower plant to be installed by the Project. Load factor was estimated at 32% and annual output at 1,261MWH.

Demand estimate of power output for rural electrification is presented in TABLE 4-1, estimate of power demand for south of

Brookes Point twon in TABLE 4-2 and precentage of energized households for town and rural communities in TABLE 4-3.

4.3 Study of Rio Tuba Mine Power Supply

4.3.1 Present Conditions

Ore drying operations consume the largest percentage of electrical energy and costs in mine operation at Rio Tuba Mine. The Rio Tuba Mine which opened in 1977, originally used an electrical drier. In 1979 however, sunlight drying was adopted and the heat source for the drier was converted from electricity to crude oil in mid 1982 in an effort to reduce production costs. At the same time, restrictions were imposed upon electric consumption in residential use by employees. The combination of the above resulted in drastic decrease in electricity consumption, peak load dropping from about 1,100kW to 310kW while the number of generators required to fulfill demand was limited to the use of only 1 unit among the 3 existing units.

Present conditions of power supply at the Rio Tuba Mine are as illustrated in FIG. 4-1.

4.3.2 Demand Forecast of Power Supply for Mine Use

The Rio Tuba Mine is presently conducting a study to develop a plan to strengthen smelting facilities, etc. and thereby to increase values added to nickel ore production. As the above is still under study, accurate estimate of energy demand for smelting facilities at this stage is difficult to determine and accordingly energy demand forecasts were made for 3 possible cases, namely:

- Case-1 resumption of ordinary drier facility used before the present sunlight method;
- Case-2 establishment of new facilities within the maximum utilization of available energy from the hydropower plant; and,
- Case-3 installation of a new smelting system.

These cases are further detailed on the following page.

(1) Case 1

The case was assumed with the following conditions.

1) Demand forecast was for a 24-year period from 1984 to 2007;

2) Energy consumption of the drier until commencement of hydropower plant operation will be 200MWH. After start-up in 1988, the drier will be used in rainy season and sunlight drying in dry season. Energy demand for the same was designated at 3,793MWH, the 1980 standard, while the operation factor for the drier was 50%; and,

3) Energy consumption, excluding the drier, was estimated to have a growth rate of 4% until 1987, 8% from 1988 to 1997 and 4% thereafter. Peak load growth rate has been the same as the above.

The results of the study are presented in TABLE 4-4.

(2) Case 2

The case was assumed according to the following conditions:

1) Demand forecast period covered 20 years from 1988 to 2007;

2) Peak load for all facilities including employees' houses was estimated at 3,450kW, taking into account transmission line loss, and power supply of communities; and,

3) With a load factor of 65%, consumption of electriicity was determined at 19,645MWH.

(3) Case 3

Conditions of the case were as follows:

1) Demand forecast period was 20 years from 1988 to 2007;

2) Peak load was estimated at 8,500kW with a similar approach as Case 2 above; and,

3) Energy consumption was determined at 59,568MWH with a load factor of 80%.

4.4 Power Distribution for Domestic and Mine Use

Residential and mine use demand forecasts to the year 2007 discussed in 4.2.3 and 4.3.2, respectively, are summarized in TABLE 4-5.

Peak demand for rural electrification 10 years after start-up of the Tamlang River Hydropower Plant is estimated at 999kW, representing 26.3% of the plant's maximum output (3,800kW)and power consumption will be 2,844MWH. As this also represents 14.9% of the annual available energy (19,087MWH), the power distribution is considered appropriate from the perspective of Project objectives. Thus, priority for use of forecast energy until 1997, and supply of 1,000kW peak demand with annual energy demand of 2,844MWH thereafter, will be given to PALECO.

4.5 Balance of Supply and Demand for Mine Use

Supply and demand balance estimation was conducted according to the following conditions:

a) Start-up of the Tamlang River Hydropower Project was designated as April 1988;

b) Forecast demand for rural electrification will be supplied up to 1997, while only 1,000kW of peak energy and 2,844MWH/year will be supplied for the same thereafter;

c) Transmission line and transformer losses were considered;

d) The Rio-Tuba Mine diesel generator installed at the pier site was not considered as a source of power supply;

e) The existing Rio Tuba Mine diesel generators which are in good condition will be used until 1997; and,

f) Regular inspection, overhaul etc. of diesel generators will be undertaken during the rainy season.

Estimated available hydropower energy for the Rio Tuba Mine is presented in TABLE 4-6.

4.5.1 Case Analysis

To determine the optimum development plan in light of power and energy demand several case studies were carried out; namely, Case-1, 2 and 3. A summary of the findings are presented hereinafter on the following page.

(1) **Case-1**

Supply and demand balance for Case-1 is provided in TABLE 4-7. In this case, a surplus of 2,173kW - 1,755kW occurs at peak, and 11,458MWH - 5,727MWH in electric energy from 1988-2007. In addition to developing further power demand at Rio Tuba Mine or planning new facilities, etc. for the same, a plan should also be developed to increase power supply for PALECO and create new sources of power demand.

(2) **Case 2**

The supply-demand balance for Case-2 is provided in TABLE 4-8. Although the hydropower plant is equipped with weekly regulation capacity via a regulating pond, it is possible that power supply to the Mine would occasionally be insufficient during the dry season as the supply to rural electrification is given priority. Simple calculations indicate that a lack of 1,350kW will occur in peak load, and accordingly, study of a coordinated operation system to compensate the peak shortage through operation of both the diesel and hydropower plants at the Rio Tuba Mine is required.

(3) **Case-3**

The supply-demand balance for Case-3 is shown in TABLE 4-9. In this case an insufficiency of 6,400kW in power output and 33,014MWH -34,127MWH in electric energy will occur from 1988-2007. As in Case-2, insufficiencies will be compensated, use of other power sources will be minimimized and balance will be maintained by coordination of diesel generator operation with hydropower plant operation.

FIG. 4-1

ENERGY DEMAND OF RIO TUBA MINING CORPORATION

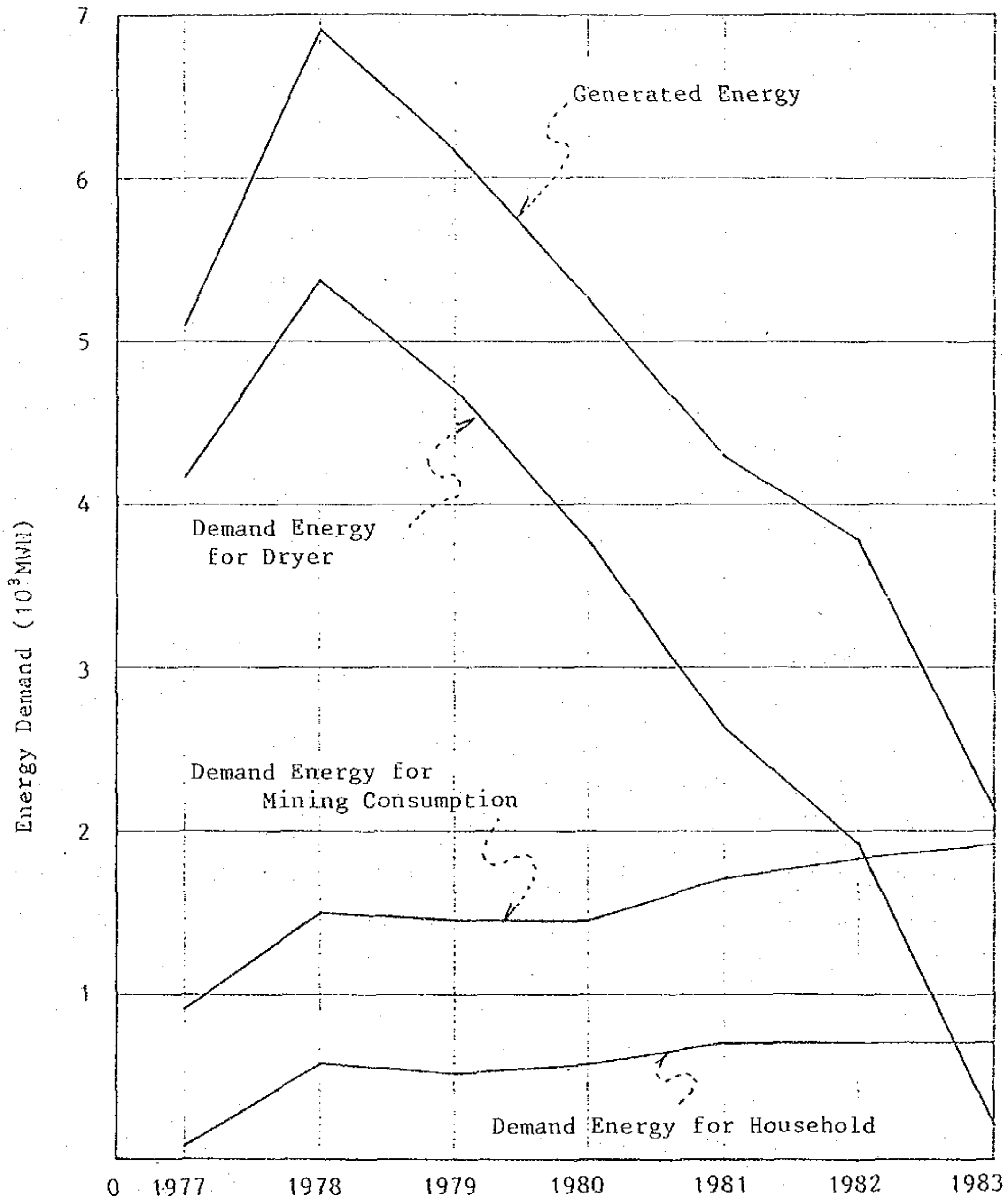


TABLE 4-1

DEMAND FORECAST FOR RURAL ELECTRIFICATION

Year	North of Brookes Point Including Brookes Point Town		South of Brookes Point Town		Total	
	Peak Demand (kW)	Energy Demand (MWH)	Peak Demand (kW)	Energy Demand (MWH)	Peak Demand (kW)	Energy Demand (MWH)
1988	450	1,261	164	470	614	1,731
1989	450	1,261	227	652	677	1,931
1990	450	1,261	291	833	741	2,094
1991	450	1,261	332	951	782	2,212
1992	450	1,261	369	1,058	819	2,319
1993	450	1,261	401	1,152	851	2,413
1994	450	1,261	434	1,248	884	2,509
1995	450	1,261	469	1,349	919	2,610
1996	450	1,261	506	1,457	959	2,718
1997	450	1,261	549	1,583	999	2,844
1998	450	1,261	590	1,703	1,040	2,964
1999	450	1,261	639	1,854	1,089	3,106
2000	450	1,261	690	1,992	1,140	3,253
2001	450	1,261	745	2,157	1,195	3,418
2002	450	1,261	808	2,338	1,258	3,599
2003	450	1,261	870	2,521	1,320	3,782
2004	450	1,261	942	2,729	1,329	3,990
2005	450	1,261	1,017	2,949	1,467	4,210
2006	450	1,261	1,097	3,186	1,547	4,447
2007	450	1,261	1,189	3,457	1,639	4.718

TABLE 4-2

ESTIMATED MAXIMUM POWER DEMAND AND ENERGY DEMAND FOR SOUTH OF BROOKES POINT TOWN

RESIDENTIAL
INCREASE RATE OF DEMAND 4%
LOAD FACTOR 30%
COMMERCIAL,PUBLIC BUILDINGS AND STREET LIGHTS
INCREASE RATE OF DEMAND 5%
LOAD FACTOR 35%

				RESIDENTIAL			
	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED HOUSEHOLD	AVERAGE DEMAND	PEAK DEMAND	ENERGY DEMAND
1	1988	24,802	5,047	1,984	80W	159KW	418MWH
2	1989	25,738	5,238	2,652	83W	220KW	578MWH
3	1990	26,706	5,430	3,244	87W	282KW	741MWH
4	1991	27,718	5,632	3,562	90W	321KW	844MWH
5	1992	28,770	5,848	3,795	94W	357KW	938MWH
6	1993	29,862	6,067	3,995	97W	388KW	1,020MWH
7	1994	30,996	6,297	4,160	101W	420KW	1,104MWH
8	1995	32,179	6,536	4,319	105W	453KW	1,190MWH
9	1996	33,405	6,783	4,482	109W	489KW	1,285MWH
10	1997	34,680	7,040	4,652	114W	530KW	1,393MWH
11	1998	36,010	7,307	4,828	118W	570KW	1,498MWH
12	1999	37,387	7,586	5,014	123W	617KW	1,621MWH
13	2000	38,822	7,875	5,205	128W	666KW	1,750MWH
14	2001	40,315	8,175	5,405	133W	719KW	1,890MWH
15	2002	41,868	8,485	5,609	139W	780KW	2,050MWH
16	2003	43,483	8,814	5,827	144W	839KW	2,205MWH
17	2004	45,159	9,149	6,050	150W	908KW	2,386MWH
18	2005	46,906	9,503	6,285	156W	980KW	2,575MWH
19	2006	48,723	9,866	6,525	162W	1,057KW	2,778MWH
20	2007	50,612	10,247	6,775	169W	1,145KW	3,009MWH

		COMMERCIAL				TOTAL	
	YEAR	NUMBER	AVERAGE DEMAND	PEAK DEMAND	ENERGY DEMAND	PEAK DEMAND	ENERGY DEMAND
1	1988	99	170W	17KW	52MWH	164KW	470MWH
2	1989	133	179W	24KW	74MWH	227KW	652MWH
3	1990	162	187W	30KW	92MWH	291KW	833MWH
4	1991	178	197W	35KW	107MWH	332KW	951MWH
5	1992	190	207W	39KW	120MWH	369KW	1,058MWH
6	1993	200	217W	43KW	132MWH	401KW	1,152MWH
7	1994	208	228W	47KW	144MWH	434KW	1,248MWH
8	1995	216	239W	52KW	159MWH	469KW	1,349MWH
9	1996	224	251W	56KW	172MWH	506KW	1,457MWH
10	1997	233	264W	62KW	190MWH	549KW	1,583MWH
11	1998	241	277W	67KW	205MWH	590KW	1,703MWH
12	1999	251	291W	73KW	224MWH	639KW	1,845MWH
13	2000	260	305W	79KW	242MWH	690KW	1,992MWH
14	2001	270	321W	87KW	267MWH	745KW	2,157MWH
15	2002	280	337W	94KW	288MWH	808KW	2,338MWH
16	2003	291	353W	103KW	316MWH	870KW	2,521MWH
17	2004	303	371W	112KW	343MWH	942KW	2,729MWH
18	2005	314	390W	122KW	374MWH	1,017KW	2,949MWH
19	2006	326	409W	133KW	408MWH	1,097KW	3,186MWH
20	2007	339	430W	146KW	448MWH	1,189KW	3,457MWH

PERCENTAGE OF ENERGIZED HOUSEHOLDS FOR TOWN AND RURAL COMMUNITIES

TUBTUB
INCREASE RATE OF POPULATION 4.4%

	YEAR	POPULATION	HOUSEHOLD	RATE	ENERGIZED HOUSEHOLD
1	1988	1,082	208	40%	83
2	1989	1,130	217	50%	109
3	1990	1,179	227	60%	136
4	1991	1,231	237	60%	142
5	1992	1,285	247	60%	148
6	1993	1,342	258	60%	155
7	1994	1,401	269	60%	161
8	1995	1,463	281	60%	169
9	1996	1,527	294	60%	176
10	1997	1,594	307	60%	184
11	1998	1,664	320	60%	192
12	1999	1,738	334	60%	200
13	2000	1,814	349	60%	209
14	2001	1,894	364	60%	218
15	2002	1,977	380	60%	228
16	2003	2,064	397	60%	238
17	2004	2,155	414	60%	248
18	2005	2,250	433	60%	260
19	2006	2,349	452	60%	271
20	2007	2,452	472	60%	283

SAMARINIANA
INCREASE RATE OF POPULATION 4.4%

	YEAR	POPULATION	HOUSEHOLD	RATE	ENERGIZED HOUSEHOLD
1	1988	795	153	40%	61
2	1989	830	160	50%	80
3	1990	866	167	60%	100
4	1991	905	174	60%	104
5	1992	944	182	60%	109
6	1993	986	190	60%	114
7	1994	1,029	198	60%	119
8	1995	1,075	207	60%	124
9	1996	1,122	216	60%	130
10	1997	1,171	225	60%	135
11	1998	1,223	235	60%	141
12	1999	1,277	246	60%	148
13	2000	1,333	256	60%	154
14	2001	1,391	268	60%	161
15	2002	1,453	279	60%	167
16	2003	1,517	292	60%	175
17	2004	1,583	304	60%	182
18	2005	1,653	318	60%	191
19	2006	1,726	332	60%	199
20	2007	1,802	347	60%	208

TAGPERARA
INCREASE RATE OF POPULATION 4.4%

	YEAR	POPULATION	HOUSEHOLD	RATE	ENERGIZED HOUSEHOLD
1	1988	1,236	238	40%	95
2	1989	1,290	248	50%	124
3	1990	1,347	259	60%	155
4	1991	1,406	270	60%	162
5	1992	1,468	282	60%	169
6	1993	1,533	295	60%	177
7	1994	1,600	308	60%	185
8	1995	1,671	321	60%	193
9	1996	1,744	335	60%	201
10	1997	1,821	350	60%	210
11	1998	1,901	366	60%	220
12	1999	1,985	382	60%	229
13	2000	2,072	398	60%	239
14	2001	2,163	416	60%	250
15	2002	2,259	434	60%	260
16	2003	2,358	453	60%	272
17	2004	2,462	473	60%	284
18	2005	2,570	494	60%	296
19	2006	2,683	516	60%	310
20	2007	2,801	539	60%	323

ORINGORING
INCREASE RATE OF POPULATION 4.4%

	YEAR	POPULATION	HOUSEHOLD	RATE	ENERGIZED HOUSEHOLD
1	1988	1,313	253	40%	101
2	1989	1,371	264	50%	132
3	1990	1,431	275	60%	165
4	1991	1,494	287	60%	172
5	1992	1,560	300	60%	180
6	1993	1,628	313	60%	188
7	1994	1,700	327	60%	196
8	1995	1,775	341	60%	205
9	1996	1,853	356	60%	214
10	1997	1,935	372	60%	223
11	1998	2,020	388	60%	233
12	1999	2,108	405	60%	243
13	2000	2,201	423	60%	254
14	2001	2,298	442	60%	265
15	2002	2,399	461	60%	277
16	2003	2,505	482	60%	289
17	2004	2,615	503	60%	302
18	2005	2,730	525	60%	315
19	2006	2,850	548	60%	329
20	2007	2,976	572	60%	343

SALOGON
INCREASE RATE OF POPULATION 4.4%

	YEAR	POPULATION	HOUSEHOLD	RATE	ENERGIZED HOUSEHOLD
1	1988	2,272	437	40%	175
2	1989	2,372	456	50%	228
3	1990	2,476	476	60%	286
4	1991	2,585	497	60%	298
5	1992	2,699	519	60%	311
6	1993	2,818	542	60%	325
7	1994	2,942	566	60%	340
8	1995	3,071	591	60%	355
9	1996	3,206	617	60%	370
10	1997	3,347	644	60%	386
11	1998	3,495	672	60%	403
12	1999	3,648	702	60%	421
13	2000	3,809	733	60%	440
14	2001	3,977	765	60%	459
15	2002	4,152	798	60%	479
16	2003	4,334	833	60%	500
17	2004	4,525	870	60%	522
18	2005	4,724	908	60%	545
19	2006	4,932	948	60%	569
20	2007	5,149	990	60%	594

SARAZA
INCREASE RATE OF POPULATION 4.4%

	YEAR	POPULATION	HOUSEHOLD	RATE	ENERGIZED HOUSEHOLD
1	1988	2,258	434	40%	174
2	1989	2,357	453	50%	227
3	1990	2,461	473	60%	284
4	1991	2,569	494	60%	296
5	1992	2,682	516	60%	310
6	1993	2,800	538	60%	323
7	1994	2,924	562	60%	337
8	1995	3,052	587	60%	352
9	1996	3,187	613	60%	368
10	1997	3,327	640	60%	384
11	1998	3,473	668	60%	401
12	1999	3,626	697	60%	418
13	2000	3,786	728	60%	437
14	2001	3,952	760	60%	456
15	2002	4,126	793	60%	476
16	2003	4,308	828	60%	497
17	2004	4,497	865	60%	519
18	2005	4,695	903	60%	542
19	2006	4,902	943	60%	566
20	2007	5,117	984	60%	590

MALIS
INCREASE RATE OF POPULATION 4.4%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	2,291	441	40%	176
2	1989	2,392	460	50%	230
3	1990	2,497	480	60%	288
4	1991	2,607	501	60%	301
5	1992	2,722	523	60%	314
6	1993	2,841	546	60%	328
7	1994	2,966	570	60%	342
8	1995	3,097	596	60%	358
9	1996	3,233	622	60%	373
10	1997	3,375	649	60%	389
11	1998	3,524	678	60%	407
12	1999	3,679	708	60%	425
13	2000	3,841	739	60%	443
14	2001	4,010	771	60%	463
15	2002	4,186	805	60%	483
16	2003	4,371	841	60%	505
17	2004	4,563	878	60%	527
18	2005	4,764	916	60%	550
19	2006	4,973	956	60%	574
20	2007	5,192	998	60%	599

INOGBONG
INCREASE RATE OF POPULATION 3.3%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	1,000	213	40%	85
2	1989	1,033	220	50%	110
3	1990	1,067	227	60%	136
4	1991	1,102	234	60%	140
5	1992	1,139	242	60%	145
6	1993	1,176	250	60%	150
7	1994	1,215	259	60%	155
8	1995	1,255	267	60%	160
9	1996	1,297	276	60%	166
10	1997	1,339	285	60%	171
11	1998	1,384	294	60%	176
12	1999	1,429	304	60%	182
13	2000	1,476	314	60%	188
14	2001	1,525	324	60%	194
15	2002	1,575	335	60%	201
16	2003	1,627	346	60%	208
17	2004	1,681	358	60%	215
18	2005	1,737	370	60%	222
19	2006	1,794	382	60%	229
20	2007	1,853	394	60%	236

BONGBONG
INCREASE RATE OF POPULATION 3.3%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	744	158	40%	63
2	1989	769	164	50%	82
3	1990	794	169	60%	101
4	1991	820	174	60%	104
5	1992	847	180	60%	108
6	1993	875	186	60%	112
7	1994	904	192	60%	115
8	1995	934	199	60%	119
9	1996	965	205	60%	123
10	1997	996	212	60%	127
11	1998	1,029	219	60%	131
12	1999	1,063	226	60%	136
13	2000	1,098	234	60%	140
14	2001	1,135	241	60%	145
15	2002	1,172	249	60%	149
16	2003	1,211	258	60%	155
17	2004	1,251	266	60%	160
18	2005	1,292	275	60%	165
19	2006	1,335	284	60%	170
20	2007	1,379	293	60%	176

BATARAZA
INCREASE RATE OF POPULATION 4.2%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	2,872	611	65%	397
2	1989	2,993	637	75%	478
3	1990	3,118	663	85%	564
4	1991	3,249	691	85%	587
5	1992	3,386	720	85%	612
6	1993	3,528	751	85%	638
7	1994	3,676	782	85%	665
8	1995	3,831	815	85%	693
9	1996	3,991	849	85%	722
10	1997	4,159	885	85%	752
11	1998	4,334	922	85%	784
12	1999	4,516	961	85%	817
13	2000	4,705	1,001	85%	851
14	2001	4,903	1,043	85%	887
15	2002	5,109	1,087	85%	924
16	2003	5,324	1,133	85%	963
17	2004	5,547	1,180	85%	1,003
18	2005	5,780	1,230	85%	1,046
19	2006	6,023	1,281	85%	1,089
20	2007	6,276	1,335	85%	1,135

MALIHOD
INCREASE RATE OF POPULATION 3.3%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	448	95	40%	38
2	1989	463	99	50%	50
3	1990	478	102	60%	61
4	1991	494	105	60%	63
5	1992	510	109	60%	65
6	1993	527	112	60%	67
7	1994	544	116	60%	70
8	1995	562	120	60%	72
9	1996	581	124	60%	74
10	1997	600	128	60%	77
11	1998	620	132	60%	79
12	1999	640	136	60%	82
13	2000	661	141	60%	85
14	2001	683	145	60%	87
15	2002	706	150	60%	90
16	2003	729	155	60%	93
17	2004	753	160	60%	96
18	2005	778	166	60%	100
19	2006	804	171	60%	103
20	2007	830	177	60%	106

TABLE 4-3
3 of 4

BULALACAO
INCREASE RATE OF
POPULATION 3.1%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	641	136	40%	54
2	1989	661	141	50%	71
3	1990	681	145	60%	87
4	1991	702	149	60%	89
5	1992	724	154	60%	92
6	1993	747	159	60%	95
7	1994	770	164	60%	98
8	1995	794	169	60%	101
9	1996	818	174	60%	104
10	1997	844	180	60%	108
11	1998	870	185	60%	111
12	1999	897	191	60%	115
13	2000	925	197	60%	118
14	2001	953	203	60%	122
15	2002	983	209	60%	125
16	2003	1,013	216	60%	130
17	2004	1,045	222	60%	133
18	2005	1,077	229	60%	137
19	2006	1,110	236	60%	142
20	2007	1,145	244	60%	146

SANDOVAL
INCREASE RATE OF
POPULATION 3.3%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	1,093	233	50%	117
2	1989	1,129	240	60%	144
3	1990	1,166	248	70%	174
4	1991	1,205	256	70%	179
5	1992	1,245	265	70%	186
6	1993	1,286	274	70%	192
7	1994	1,328	283	70%	198
8	1995	1,372	292	70%	204
9	1996	1,417	301	70%	211
10	1997	1,464	311	70%	218
11	1998	1,512	322	70%	225
12	1999	4,562	332	70%	232
13	2000	1,614	343	70%	240
14	2001	1,667	355	70%	249
15	2002	1,722	366	70%	256
16	2003	1,779	379	70%	265
17	2004	1,837	391	70%	274
18	2005	1,898	404	70%	283
19	2006	1,961	417	70%	292
20	2007	2,025	431	70%	302

RIO TUBA
INCREASE RATE OF
POPULATION 3.7%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	1,269	270	70%	189
2	1989	1,316	280	80%	224
3	1990	1,365	290	90%	261
4	1991	1,415	301	90%	271
5	1992	1,467	312	90%	281
6	1993	1,522	324	90%	292
7	1994	1,578	336	90%	302
8	1995	1,636	348	90%	313
9	1996	1,697	361	90%	325
10	1997	1,760	374	90%	337
11	1998	1,825	388	90%	349
12	1999	1,892	403	90%	363
13	2000	1,962	417	90%	375
14	2001	2,035	433	90%	390
15	2002	2,110	449	90%	404
16	2003	2,188	466	90%	419
17	2004	2,269	483	90%	435
18	2005	2,353	501	90%	451
19	2006	2,441	519	90%	467
20	2007	2,531	539	90%	485

TARUSAN
INCREASE RATE OF
POPULATION 3.7%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	1,650	351	50%	176
2	1989	1,711	364	60%	218
3	1990	1,774	377	70%	264
4	1991	1,840	391	70%	274
5	1992	1,908	406	70%	284
6	1993	1,979	421	70%	295
7	1994	2,052	437	70%	306
8	1995	2,128	453	70%	317
9	1996	2,207	470	70%	329
10	1997	2,288	487	70%	341
11	1998	2,373	505	70%	354
12	1999	2,461	524	70%	367
13	2000	2,552	543	70%	380
14	2001	2,646	563	70%	394
15	2002	2,744	584	70%	409
16	2003	2,846	606	70%	424
17	2004	2,951	628	70%	440
18	2005	3,060	651	70%	456
19	2006	3,173	675	70%	473
20	2007	3,291	700	70%	490

COLANDANUM
INCREASE RATE OF
POPULATION 2%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	1,007	214	0%	0
2	1989	1,027	219	40%	88
3	1990	1,048	223	50%	112
4	1991	1,069	227	60%	136
5	1992	1,090	232	60%	139
6	1993	1,112	237	60%	142
7	1994	1,134	241	60%	145
8	1995	1,157	246	60%	148
9	1996	14180	251	60%	151
10	1997	1,203	256	60%	154
11	1998	1,228	261	60%	157
12	1999	1,252	266	60%	160
13	2000	1,277	272	60%	163
14	2001	1,303	277	60%	166
15	2002	1,329	283	60%	170
16	2003	1,355	288	60%	173
17	2004	1,382	294	60%	176
18	2005	1,410	300	60%	180
19	2006	1,438	306	60%	184
20	2007	1,467	312	60%	187

OCAYAN
INCREASE RATE OF
POPULATION 3.1%

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED RATE	ENERGIZED HOUSEHOLD
1	1988	514	109	0%	0
2	1989	530	113	50%	57
3	1990	546	116	60%	70
4	1991	563	120	70%	84
5	1992	581	124	70%	87
6	1993	599	127	70%	89
7	1994	617	131	70%	92
8	1995	636	135	70%	95
9	1996	656	140	70%	98
10	1997	677	144	70%	101
11	1998	698	149	70%	104
12	1999	719	153	70%	107
13	2000	741	158	70%	111
14	2001	764	163	70%	114
15	2002	788	168	70%	118
16	2003	813	173	70%	121
17	2004	838	178	70%	125
18	2005	864	184	70%	129
19	2006	890	189	70%	132
20	2007	918	195	70%	137

IWAHIG
INCREASE RATE OF
POPULATION 1.7%

	YEAR	POPULA-TION	HOUSE-HOLD	RATE	ENERGIZED HOUSEHOLD
1	1988	983	209	0%	0
2	1989	1,000	213	0%	0
3	1990	1,017	216	0%	0
4	1991	1,034	220	40%	88
5	1992	1,052	224	50%	112
6	1993	1,069	227	60%	136
7	1994	1,088	231	60%	139
8	1995	1,106	235	60%	141
9	1996	1,125	239	60%	143
10	1997	1,144	243	60%	146
11	1998	1,163	247	60%	148
12	1999	1,183	252	60%	151
13	2000	1,203	256	60%	154
14	2001	1,224	260	60%	156
15	2002	1,245	265	60%	159
16	2003	1,266	269	60%	161
17	2004	1,287	274	60%	164
18	2005	1,309	279	60%	167
19	2006	1,331	283	60%	170
20	2007	1,354	288	60%	173

IGANGIGANG
INCREASE RATE OF
POPULATION 2%

	YEAR	POPULA-TION	HOUSE-HOLD	RATE	ENERGIZED HOUSEHOLD
1	1988	555	118	0%	0
2	1989	566	120	0%	0
3	1990	577	123	0%	0
4	1991	589	125	0%	0
5	1992	601	128	40%	51
6	1993	613	130	50%	65
7	1994	625	133	60%	80
8	1995	638	136	60%	82
9	1996	650	138	60%	83
10	1997	663	141	60%	85
11	1998	677	144	60%	86
12	1999	690	147	60%	88
13	2000	704	150	60%	90
14	2001	718	153	60%	92
15	2002	732	156	60%	94
16	2003	747	159	60%	95
17	2004	762	162	60%	97
18	2005	777	165	60%	99
19	2006	793	169	60%	101
20	2007	809	172	60%	103

SARONG
INCREASE RATE OF
POPULATION 2.5%

	YEAR	POPULA-TION	HOUSE-HOLD	RATE	ENERGIZED HOUSEHOLD
1	1988	779	166	0%	0
2	1989	798	170	0%	0
3	1990	818	174	0%	0
4	1991	839	179	40%	72
5	1992	860	183	50%	92
6	1993	881	187	60%	112
7	1994	903	192	60%	115
8	1995	926	197	60%	118
9	1996	949	202	60%	121
10	1997	973	207.	60%	124
11	1998	997	212	60%	127
12	1999	1,022	217	60%	130
13	2000	1,048	223	60%	134
14	2001	1,074	229	60%	137
15	2002	1,101	234	60%	140
16	2003	1,128	240	60%	144
17	2004	1,156	246	60%	148
18	2005	1,185	252	60%	151
19	2006	1,215	259	60%	155
20	2007	1,245	265	60%	159

TOTAL

	YEAR	POPULA-TION	HOUSE-HOLD	ENERGIZED HOUSEHOLD
1	1988	24,802	5,047	1,984
2	1989	25,738	5,238	2,652
3	1990	26,706	5,430	3,244
4	1991	27,718	5,632	3,562
5	1992	28,770	5,848	3,795
6	1993	29,862	6,067	3,995
7	1994	30,996	6,297	4,160
8	1995	32,179	6,536	4,319
9	1996	33,405	6,783	4,482
10	1997	34,680	7,040	4,652
11	1998	36,010	7,307	4,828
12	1999	37,387	7,586	5,014
13	2000	38,822	7,875	5,205
14	2001	40,315	8,175	5,405
15	2002	41,868	8,485	5,609
16	2003	43,483	8,814	5,827
17	2004	45,159	9,149	6,050
18	2005	46,906	9,503	6,285
19	2006	48,723	9,866	6,525
20	2007	50,612	10,247	6,775

TABLE 4-4

DEMAND FORECAST OF RIO TUBA MINING CORPORATION (CASE 1)

Year	Facilities Excepting Drier		Drier System		Total	
	Peak Demand (kW)	Energy Demand (MWH)	Peak Demand (kW)	Energy Demand (MWH)	Peak Demand (kW)	Energy Demand (MWH)
1984	322	2,014	900	200	1,222	2,214
85	335	2,095	900	200	1,235	2,295
86	349	2,179	900	200	1,249	2,379
87	363	2,666	900	200	1,263	2,866
1988	377	2,357	900	3,793	1,277	6,150
89	392	2,546	900	3,793	1,292	6,339
90	408	2,749	900	3,793	1,308	6,542
91	424	2,969	900	3,793	1,324	6,762
92	441	3,207	900	3,793	1,341	7,000
93	459	3,463	900	3,793	1,359	7,256
94	477	3,740	900	3,793	1,377	7,533
95	496	4,039	900	3,793	1,396	7,832
96	516	4,363	900	3,793	1,416	8,156
97	536	4,712	900	3,793	1,436	8,505
1998	558	4,900	900	3,793	1,458	8,693
99	581	5,096	900	3,793	1,481	8,889
2000	604	5,300	900	3,793	1,504	9,903
01	628	5,512	900	3,793	1,528	9,305
02	653	5,733	900	3,793	1,553	9,526
03	679	5,962	900	3,793	1,579	9,755
04	706	6,201	900	3,793	1,606	9,994
05	735	6,449	900	3,793	1,635	10,242
06	764	6,707	900	3,793	1,664	10,500
07	795	6,975	900	3,793	1,695	10,768

TABLE 4-5

SUMMARY OF DEMAND FORECAST

Year	Rural Electrification		Rio Tuba Case-1		Rio Tuba Case-2		Rio Tuba Case-3	
	Peak Demand (kW)	Energy Demand (MWH)	Peak Demand (kW)	Energy Demand (MWH)	Peak Demand (kW)	Energy Demand (MWH)	Peak Demand (kW)	Energy Demand (MWH)
1988	614	1,731	1,277	6,150	3,450	19,645	8,500	59,568
89	677	1,913	1,292	6,339	3,450	19,645	8,500	59,568
90	741	2,094	1,308	6,542	3,450	19,645	8,500	59,568
91	782	2,212	1,324	6,762	3,450	19,645	8,500	59,568
92	819	2,319	1,341	7,000	3,450	19,645	8,500	59,568
93	851	2,413	1,349	7,256	3,450	19,645	8,500	59,568
94	884	2,509	1,377	7,553	3,450	19,645	8,500	59,568
95	919	2,610	1,396	7,832	3,450	19,645	8,500	59,568
96	956	2,718	1,416	8,156	3,450	19,645	8,500	59,568
97	999	2,844	1,436	8,505	3,450	19,645	8,500	59,568
1998	1,040	2,964	1,458	8,693	3,450	19,645	8,500	59,568
99	1,089	3,106	1,481	8,889	3,450	19,645	8,500	59,568
2000	1,140	3,253	1,504	9.093	3,450	19,645	8,500	59,568
01	1,195	3,418	1,528	9,305	3,450	19,645	8,500	59,568
02	1,258	3,599	1,553	9,526	3,450	19,645	8,500	59,568
03	1,320	3,782	1,579	9,755	3,450	19,645	8,500	59,568
04	1,392	3,990	1,606	9.994	3,450	19,645	8,500	59,568
05	1,467	4,210	1,635	10.242	3,450	19,645	8,500	59,568
06	1,547	4,447	1,664	10,500	3,450	19,645	8,500	59,568
07	1,639	4,718	1,695	10,768	3,450	19,645	8,500	59,568

AVAILABLE HYDROPOWER ENERGY FOR RIO TUBA MINING CORPORATION

TABLE 4-6

Year	Available Energy 1/ (MWH)	Energy A 2/ (MWH)	Demand B 3/ (MWH)
1988	19,087	1,731	17,356
89	19,087	1,913	17,174
90	19,087	2,094	16,993
91	19,087	2,212	16,875
92	19,087	2,319	16,768
93	19,087	2,413	16,674
94	19,087	2,509	16,578
95	19,087	2,610	16,477
96	19,087	2,718	16,369
97	19,087	2,844	16,243
1998	19,087	2,844	16,243
99	19,087	2,844	16,243
2000	19,087	2,844	16,243
01	19,087	2,844	16,243
02	19,087	2,844	16,243
03	19,087	2,844	16,243
04	19,087	2,844	16,243
05	19,087	2,844	16,243
06	19,087	2,844	16,243
07	19,087	2,844	16,243

1/ Available Annual Produced Energy
2/ Energy Demand for Rural Electrification
3/ Available Energy for Rio Tuba Mining Corp.

TABLE 4-7

BALANCE BETWEEN POWER DEMAND AND SUPPLY FOR RIO TUBA MINING CORPORATION (CASE 1)

Year	Power Demand		Supply			Surplus	
			Hydropower		Diesel Generation		
	Peak Demand (kW)	Energy Demand (MWH)	Peak (kW)	Energy (MWH)	(MWH)	Peak (kW)	Energy (MWH)
1988	1,277	6,150	3,450	17,356	252	2,173	11,458
89	1,292	6,339	3,450	17,174	252	2,158	11,087
90	1,308	6,542	3,450	16,993	252	2,142	10,703
91	1,324	6,762	3,450	16,875	252	2,126	10,365
92	1,341	7,000	3,450	16,768	252	2,109	10,020
93	1,359	7,256	3,450	16,674	252	2,091	9,670
94	1,377	7,533	3,450	16,578	252	2,073	9.297
95	1,396	7,832	3,450	16,477	252	2,054	8,573
96	1,416	8,156	3,450	16,369	252	2,034	8,465
97	1,436	8,505	3,450	16,243	252	2,014	7,990
1998	1,458	8,693	3,450	16,243	252	1,992	7,802
99	1,481	8,889	3,450	16,243	252	1,969	7,606
2000	1,504	9,093	3,450	16,243	252	1,946	7,402
01	1,528	9,305	3,450	16,243	252	1,922	7,190
02	1,553	9,526	3,450	16,243	252	1,897	6,969
03	1,579	9,755	3,450	16,243	252	1,871	6,740
04	1,606	9,994	3,450	16,243	252	1,844	6,501
05	1,635	10,242	3,450	16,243	252	1,815	6,253
06	1,664	10,500	3,450	16,243	252	1,786	5,995
07	1,695	10,768	3,450	16,243	252	1,755	5,727

TABLE 4-8

BALANCE BETWEEN POWER DEMAND AND SUPPLY FOR RIO TUBA MINING CORPORATION (CASE 2)

Year	Power Demand		Supply			Shortage
			Hydropower	Existing Diesel Power		
	Peak Load (kW)	Energy Demand (MWH)	(MWH)	Peak (kW)	Energy (MWH)	Peak (kW)
1988	3,450	19,645	17,356	2,100	2,289	1,350
89	3,450	19,645	17,174	2,100	2,471	1,350
90	3,450	19,645	16,993	2,100	2,650	1,350
91	3,450	19,645	16,875	2,100	2,770	1,350
92	3,450	19,645	16,768	2,100	2,877	1,350
93	3,450	19,645	16,674	2,100	2,971	1,350
94	3,450	19,645	16,578	2,100	3,067	1,350
95	3,450	19,645	16,477	2,100	3,168	1,350
96	3,450	19,645	16,369	2,100	3,276	1,350
97	3,450	19,645	16,243	2,100	3,402	1,350
1998	3,450	19,645	16,243	2,100	3,402	1,350
99	3,450	19,645	16,243	2,100	3,402	1,350
2000	3,450	19,645	16,243	2,100	3,402	1,350
01	3,450	19,645	16,243	2,100	3,402	1,350
02	3,450	19,645	16,243	2,100	3,402	1,350
03	3,450	19,645	16,243	2,100	3,402	1,350
04	3,450	19,645	16,243	2,100	3,402	1,350
05	3,450	19,645	16,243	2,100	3,402	1,350
06	3,450	19,645	16,243	2,100	3,402	1,350
07	3,450	19,645	16,243	2,100	3,402	1,350

TABLE 4-9

BALANCE BETWEEN POWER DEMAND AND SUPPLY FOR RIO TUBA MINING CORPORATION (CASE 3)

Year	Power Demand		Supply			Shortage	
			Hydropower	Existing Diesel Power			
	Peak Load (kW)	Energy Demand (MWH)	(MWH)	Peak (kW)	Energy (MWH)	Peak (kW)	Energy (MWH)
1988	8,500	59,568	17,356	2,100	9,198	6,400	33,014
89	8,500	59,568	17,174	2,100	9,198	6,400	33,196
90	8,500	59,568	16,993	2,100	9,198	6,400	33,377
91	8,500	59,568	16,875	2,100	9,198	6,400	33,495
92	8,500	59,568	16,768	2,100	9,198	6,400	33,602
93	8,500	59,568	16,674	2,100	9,198	6,400	33,696
94	8,500	59,568	16,578	2,100	9,198	6,400	33,792
95	8,500	59,568	16,477	2,100	9,198	6,400	33,893
96	8,500	59,568	16,369	2,100	9,198	6,400	34,001
97	8,500	59,568	16,243	2,100	9,198	6,400	34,127
1998	8,500	59,568	16,243	2,100	9,198	6,400	34,127
99	8,500	59,568	16,243	2,100	9,198	6,400	34,127
2000	8,500	59,568	16,243	2,100	9,198	6,400	34,127
01	8,500	59,568	16,243	2,100	9,198	6,400	34,127
02	8,500	59,568	16,243	2,100	9,198	6,400	34,127
03	8,500	59,568	16,243	2,100	9,198	6,400	34,127
04	8,500	59,568	16,243	2,100	9,198	6,400	34,127
05	8,500	59,568	16,243	2,100	9,198	6,400	34,127
06	8,500	59,568	16,243	2,100	9,198	6,400	34,127
07	8,500	59,568	16,243	2,100	9,198	6,400	34,127

V. SCHEME OF DEVELOPMENT

CHAPTER V SCHEME OF DEVELOPMENT

5.1 Optimum Development Plan

5.1.1 Basic Considerations in Planning

The hydro-electric power plant will supply electricity required for operation of the Rio Tuba Mine, and at the same time supply electricity to local residents for domestic use. Although an exact figure has not yet been determined, approximately 7.5MW is preferrable for mine operation. However, from the viewpoint of economic head and discharge of the Tamlang River at the optimum hydropower development site, power output will be limited to approximately 4MW. To compensate for the resultant shortage in output, use of the existing diesel generators will be continued on an auxiliary basis. At the same time, development of an additional hydropower site or of another electrical power source is urgently required. To be considered economically feasible, hydropower costs must be less than costs for the selected alternative energy source, namely diesel, coal or alternative power plant.

As for domestic electric supply, the Project must satisfy future demand increases, including electrification of rural communities which presently lack any electric facilities, and also supplement older PALECO diesel generators, contributing about 1MW to PALECO's demand and thus reducing fees.

From the viewpoint of immediate benefits, a plan with low preliminary capital cost is preferrable. In consideration of future increases in fuel prices and unreliable supply for energy sources other than hydropower however, the Project should be evaluated not on simple construction costs per kW and kWh of the hydropower plant alone but rather on the benefit/cost ratio where benefit is equivalent to the unit cost per kW and kWh for the alternative power plant.

Although the run-of-river type generation method is generally used for mini-hydropower, from the viewpoint of low dry season discharge and power demand characteristics, comparative study of a canal type with regulating pond is necessary for selection of the most appropriate plan. The proposed power plant is to serve both the mine and local residents and will be located approximately 44km from the mine. The power station will have a full-time supervision system with a simple and maintenance free automatic control system.

5.1.2 Comparative Cost Analysis for Alternative Power Generation Plant and Determination of Benefit Value of kW and kWh

The Rio Tuba Mining Corporation is presently investigating new electrical smelting processes to reduce production costs and thus increase the viability of the mine. Comparative study of power sources other than hydro including diesel, coal, oil, wood, and geothermal plants, was conducted for a 10MW scale electric power generation system and a coal-fired plant was selected as the most suitable plant for the following reasons:

a) coal has the highest overall reliability in terms of supply and efficiency;

b) diesel generation is considered a supplementary rather than a main power source;

c) petroleum is too expensive;

d) combined use of coal and wood for fuel is possible, but supply of firewood is insufficient and cost is too high for economic use;

e) geothermal power development is considered to be costly with lengthy implementation and should particularly be avoided by private enterprises; and,

f) cost and supply of coal is likely to remain stable for a long period of time.

For the above reasons therefore, fixed cost and fuel cost (variable cost) for a 10MW coal-fired thermal plant should be selected for comparative cost analysis to determine the optimum scale of hydropower development plan However, a diesel power plant was adopted for comparative cost analysis or benefit value of kW and kWh in place of the above 10MW coal-fired theremal plant due to the following points; i) ash treatment is comparatively difficult; ii) small plant capacity results in a higher power cost; iii) power cost of diesel and coal plants in almost the same; and, iv) investment cost for the diesel plant is smaller than that for the plant.

Although use of equal scale diesel and hydropower plants in comparative analysis is generally desirable, a 10MW scale plant was selected for the diesel plant as a plant smaller than 10MW would result in higher estimated production costs and would be conservative (Detailed

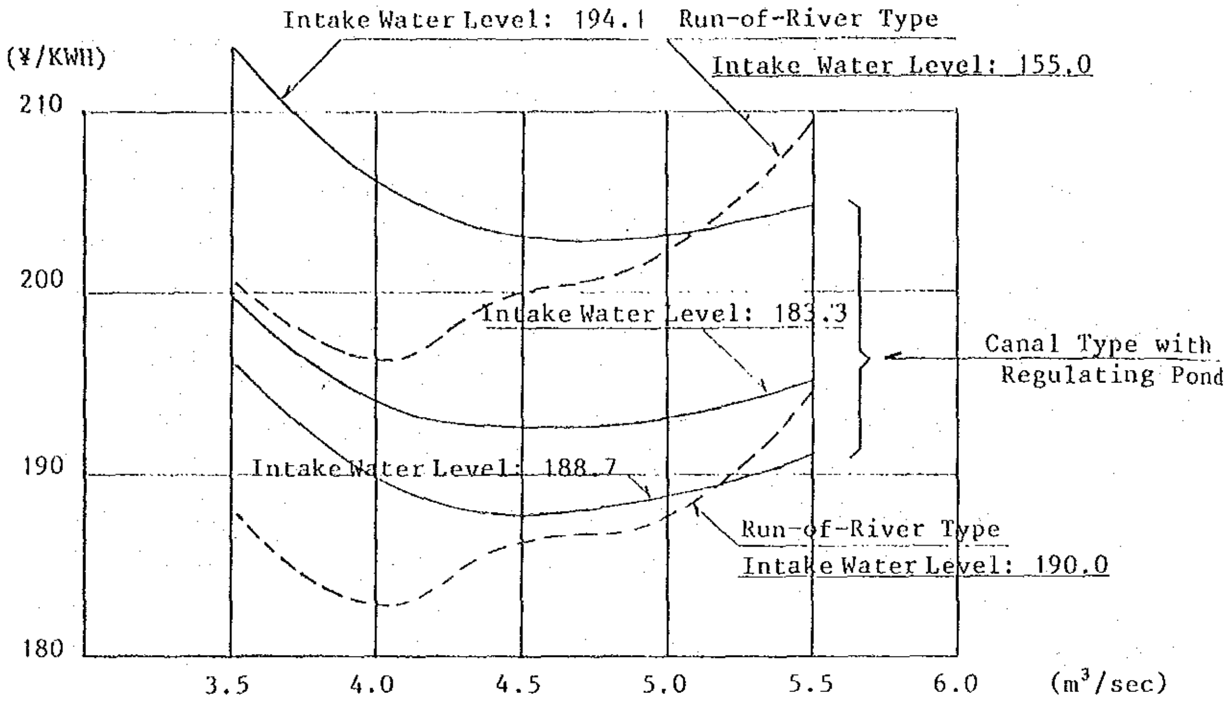
Project economic evaluation is presented in Chapters VII and VIII). The result of above study is shown in TABLE 5-1.

5.1.3 Optimum Development Plan

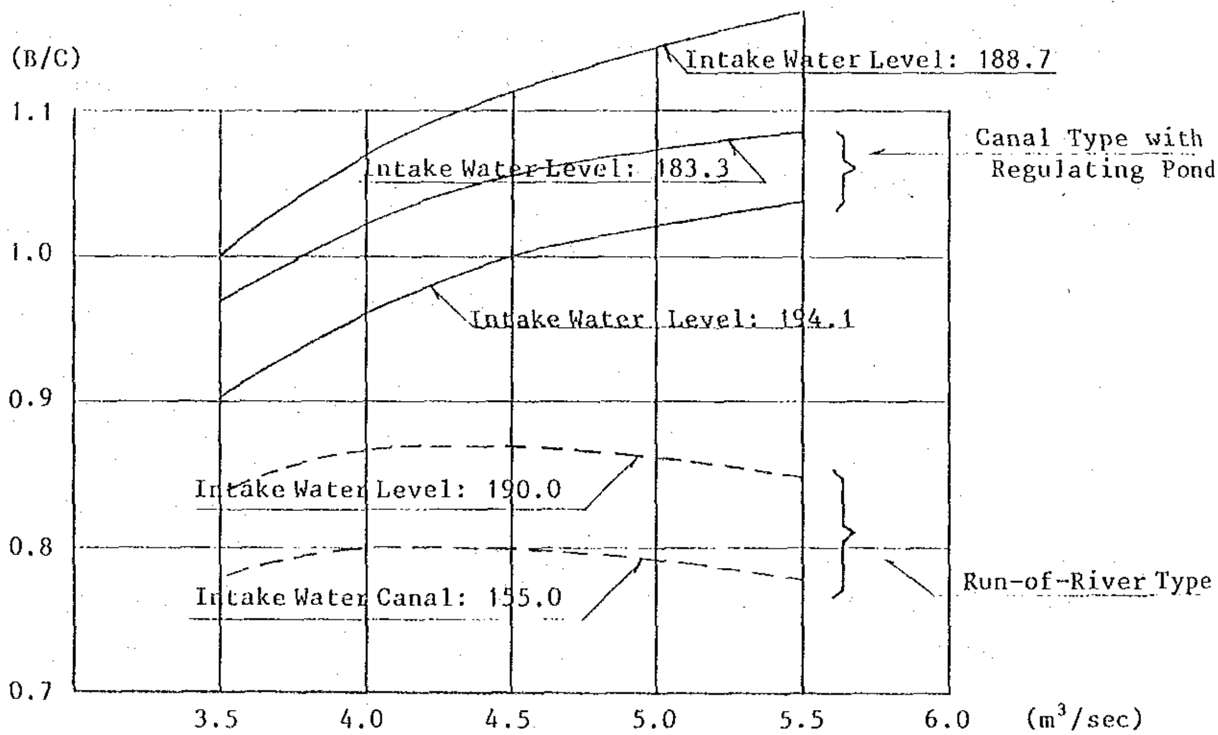
A case study was conducted to determine the optimum development scheme, comparing run-of-river and canal with regulating pond type generation methods. A total of 15 cases were compared including 3 different maximum turbine discharges with 2 intake water levels for the former, and 3 maximum turbine discharges with 3 different dam heights for the latter. On the basis of unit construction cost and benefit/cost ratio for each case, and after overall evaluation of capital cost, plant management, operation and maintenance, and effective use of the island's limited water resources, Case 5 was judged the optimum development plan (Refer to TABLE 5-2 and FIG. 5-1).

Optimum benefit/cost ratio for each case is obtained with a maximum turbine discharge of $5m^3/s$. However, in the event of 24-hour mine operation, the yearly period in which the said turbine discharge is available is greatly reduced while unit kWh costs correspondingly increase. For this reason, a maximum turbine discharge of less than $5m^3/s$ was adopted. An outline of the development plan for Case-5 is presented in TABLE 5-3.

FIG. 5.1 STUDY OF SCALE



UNIT CONSTRUCTION COST (¥/KWH)



Cost Benefit (B/C)

TABLE 5-1 COMPARATIVE COST ANALYSIS

As of Feb. 1984 (1 US$/14 P/233 ¥)

Description	Unit	Remarks
I. Diesel Plant		
-Plant Capacity	5,000kW x 2	
-Standard Annual Operation	7,000Hr	Assumed Plant Factor 80%
-Service Life	15 years	
-Generator Terminal Output	70 GWH	
-Plant Energy Consumption	18%	
-Annual Produced Energy	70 x (1-0.18) = 57.4 GWH	
-Construction Cost	2.,18 x 10^6 yen	Including Re-investment Cost after 15 years
<u>Annual Cost</u>		
II. Fixed Charge		
1) Capital Recovery Cost	2,118 x 10^6 x 0.124 = 262.63 x 10^6 yen	Interest 9%, C.V.F. = 0.124
2) O & M and Administrative Cost	2,118 x 10^6 x 0.03 = 63.54 x 10^6 yen	Ratio 3.0%
3) Total Fixed Charge	326.17 x 10^6 yen	1) + 2)
4) Unit Fixed Charge Per kW	32,620 yen	
5) kW value	32,620 x 1.06 = 34,577 yen/kW	*Revised Factor, per kW Value α = 1.06
III. Variable Cost		
1) Fuel Cost	38.12 yen/ℓ	
2) Fuel Consumption per KWH	0.329ℓ/KWH	
3) Unit Cost per KWH	38.12 x 0.329 = 12.54 yen/KWH	
4) KWH Value	12.54/(1-0.18) = 15.29 yen/KWH	*Revised Factor for KWH Value β = 1.00

<u>Assumption</u>

	Hydro	Diesel
Transmission Loss	4.0%	1.0%
Fault	-	2.0
Station Service Use	0.3	3.0
Check and Repair	2.0	6.0

$$\alpha = \frac{(1-0.04) \times (1-0.003) \times (1-0.02)}{(1-0.01) \times (1-0.002) \times (1-.0.03) \times (1-0.06)} = 1.06$$

$$\beta = \frac{(1-0.04) \times (1-0.003)}{(1-0.01) \times (1-0.03)} = 1.00$$

TABLE 5-2. **COMPARISON OF DEVELOPMENT SCALE**

ALTERNATIVE		CANAL WITH REGULATING POND TYPE									RUN-OF-RIVER-TYPE					
DAM CREST EL.	m		190			185			180			190			155	
CASE		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
INTAKE EL	m		194.1			188.7			183.3			190.0			155.0	
OUTLET EL.	"		85.0			85.0			85.0			85.0			85.0	
EFFECTIVE HEAD	"	106.6	106.9	107.2	102.0	102.3	102.6	96.4	96.7	98.0	101.0	101.0	101.0	68.0	68.0	68.0
MAXIMUM DISCHARGE	m^3/s	5.0	4.5	4.0	5.0	4.5	4.0	4.0	5.0	4.5	4.0	4.5	3.5	4.5	4.0	3.5
MAXIMUM OUTPUT	KW	4,390	3,960	3.530	4,200	3,790	3,380	3,970	3,580	3,230	3,740	3,320	2,910	2,520	2,240	1,950
GENERATING CAPACITY	10^6 kWH	21.90	21.44	20.76	20.95	20.51	19.87	19.81	19.39	18.98	17.38	17.33	16.54	12.93	12.88	12.33
CONSTRUCTION COST	10^6 ¥	4,450	4,350	4,280	4,030	3,920	3,840	3,820	3,730	3,660	3,240	3,168	3,108	2,588	2,526	2,472
CONSTRUCTION COST PER KWH	¥/kWH	203.2	202.9	206.2	192.3	191.1	193.3	192.9	192.4	192.9	186.5	182.8	187.9	200.0	196.1	200.5
BENEFIT/COST RATIO	B/C	1.020	0.997	0.959	1.077	1.058	1.022	1.076	1.053	1.023	0.860	0.867	0.837	0.793	0.801	0.771

TABLE 5-3

OUTLINE OF DEVELOPMENT PLAN

ITEM	DESCRIPTION	REMARKS
Name of River	Tamlang River	
Power Plant Location	Brookes Point	
Catchment Area (km^2)	39.0	
POWER PLANT SCHEME		
Generation Method	Canal Type with Regulating Pond	
Intake Water Level (m)	188.7	At Maximum Output
Tailrace Water Level(m)	85.0	"
Gross Head (m)	103.7	
Maximum Output (kW)	3,800	
Maximum Discharge (m^3/s)	4.50	
Effective Head (m)	101.3	At Maximum Output
Annual Produced Energy (GWH)	20.51	
OUTLINE OF FACILITIES		
Regulating Pond		
Maximum high water level (m)	188.7	
Available depth (m)	1.8	
Effective capacity (10^3m^3)	360	
Dam		
Type	Concrete Gravity Dam	
Height (m)	46.0	
Crest length (m)	49.0	
Dam concrete volume (m^3)	17,000	
Headrace length (m)	1,493	Including Pressure Pipe
Tailrace Length (m)	300	

VI. POWER PLANT: COST AND CONSTRUCTION IMPLEMENTATION

CHAPTER VI POWER PLANT: COST AND CONSTRUCTION IMPLEMENTATION

6.1 Power Plant

6.1.1 Main Structures

The main structures of the Project are dam, diversion tunnel, penstock and power plant. These structures are explained in brief below, while related preliminary designs are presented in APPENDIX I as FIG. 4-1, 4-3, 4-4, 4-7 and 4-9.

(1) Dam

Type	: concrete gravity dam
Height	: 46.0m
Length	: 49.0m
Design Flood	: 505m^3/s
Overflow Width	: 25.0m
Overflow Depth	: 4.7m

An automatic inflatable rubber dam 3.7m in height will be installed at overflow crest to increase the available head. The upstream dam face will have a slope of 0.2 while the downstream face will be 0.8.

(2) Diversion Tunnel

The tunnel section will be rectangular horseshoe shaped with a bottom width of about 4.0m to allow use as an access road during construction. Approximately 70% of the total length will be unlined while 30% will be concrete lined.

Tunnel Length	: 1,277m
Lined Canal Slope	: 1/1,000

(3) Penstock

A 1.5m diameter FRPM (Fiberglass Reinforced Plastic Mortar Pipe) will be used for the penstock which will be embedded.

(4) Power Plant

The river side of the powerhouse building will be waterproof to ensure water tightness for the horizontal-shaft turbine during floods.

Powerhouse	: 8.5m x 16.0m

6.1.2 Main Electrical Facilities

The main electrical facilities of the Project are provided below.

(1) Dam

Type	: 1 horizontal-shaft, Francis-type turbine
Maximum Output	: 4,000kW (turbine efficiency = 91.1%)
Maximum Discharge	: 4.5m^3/s
Rotation Speed	: 720RPM
Speed with Closed Governor	: 2.5s

(2) Generator

Type	: 1 horizontal axis 3-phase alternating current synchronized generator
Output	: 4,700 kVA
Voltage	: 4.16kV
Power Ratio	: 0.81
Frequency	: 60HZ

(3) Main Transformer

Type	: 2 outdoor, 3-phase, self-cooling type transformers
Capacity	: 4,700kVA
Voltage:	: 4.16/34.5 ± 5%kV

(4) Transmission Line

No. of Circuits	: 1
Cables	: Aluminum Cable Steel Reinforced (ACSR) 176.9MCM (89.7mm^2)
Insulators	: 4 suspension insulators (250mm)
Overhead Ground Wire	: 1 zinc-coated steel cable AWG 2 (33.62mm^2)
Support	: Wood pole
Voltage	: 34.5kV
Total Length	: 44km

6.2 Estimated Construction Cost

Estimated construction costs have been worked out in terms of the 1984 price index and are presented hereunder.

		unit: million yen
(1)	Civil Construction Costs	
	Dam	1,333.9
	Intake	70.3
	Diversion Tunnel	737.4
	Surge Tank	93.6
	Penstock	63.9
	Diversion Channel	65.5
	Powerhouse (building and equipment foundation)	293.7
(2)	Electrical Facilities	
	Power Plant Equipment (turbine, generator)	448.0
	Transmission Line	165.0
(3)	Technical Maintenance Cost	300.0
(4)	Contingency (including land compensation)	278.7
(5)	Cost Escalation	181.3
	Total	4,031.3

6.3 Annual Disbursement Schedule

The construction period required is estimated to be approximately 4 years. The annual disbursement schedule is shown in the following table and the total construction cost is about 4,000 million yen.

ANNUAL DISBURSEMENT SCHEDULE

Unit: million. yen

Item \ Year	1st	2nd	3rd	4th	Total
Civil Construction	1,030.4	1,174.0	159.9	294.0	2,658.3
Electrical Facilities	44.8	358.4	-	44.8	448.0
Transmission Line	16.5	132.0	-	16.5	165.0
Contingency	60.6	184.0	25.1	-	278.7
Engineering Services	120.0	120.0	60.0	-	300.0
Cost Escalation	105.7	73.8	1.8	-	181.3
Total	1,387.0	2,042.2	246.8	355.3	4,031.3

6.4 Implementation Schedule

The envisaged implementation schedule is presented in TABLE 6-1 and shows a period of approximately 28 months commencing upon award of contract as required for completion of the same. Approximately one year will be required prior to contract award for lining up financing, preparation of detailed design works, tender bidding and tender evaluation.

Table 6-1 Implementation Schedule

Item	Unit	Amount	1st Year (months 1–12)	2nd Year (months 13–24)	3rd Year (months 25–36)
Preparatory Works					
Temporary Facilities			Aggregate Plant; for Tunneling	Concrete Placing Facilities	Removal
Civil Works					
Tunnel Works	m	1,510			
Diversion Works	set	1			
Dam	m³	Excavation 6,700; Concrete volume 17,000			Rubber Dam; Plug Works
Intake	set	1			
Surge Tank	set	1			
Penstock	m	180			
Tailrace	m	300			
Powerhouse	set	1			Site Development
Electro-Mechanical Works					
Turbine & Generator	set	1	Manufacturing Design; Manufacturing	Transportation	Erection
Transmission Line & Substation	set	1			
Filling Reservoir, Test	set	1			
Commissioning					
			Dry Season / Rainy Season	Dry Season / Rainy Season	Dry Season / Rainy Season

VII. FINANCIAL ANALYSIS

CHAPTER VII FINANCIAL ANALYSIS

7.1 General

The objective of project analysis, or financial and economic analysis, methods of which were developed primarily by UNIDO and OECD, is efficient allocation of scarce resources (usually potential capital for investment). These methods have been adopted by all international financing and bilateral aid agencies in implementation of feasibility studies.

Originally, both methods were developed to analyse such production sectors as industry and agriculture, etc. Evaluation of feasibility and infeasibility thus depended upon whether a certain standard of surplus benefit by production could be achieved during the project life. One indicator used to express this standard is Internal Rate of Return (IRR). Application of this approach has been expanded, mainly by the World Bank Group, to evaluate such sectors as infrastructure and utility in which neither transactions nor competitive market prices exist.

In project analysis of those sectors, for example, benefit is often measured by cost savings with other second best alternatives, while turnover of the products is regarded as project benefit in the evaluation of production sectors. Likewise, in communication projects, consumer surplus is regarded as benefit.

It should be noted that IRR is affected by identification of benefits for each project. IRR is thus often inappropriate as a standard for selection of optimum resource allocation of projects in the same sector as well as in different sectors. Most feasibility studies of power projects in Japan, for example, have adopted costs of alternative power plants using different energy sources (opportunity costs of capital) as a project benefit. In this case, different and more accurate values of IRR could be obtained as compared to internationally recognized cases where the savings in operation and maintenance (O & M) or revenues from electric rates are regarded as benefits of power projects.

It is therefore essential not to merely compare values of benefit but to clearly identify the benefit used in the evaluation for determining whether a newly proposed project should be implemented or not.

7.2 Conditions of Financial Analysis

Financial analysis of a project compares benefit expressed as revenues, and costs expressed as expenditures from the perspective of the implementation agencies of the project. In financial analysis of a power project, investment and O & M costs are generally regarded as expenditures while sale of electricity is regarded as revenue. However, unlike ordinary projects, in the proposed Tamlang River Hydropower Project, electricity will be supplied by a dual system to two groups of consumers; neighbouring rural residents who are or will be served through PALECO, and the Rio Tuba Mine. Revenues for the former are equivalent to total power rates to be collected from end-users. For the latter, however, no such revenues exist; rather power production is regarded as one item of mine operation costs.

Projects are generally formulated corresponding to present and future demand. In this case, however, future demand for the Rio Tuba Mine itself has not yet been clearly determined. The primary reason for initiating the present study was to reduce power production costs by conversion to hydropower generation, and in addition, to provide an inexpensive electric supply for future expected demand for the envisioned new smelting plant. However, the smelting plant is still under study, and the present report will likely be a contributing factor in determination of scale, required electric energy, etc. Accordingly, financial analysis of this Project is necessarily different from ordinary projects and conducted assuming three possible energy demand cases as described in Chapter 4.

Based upon the premises mentioned above, it might be appropriate to consider that the benefit for the Rio Tuba Mine itself should be as follows:

(1) Case-1: Substitution of Existing Diesel Generator

This case substitutes hydropower generation for supply by the existing diesel generator alone. Where energy consumption is for the Mine's own use, benefit is regarded as the difference or the savings in costs between the two cases, i.e., generation by the construction of a hydropower plant and generation by the existing diesel facilities without construction of ahydro plant.

(2) Case-2: Peak Load 3,600kW

As fulfillment of power demand during the dry season is impossible with the planned hydropower plant, this case compares O & M costs for generation by diesel facilities alone including installation of a new diesel power plant with two 1,500kW diesel generators and by the combination of a hydropower plant and existing diesel facilities. Difference in the said costs is regarded as benefit.

(3) Case-3: Peak Load 9,500kW

In this case, installation of additional generators is required for both cases not only in the dry season but also during the rainy season. Benefit for this case is determined as for Case-2 in comparison of O & M costs with diesel facilities alone and combined use of the hydropower plant and existing diesel facilities.

Costs can be evaluated in the same way as benefit, the difference between construction and installation costs for the hydropower plant and for diesel plants being adopted as cost. Following the above framework in financial analysis, further considerations concerning benefit and costs for this Project are presented below, and are directly related to discussion in Chapter 4 and 5.

7.3 Benefit/Cost Calculation

7.3.1 Benefit

As stated above, Rio Tuba Mine revenues from sale of electricity to PALECO is regarded as benefit for rural electrification while the difference in cost between diesel generation only and combined use of hydro and diesel generation is regarded as benefit in the case of production by the Mine for its own consumption.

If electricity is supplied by public power corporations, the electric rate will be determined by Long-Run Marginal Costs (LRMC). In this Project, however, as electricity is supplied by a private company, the electric rate can be determined by multiplication of the capital recovery factor (CRF) and coefficients of maintenance and fair return for construction cost as practiced in Japan.

Therefore, system rates for the Project are as tabulated below.

Item	Unit	Amount
Construction Cost	Yen	$4{,}031 \times 10^6$
Available Electric Energy	kWh	$19{,}087 \times 10^3$
Construction Cost	kWh	$(4{,}031 \times 10^6) \div (19{,}087 \times 10^3) = 211.2$
CRF:		$\dfrac{0.045 \times (1+0.045)^{45}}{(1+0.045)^{45} - 1} = 0.0522$ 5.2%
Maintenance Cost Coefficient		1.5%
Fair Return Coefficient		3.3%
		Total 10.0%
System Rate		211.2yen x 0.10 = 21.1 = 21.0yen/kWh

The above system rate is relatively inexpensive in comparison with the present PALECO system rate of 29.4 yen and that of NPC, 24.9 yen,1/ and consequently may be expected to contribute to reduction of present PALECO deficits. As for benefit of savings, the main component is savings resulting from reduction of diesel fuel use. According to the principles of project evaluation, increases in costs caused by inflation can be offset by the same effect on items of benefit. In cases where some specific costs of goods and/or services are expected explicitly to rise in relation to other costs and benefits, however, those costs can be allowed to escalate. According to 'Commodity Price Forecasts' by World Bank/IFC, oil-related energy prices during 1984-95 will increase by 1.8% annually in comparison with other principal items. Thus, a 1.8% annual escalation in diesel costs alone was adopted for this study2/.

1/ Calculations based on PALECO's Annual Report and Profit and Loss Report.

2/ Commodity Price Forecasts (Revisions), The World Bank, Jan. 6, 1984. Calculated from P.11 Table 3 "Weighted Index of Commodity Prices".

7.3.2 Cost

As the difference in O & M cost was adopted as project benefit, cost was determined as the difference in costs for construction and replacement of equipment for hydropower generation (including cogeneration of hydro and diesel) and those for diesel generation alone. Moreover, residual cost of diesel generators at the end of project life was regarded as the same as removal costs.

Interest rates during the construction period have increasingly been considered in financial analysis for recent feasibility studies in Japan. The main reason seems to be facilitation of book-keeping and accounting, as well as evaluation by funding agencies after completion of the feasibility study. Project evaluation or internal rate of return in financial analysis, however, is in reality unrelated to interest rates or depreciation, evaluating only the rate of returns within the Project itself. Accordingly, interest rates during the construction period were not included within the present Report in conformity with the principles of project analysis.

Finally, project life for the hydropower generation facilities such as dam, generators, transmission lines, etc., is estimated at 45 years after completion of construction; residual costs in the last year of project implementation is estimated at zero.

In addition, a fixed depreciation method was adopted for the replaced diesel plant facilities and residual values were calculated at the final project year. However, although these residual values appear in the costs cash/flow column, these costs are minus by nature and are clearly considered as benefit.

7.4 Financial Internal Rate of Return (FIRR)

Based on the conditions outlined above, FIRR for each case were calculated as follows, details of which are presented in TABLE 7-1:

Case-1	Substitution of Existing Diesel Generator	: FIRR 3.2%
Case-2	Peak load 3,600kW	: " " 7.9%
Case-3	Peak load 9,500kW	: " " 9.0%

7.5 Sensitivity Analysis

Sensitivity analysis was conducted for Case 3 (peak load 9,500kW) which would be considered most realistic and acheived the highest FIRR. The following results were obtained:

- 10% increase in construction costs	8.1%
- 20% increase in construction costs	7.3
- fuel prices remain constant from 1984	7.8
- fuel prices increase 5% from 1984	11.4
- fuel prices increase 10% from 1984	15.6
- combination of first and third items above (worst case can be assumed)	6.2
- combination of first and forth items above	10.4

THREE CASE STUDIES FOR FIRR

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######################## CASE 1 FIRR################################

		HYDRO INV	DEISEL W/ HY	DIESEL ONLY	HYDRO OM	ELCTRICITY
1)	Y-1985	1281000	0	0	0	0
2)	Y-1986	1968000	0	0	0	0
3)	Y-1987	245000	0	0	0	0
4)	1988	356000	0	0	60000	1731
5)	1989	0	0	0	60000	1913
6)	1990	0	0	0	60000	2094
7)	1991	0	0	0	60000	2212
8)	1992	0	0	317600	60000	2319
9)	1993	0	0	0	60000	2413
10)	1994	0	0	0	60000	2413
11)	1995	0	0	0	60000	2509
12)	1996	0	0	0	60000	2509
13)	1997	0	105900	0	60000	2610
14)	1998	0	0	0	60000	2718
15)	1999	0	0	0	60000	2844
16)	2000	0	0	0	60000	2844
17)	2001	0	0	0	60000	2844
18)	2002	0	0	0	60000	2844
19)	2003	0	0	0	60000	2844
20)	2004	0	0	0	60000	2844
21)	2005	0	0	0	60000	2844
22)	2006	0	0	0	60000	2844
23)	2007	0	0	317600	60000	2844
24)	2008	0	0	0	60000	2844
25)	2009	0	0	0	60000	2844
26)	2010	0	0	0	60000	2844
27)	2011	0	0	0	60000	2844
28)	2012	0	0	0	60000	2844
29)	2013	0	0	0	60000	2844
30)	2014	0	0	0	60000	2844
31)	2015	0	0	0	60000	2844
32)	2016	0	0	0	60000	2844
33)	2017	0	105900	0	60000	2844
34)	2018	0	0	0	60000	2844
35)	2019	0	0	0	60000	2844
36)	2020	0	0	0	60000	2844
37)	2021	0	0	0	60000	2844
38)	2022	0	0	317600	60000	2844
39)	2023	0	0	0	60000	2844
40)	2024	0	0	0	60000	2844
41)	2025	0	0	0	60000	2844
42)	2026	0	0	0	60000	2844
43)	2027	0	0	0	60000	2844
44)	2028	0	0	0	60000	2844
45)	2029	0	-48714	-184210	60000	2844

		ELCT REVENUE	MWH DSL ONLY	MWH DSL W/HY	D ONLY OM	D W/HY OM
1)	Y-1985	0	0	0	0	0
2)	Y-1986	0	0	0	0	0
3)	Y-1987	0	0	0	0	0
4)	1988	36351	6150	252	125999	14428
5)	1989	40173	6339	252	131100	14520
6)	1990	43974	6542	252	136595	14613
7)	1991	46452	6762	252	142555	14708
8)	1992	48699	7000	252	149017	14804
9)	1993	50673	7256	252	156005	14903
10)	1994	50673	7533	252	163596	15003
11)	1995	52689	7832	252	171837	15105
12)	1996	52689	8156	252	180814	15209
13)	1997	54810	8505	252	190560	15314
14)	1998	57078	8505	252	190560	15314
15)	1999	59724	8505	252	190560	15314
16)	2000	59724	8505	252	190560	15314
17)	2001	59724	8505	252	190560	15314
18)	2002	59724	8505	252	190560	15314
19)	2003	59724	8505	252	190560	15314
20)	2004	59724	8505	252	190560	15314
21)	2005	59724	8505	252	190560	15314
22)	2006	59724	8505	252	190560	15314
23)	2007	59724	8505	252	190560	15314
24)	2008	59724	8505	252	190560	15314
25)	2009	59724	8505	252	190560	15314
26)	2010	59724	8505	252	190560	15314
27)	2011	59724	8505	252	190560	15314
28)	2012	59724	8505	252	190560	15314
29)	2013	59724	8505	252	190560	15314
30)	2014	59724	8505	252	190560	15314
31)	2015	59724	8505	252	190560	15314
32)	2016	59724	8505	252	190560	15314
33)	2017	59724	8505	252	190560	15314
34)	2018	59724	8505	252	190560	15314
35)	2019	59724	8505	252	190560	15314
36)	2020	59724	8505	252	190560	15314
37)	2021	59724	8505	252	190560	15314
38)	2022	59724	8505	252	190560	15314
39)	2023	59724	8505	252	190560	15314
40)	2024	59724	8505	252	190560	15314
41)	2025	59724	8505	252	190560	15314
42)	2026	59724	8505	252	190560	15314
43)	2027	59724	8505	252	190560	15314
44)	2028	59724	8505	252	190560	15314
45)	2029	59724	8505	252	190560	15314

		COST SAVING	BENEFIT	COST	CASH FLOW
1)	Y-1985	0	0	1281000	-1281000
2)	Y-1986	0	0	1968000	-1968000
3)	Y-1987	0	0	245000	-245000
4)	1988	51571	87922	356000	-268078
5)	1989	56580	96753	0	96753
6)	1990	61982	105956	0	105956
7)	1991	67847	114299	0	114299
8)	1992	74213	122912	-317600	440512
9)	1993	81102	131775	0	131775
10)	1994	88593	139266	0	139266
11)	1995	96732	149421	0	149421
12)	1996	105606	158295	0	158295
13)	1997	115246	170056	105900	64156
14)	1998	115246	172324	0	172324
15)	1999	115246	174970	0	174970
16)	2000	115246	174970	0	174970
17)	2001	115246	174970	0	174970
18)	2002	115246	174970	0	174970
19)	2003	115246	174970	0	174970
20)	2004	115246	174970	0	174970
21)	2005	115246	174970	0	174970
22)	2006	115246	174970	0	174970
23)	2007	115246	174970	-317600	492570
24)	2008	115246	174970	0	174970
25)	2009	115246	174970	0	174970
26)	2010	115246	174970	0	174970
27)	2011	115246	174970	0	174970
28)	2012	115246	174970	0	174970
29)	2013	115246	174970	0	174970
30)	2014	115246	174970	0	174970
31)	2015	115246	174970	0	174970
32)	2016	115246	174970	0	174970
33)	2017	115246	174970	105900	69070
34)	2018	115246	174970	0	174970
35)	2019	115246	174970	0	174970
36)	2020	115246	174970	0	174970
37)	2021	115246	174970	0	174970
38)	2022	115246	174970	-317600	492570
39)	2023	115246	174970	0	174970
40)	2024	115246	174970	0	174970
41)	2025	115246	174970	0	174970
42)	2026	115246	174970	0	174970
43)	2027	115246	174970	0	174970
44)	2028	115246	174970	0	174970
45)	2029	115246	174970	135496	39474

INTERNAL RATE OF RETURN IS 1.031956677310852
PRESENT VALUE IS -2.8991699218750-04

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######################## CASE 2 FIRR################################

		HYDRO INV	DEISEL W/ HY	DIESEL ONLY	HYDRO OM	ELCTRICITY
1)	Y-1985	1281000	0	0	0	0
2)	Y-1986	1968000	0	0	0	0
3)	Y-1987	245000	0	459000	0	0
4)	1988	356000	0	0	60000	1731
5)	1989	0	0	0	60000	1913
6)	1990	0	0	0	60000	2094
7)	1991	0	0	0	60000	2212
8)	1992	0	0	280000	60000	2319
9)	1993	0	0	0	60000	2413
10)	1994	0	0	0	60000	2413
11)	1995	0	0	0	60000	2509
12)	1996	0	0	0	60000	2509
13)	1997	0	105900	0	60000	2610
14)	1998	0	0	0	60000	2718
15)	1999	0	0	0	60000	2844
16)	2000	0	0	0	60000	2844
17)	2001	0	0	0	60000	2844
18)	2002	0	0	408000	60000	2844
19)	2003	0	0	0	60000	2844
20)	2004	0	0	0	60000	2844
21)	2005	0	0	0	60000	2844
22)	2006	0	0	0	60000	2844
23)	2007	0	0	280000	60000	2844
24)	2008	0	0	0	60000	2844
25)	2009	0	0	0	60000	2844
26)	2010	0	0	0	60000	2844
27)	2011	0	0	0	60000	2844
28)	2012	0	0	0	60000	2844
29)	2013	0	0	0	60000	2844
30)	2014	0	0	0	60000	2844
31)	2015	0	0	0	60000	2844
32)	2016	0	0	0	60000	2844
33)	2017	0	105900	408000	60000	2844
34)	2018	0	0	0	60000	2844
35)	2019	0	0	0	60000	2844
36)	2020	0	0	0	60000	2844
37)	2021	0	0	0	60000	2844
38)	2022	0	0	280000	60000	2844
39)	2023	0	0	0	60000	2844
40)	2024	0	0	0	60000	2844
41)	2025	0	0	0	60000	2844
42)	2026	0	0	0	60000	2844
43)	2027	0	0	0	60000	2844
44)	2028	0	0	0	60000	2844
45)	2029	0	-48714	-236040	60000	2844

Table 7-1
4 of 9

		ELCT REVENUE	MWH DSL ONLY	MWH DSL W/HY	D ONLY OM	D W/HY OM
1)	Y-1985	0	0	0	0	0
2)	Y-1986	0	0	0	0	0
3)	Y-1987	0	0	0	0	0
4)	1988	36351	19645	2289	334403	64857
5)	1989	40173	19645	2471	339758	69048
6)	1990	43974	19645	2652	345209	73356
7)	1991	46452	19645	2770	350758	76575
8)	1992	48699	19645	2877	356407	79675
9)	1993	50673	19645	2971	362158	82606
10)	1994	50673	19645	3067	368012	85665
11)	1995	52689	19645	3168	373972	88920
12)	1996	52689	19645	3276	380039	92420
13)	1997	54810	19645	3402	386215	96416
14)	1998	57078	19645	3402	386215	96416
15)	1999	59724	19645	3402	386215	96416
16)	2000	59724	19645	3402	386215	96416
17)	2001	59724	19645	3402	386215	96416
18)	2002	59724	19645	3402	386215	96416
19)	2003	59724	19645	3402	386215	96416
20)	2004	59724	19645	3402	386215	96416
21)	2005	59724	19645	3402	386215	96416
22)	2006	59724	19645	3402	386215	96416
23)	2007	59724	19645	3402	386215	96416
24)	2008	59724	19645	3402	386215	96416
25)	2009	59724	19645	3402	386215	96416
26)	2010	59724	19645	3402	386215	96416
27)	2011	59724	19645	3402	386215	96416
28)	2012	59724	19645	3402	386215	96416
29)	2013	59724	19645	3402	386215	96416
30)	2014	59724	19645	3402	386215	96416
31)	2015	59724	19645	3402	386215	96416
32)	2016	59724	19645	3402	386215	96416
33)	2017	59724	19645	3402	386215	96416
34)	2018	59724	19645	3402	386215	96416
35)	2019	59724	19645	3402	386215	96416
36)	2020	59724	19645	3402	386215	96416
37)	2021	59724	19645	3402	386215	96416
38)	2022	59724	19645	3402	386215	96416
39)	2023	59724	19645	3402	386215	96416
40)	2024	59724	19645	3402	386215	96416
41)	2025	59724	19645	3402	386215	96416
42)	2026	59724	19645	3402	386215	96416
43)	2027	59724	19645	3402	386215	96416
44)	2028	59724	19645	3402	386215	96416
45)	2029	59724	19645	3402	386215	96416

		COST SAVING	BENEFIT	COST	CASH FLOW
1)	Y-1985	0	0	1281000	-1281000
2)	Y-1986	0	0	1968000	-1968000
3)	Y-1987	0	0	-214000	214000
4)	1988	209546	245897	356000	-110103
5)	1989	210710	250883	0	250883
6)	1990	211852	255826	0	255826
7)	1991	214183	260635	0	260635
8)	1992	216732	265431	-280000	545431
9)	1993	219552	270225	0	270225
10)	1994	222347	273020	0	273020
11)	1995	225052	277741	0	277741
12)	1996	227619	280308	0	280308
13)	1997	229799	284609	105900	178709
14)	1998	229799	286877	0	286877
15)	1999	229799	289523	0	289523
16)	2000	229799	289523	0	289523
17)	2001	229799	289523	0	289523
18)	2002	229799	289523	-408000	697523
19)	2003	229799	289523	0	289523
20)	2004	229799	289523	0	289523
21)	2005	229799	289523	0	289523
22)	2006	229799	289523	0	289523
23)	2007	229799	289523	-280000	569523
24)	2008	229799	289523	0	289523
25)	2009	229799	289523	0	289523
26)	2010	229799	289523	0	289523
27)	2011	229799	289523	0	289523
28)	2012	229799	289523	0	289523
29)	2013	229799	289523	0	289523
30)	2014	229799	289523	0	289523
31)	2015	229799	289523	0	289523
32)	2016	229799	289523	0	289523
33)	2017	229799	289523	-302100	591623
34)	2018	229799	289523	0	289523
35)	2019	229799	289523	0	289523
36)	2020	229799	289523	0	289523
37)	2021	229799	289523	0	289523
38)	2022	229799	289523	-280000	569523
39)	2023	229799	289523	0	289523
40)	2024	229799	289523	0	289523
41)	2025	229799	289523	0	289523
42)	2026	229799	289523	0	289523
43)	2027	229799	289523	0	289523
44)	2028	229799	289523	0	289523
45)	2029	229799	289523	187326	102197

INTERNAL RATE OF RETURN IS 1.07869121998192
PRESENT VALUE IS -.0890100002288184

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######################## CASE 3 FIRR##############################

		HYDRO INV	DEISEL W/ HY	DIESEL ONLY	HYDRO OM	ELCTRICITY
1)	Y-1985	1281000	0	0	0	0
2)	Y-1986	1968000	0	0	0	0
3)	Y-1987	245000	594000	1296000	0	0
4)	1988	356000	0	0	60000	1731
5)	1989	0	0	0	60000	1913
6)	1990	0	0	0	60000	2094
7)	1991	0	0	0	60000	2212
8)	1992	0	264000	384000	60000	2319
9)	1993	0	0	0	60000	2413
10)	1994	0	0	0	60000	2413
11)	1995	0	0	0	60000	2509
12)	1996	0	0	0	60000	2509
13)	1997	0	0	0	60000	2610
14)	1998	0	0	0	60000	2718
15)	1999	0	0	0	60000	2844
16)	2000	0	0	0	60000	2844
17)	2001	0	0	0	60000	2844
18)	2002	0	528000	1152000	60000	2844
19)	2003	0	0	0	60000	2844
20)	2004	0	0	0	60000	2844
21)	2005	0	0	0	60000	2844
22)	2006	0	0	0	60000	2844
23)	2007	0	264000	384000	60000	2844
24)	2008	0	0	0	60000	2844
25)	2009	0	0	0	60000	2844
26)	2010	0	0	0	60000	2844
27)	2011	0	0	0	60000	2844
28)	2012	0	0	0	60000	2844
29)	2013	0	0	0	60000	2844
30)	2014	0	0	0	60000	2844
31)	2015	0	0	0	60000	2844
32)	2016	0	0	0	60000	2844
33)	2017	0	528000	1152000	60000	2844
34)	2018	0	0	0	60000	2844
35)	2019	0	0	0	60000	2844
36)	2020	0	0	0	60000	2844
37)	2021	0	0	0	60000	2844
38)	2022	0	264000	384000	60000	2844
39)	2023	0	0	0	60000	2844
40)	2024	0	0	0	60000	2844
41)	2025	0	0	0	60000	2844
42)	2026	0	0	0	60000	2844
43)	2027	0	0	0	60000	2844
44)	2028	0	0	0	60000	2844
45)	2029	0	-300960	-545280	60000	2844

		ELCT REVENUE	MWH DSL ONLY	MWH DSL W/HY	D ONLY OM	D W/HY OM
1)	Y-1985	0	0	0	0	0
2)	Y-1986	0	0	0	0	0
3)	Y-1987	0	0	0	0	0
4)	1988	36351	59568	42212	967245	676134
5)	1989	40173	59568	42394	983481	690445
6)	1990	43974	59568	42575	1000010	705049
7)	1991	46452	59568	42693	1016837	718961
8)	1992	48699	59568	42800	1033966	732977
9)	1993	50673	59568	42894	1051403	747063
10)	1994	50673	59568	42990	1069155	761463
11)	1995	52689	59568	43091	1087226	776238
12)	1996	52689	59568	43199	1105622	791432
13)	1997	54810	59568	43325	1124350	807254
14)	1998	57078	59568	43325	1124350	807254
15)	1999	59724	59568	43325	1124350	807254
16)	2000	59724	59568	43325	1124350	807254
17)	2001	59724	59568	43325	1124350	807254
18)	2002	59724	59568	43325	1124350	807254
19)	2003	59724	59568	43325	1124350	807254
20)	2004	59724	59568	43325	1124350	807254
21)	2005	59724	59568	43325	1124350	807254
22)	2006	59724	59568	43325	1124350	807254
23)	2007	59724	59568	43325	1124350	807254
24)	2008	59724	59568	43325	1124350	807254
25)	2009	59724	59568	43325	1124350	807254
26)	2010	59724	59568	43325	1124350	807254
27)	2011	59724	59568	43325	1124350	807254
28)	2012	59724	59568	43325	1124350	807254
29)	2013	59724	59568	43325	1124350	807254
30)	2014	59724	59568	43325	1124350	807254
31)	2015	59724	59568	43325	1124350	807254
32)	2016	59724	59568	43325	1124350	807254
33)	2017	59724	59568	43325	1124350	807254
34)	2018	59724	59568	43325	1124350	807254
35)	2019	59724	59568	43325	1124350	807254
36)	2020	59724	59568	43325	1124350	807254
37)	2021	59724	59568	43325	1124350	807254
38)	2022	59724	59568	43325	1124350	807254
39)	2023	59724	59568	43325	1124350	807254
40)	2024	59724	59568	43325	1124350	807254
41)	2025	59724	59568	43325	1124350	807254
42)	2026	59724	59568	43325	1124350	807254
43)	2027	59724	59568	43325	1124350	807254
44)	2028	59724	59568	43325	1124350	807254
45)	2029	59724	59568	43325	1124350	807254

		COST SAVING	BENEFIT	COST	CASH FLOW
1)	Y-1985	0	0	1281000	-1281000
2)	Y-1986	0	0	1968000	-1968000
3)	Y-1987	0	0	-457000	457000
4)	1988	231111	267462	356000	-88538
5)	1989	233036	273209	0	273209
6)	1990	234961	278935	0	278935
7)	1991	237876	284328	0	284328
8)	1992	240989	289688	-120000	409688
9)	1993	244341	295014	0	295014
10)	1994	247692	298365	0	298365
11)	1995	250988	303677	0	303677
12)	1996	254190	306879	0	306879
13)	1997	257096	311906	0	311906
14)	1998	257096	314174	0	314174
15)	1999	257096	316820	0	316820
16)	2000	257096	316820	0	316820
17)	2001	257096	316820	0	316820
18)	2002	257096	316820	-624000	940820
19)	2003	257096	316820	0	316820
20)	2004	257096	316820	0	316820
21)	2005	257096	316820	0	316820
22)	2006	257096	316820	0	316820
23)	2007	257096	316820	-120000	436820
24)	2008	257096	316820	0	316820
25)	2009	257096	316820	0	316820
26)	2010	257096	316820	0	316820
27)	2011	257096	316820	0	316820
28)	2012	257096	316820	0	316820
29)	2013	257096	316820	0	316820
30)	2014	257096	316820	0	316820
31)	2015	257096	316820	0	316820
32)	2016	257096	316820	0	316820
33)	2017	257096	316820	-624000	940820
34)	2018	257096	316820	0	316820
35)	2019	257096	316820	0	316820
36)	2020	257096	316820	0	316820
37)	2021	257096	316820	0	316820
38)	2022	257096	316820	-120000	436820
39)	2023	257096	316820	0	316820
40)	2024	257096	316820	0	316820
41)	2025	257096	316820	0	316820
42)	2026	257096	316820	0	316820
43)	2027	257096	316820	0	316820
44)	2028	257096	316820	0	316820
45)	2029	257096	316820	244320	72500

INTERNAL RATE OF RETURN IS 1.090402494952135
PRESENT VALUE IS -.061395883560180066

VIII. ECONOMIC ANALYSIS

CHAPTER VIII ECONOMIC ANALYSIS

8.1 Approach

Financial analysis focuses on profitability of project implementation itself while economic analysis on the other hand, studies the degree of benefit to the national economy resulting from project implementation. As in financial analysis, benefit and cost are estimated first. In financial analysis, however, the same are expressed in terms of market price while in economic analysis they are expressed in terms of economic value (shadow price).

The economic benefit of electric power projects is actually the marginal value or productivity of economic activity arising from power output and the value of efficiency. It is almost impossible however, to quantify power output benefit in such terms especially for the latter. Accordingly, in lieu of the above, the cost of the second best alternative plan is often adopted as project benefit using the so-called "alternative facilities method" in many feasibility studies in Japan. The above calculation method is an application of the opportunity cost concept in which cost input into one project can be transferred to another project, thereby obtaining a different benefit.

In this Project, for example, benefit arising from implementation of a hydropower plan (With Project) should be compared to benefit which can be obtained by investing the same costs in other different types of opportunities (Without Project). In the "alternative facilities method", however, the cost for the alternative plan is not invested in other economic activities but in the same activities, and consequently this cost can not logically be considered as economic benefit. In this economic analysis therefore, as in financial analysis, benefit was divided into two kinds, economic prices of the savings in the case of Rio Tuba Mine's own use, and PALECO revenues from sale of electricity to rural residents in the case of rural electrification as explained below.

Actual quantification of effeciency for electric power use is impossible. A common method of estimating the same is the consumer's willingness to pay (WTP). However, for accurate evaluation of WTP, an interview survey, informing people of the efficiency of electricity, should be conducted, which is a difficult task to accomplish in a limited period of time. On the other hand, except for those households which must bear the cost of long extension lines, the majority of households within electrified areas are being served by PALECO and there is no particular problem for PALECO in collection of system rates. In Brookes Point Municipality, for example, 97% of residential consumers pay their system rates at a fixed time. From this fact it can be assumed that the current rates are equivalent to or less than the willingness to pay for the residential consumer.

In addition, areas to be covered by this Project are unelectrified excluding a part of Brookes Paint Municipality and the Rio Tuba Town Site, and almost all households use oil lamps for lighting and about 60% have transistor radios. Price of kerosene required for the lamps averages ₱3.3 (¥55) per 0.375ℓ according to the data collected in Sitios and Barangays, while minimum consumption is 1.6ℓ/month for 2-3 hours use per day, and, average purchase and cost reaches about 3.0ℓ/month and about ₱26.4/month (about ¥438/month), respectively. Battery consumption, moreover, averages approximately 5 batteries/month at about ₱3/battery, or a total monthly expenditure of ₱15. Kerosene and batteries are purchased at kiosks or weekly markets on specific days and some people must walk several kilometers to purchase the same.

In comparison to the above, minimum PALECO system rates as of March '84 were ₱31.10 (up to 12kWh) and few households are paying more than the minimum rates. Conversion from present kerosene and battery consumption to electricity will thus result in real and significant savings and sufficient willingness to pay may therefore also be assumed.

8.2 Benefit Estimates

8.2.1 Benefit for Rio Tuba Mine Use

As previously stated, benefit was expressed as the economic value of the savings in O & M costs. The majority of O & M costs consist of diesel fuel and its economic value is given in border prices. The Philippines has a large petroleum refining capacity, producing for both domestic consumption and an equivalent amount on consignment for PERTAMINA, the national oil company of Indonesia. Accordingly, FOB rather than CIF prices are most appropriate for diesel border prices. FOB diesel prices in the Philippines are approximately US$1 less per barrel (about 159ℓ) than international prices (Singapore price) the average prices of which is US$31.20/barrel as of February 1984[1/].

Although savings also occur in cost of lubricating oil and maintenance, the above are insignificant in comparison with costs of diesel fuel and can therefore be disregarded.

8.2.2 Residential Supply Benefit

Benefit of the proposed rural electrification was generally esimated as willingness to pay reflected by revenues from PALECO system rates. As the PALECO unit rate for residential consumers in economic analysis is estimated at ¥43.0/kWh (₱2.59/kWh) versus the purchase rate of ¥21.0/kWh (₱1.27kWh) from the Rio Tuba Mining Corp., a unit rate more than twice that of the financial analysis may be obtained, indicating a substantial benefit to the national economy.

8.3 Cost Estimates

Economic costs, as stated previously, are the difference in costs between construction of the hydropower generation plant (including auxiliary diesel generation) and the alternative diesel generation plant, expressed in terms of economic prices. Construction costs are divided into those paid in foreign currencies, and those paid in domestic currencies such as labor, fuel, etc. which are procured domestically. In principle, a portion of the Project will be in Japanese yen which is assumed to reflect economic price in a free competitive market. Distortion of market prices is presumed for the domestic portion, on the other hand, and shadow prices are used to convert to economic prices as presented below.

1/ Platt's Oilgram Price Report, Vol. 62 No. 33, Mcgraw-Hill Inc., N.Y., P6-A.

8.3.1 Tax

In economic analysis, taxes are regarded simply as the transfer of resources within the country itself and are therefore deducted from cost. As the Rio Tuba Mining Corp. is an export oriented enterprise and as the objective of the present plan is conversion of energy generation to non-oil consuming sources, the Project is exempted from import duties on capital goods according to Presidential Decree No.1789. Taxes for the present Project are, therefore, not included within costs for financial evaluation and conversion of the same to economic price is unnecessary.

8.3.2 Exchange Rate

Due to political and economic uncertainties, fluctuation in the exchange rate within the Philippines is rather large. A shadow exchange rate rather than the official rate is therefore used to convert domestic currency to foreign currency for economic analysis. Although the shadow exchange rate is obtained by a weighted average of past import-export duties and subsidies from the past few years, statistical data during the present study period was available only up to September '83, after which period the Philippine economy underwent significant change. Consequently, the shadow exchange rate derived by the above method will naturally vary from the exchange rate of February '84. For this reason, the shadow exchange rate used by NEDA (official rate x standard conversion factor of 1.2)[1/] was adopted for the present Study as follows: US$1 = ₱1, 4 x 1.2 = ₱16.8.

8.3.3 Labor Wage

Shadow wages are also used for unskilled labor. NEDA multiplies real wages by a coefficient of 0.80 to obtain shadow wages for unskilled labor. The above coefficient however, is the average for the entire country rather than for Palawan Island where underemployment is higher than average, and a lower coefficient should be required for opportunity costs of laborers.

1/ As explained by NEDA in a meeting of NEDA, Economic Staff and Infrastructure Staff on February 17, 1984.

Unskilled laborers on Palawan Island also receive the minimum wage fixed by the Philippine Government when they are hired as seasonal or day labor, and the total minimum wage is equivalent to ₱38 per day (minimum wage ₱20 plus daily allowances ₱18 per day). The Rio Tuba Mine employs about 480 unskilled laborers on a regular basis, and a monthly average of 70 unskilled laborers are employed on a seasonal basis. A survey of seasonal employees revealed that they were employed by the Mine for an average of three months per year with a total income of approximately ₱1,500 per person. Income for the remaining 9 months is derived from the sale of bananas, bamboo, chickens, etc., at the market, amounting to less than ₱100.

Seasonal employees are still more fortunate however, than those who are not employed as the majority of able workers are engaged in low household agricultural production. Non-cash economic activities such as fishing and hunting for supplementary food supply are also common. Accordingly, opportunity cost for unskilled labor in the present Report has been determined at an average of ₱1,500/year, with 300 working days a year and a ₱5/day shadow wage. The coefficient used therefore, is 0.13 rather than the NEDA value of 0.80.

8.3.4 Land

The proposed Project dam site is located on public land with no residences in the reservoir area, while, except for an application fee to NWRC for hydropower development, no payment to the government is required for the Project. For these reasons land acquisition and compensation costs were not included in calculations for the financial analysis of the present Report.

In economic evaluation, economic price is given by the opportunity cost of land or marginal productivities of land. The total area for reservoir pondage, temporary access roads, building etc. for the present Project is approximately 100,000m^2. The majority of the said area is unused jungle and accordingly any losses in economic land value due to temporary roads or ponding may be disregarded. Any items other than the above, such as use of temporary roads by local residents, should be regarded as benefit rather than loss. In the present Report therefore, economic losses related to land use were regarded as minimal, offset by potential benefits and accordingly, as in financial analysis, land costs were regarded as zero.

8.3.5 Fuel

About 17% of domestic portions or costs for civil works consist of fuel costs. As in 8.2 above, the conversion of fuels to economic costs was performed by using border prices which were equivalent to the FOB price of US$31.20/barrel.

8.4 Economic Internal Rate of Return (EIRR)

The EIRR for each case was calculated as follows according to the basic approach discussed above while details of the same are presented in TABLE 8-1 (1 to 9):

Case-1	Substitution of Existing Diesel Generator	:	5.7%
Case-2	Peak Load 3,600kW	:	10.1
Case-3	Peak Load 9,500kW	:	11.6

THREE CASE STUDIES FOR EIRR

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######################### CASE 1 EIRR##################################

		HYDRO INV	DEISEL W/ HY	DIESEL ONLY	HYDRO OM	ELCTRICITY
1)	Y-1985	999000	0	0	0	0
2)	Y-1986	1671000	0	0	0	0
3)	Y-1987	179000	0	0	0	0
4)	1988	285000	0	0	49000	1731
5)	1989	0	0	0	49000	1913
6)	1990	0	0	0	49000	2094
7)	1991	0	0	0	49000	2212
8)	1992	0	0	305700	49000	2319
9)	1993	0	0	0	49000	2413
10)	1994	0	0	0	49000	2413
11)	1995	0	0	0	49000	2509
12)	1996	0	0	0	49000	2509
13)	1997	0	100300	0	49000	2610
14)	1998	0	0	0	49000	2718
15)	1999	0	0	0	49000	2844
16)	2000	0	0	0	49000	2844
17)	2001	0	0	0	49000	2844
18)	2002	0	0	0	49000	2844
19)	2003	0	0	0	49000	2844
20)	2004	0	0	0	49000	2844
21)	2005	0	0	0	49000	2844
22)	2006	0	0	0	49000	2844
23)	2007	0	0	305700	49000	2844
24)	2008	0	0	0	49000	2844
25)	2009	0	0	0	49000	2844
26)	2010	0	0	0	49000	2844
27)	2011	0	0	0	49000	2844
28)	2012	0	0	0	49000	2844
29)	2013	0	0	0	49000	2844
30)	2014	0	0	0	49000	2844
31)	2015	0	0	0	49000	2844
32)	2016	0	0	0	49000	2844
33)	2017	0	100300	0	49000	2844
34)	2018	0	0	0	49000	2844
35)	2019	0	0	0	49000	2844
36)	2020	0	0	0	49000	2844
37)	2021	0	0	0	49000	2844
38)	2022	0	0	305700	49000	2844
39)	2023	0	0	0	49000	2844
40)	2024	0	0	0	49000	2844
41)	2025	0	0	0	49000	2844
42)	2026	0	0	0	49000	2844
43)	2027	0	0	0	49000	2844
44)	2028	0	0	0	49000	2844
45)	2029	0	-46138	-177310	49000	2844

Table 8-1
1 of 9

		ELCT REVENUE	MWH DSL ONLY	MWH DSL W/HY	D ONLY OM	D W/HY OM
1)	Y-1985	0	0	0	0	0
2)	Y-1986	0	0	0	0	0
3)	Y-1987	0	0	0	0	0
4)	1988	74433	59568	42212	804878	561075
5)	1989	82259	59568	42394	818193	572811
6)	1990	90042	59568	42575	831746	584786
7)	1991	95116	59568	42693	845544	596193
8)	1992	99717	59568	42800	859590	607687
9)	1993	103759	59568	42894	873889	619237
10)	1994	103759	59568	42990	888445	631045
11)	1995	107887	59568	43091	903263	643161
12)	1996	107887	59568	43199	918348	655620
13)	1997	112230	59568	43325	933705	668593
14)	1998	116874	59568	43325	933705	668593
15)	1999	122292	59568	43325	933705	668593
16)	2000	122292	59568	43325	933705	668593
17)	2001	122292	59568	43325	933705	668593
18)	2002	122292	59568	43325	933705	668593
19)	2003	122292	59568	43325	933705	668593
20)	2004	122292	59568	43325	933705	668593
21)	2005	122292	59568	43325	933705	668593
22)	2006	122292	59568	43325	933705	668593
23)	2007	122292	59568	43325	933705	668593
24)	2008	122292	59568	43325	933705	668593
25)	2009	122292	59568	43325	933705	668593
26)	2010	122292	59568	43325	933705	668593
27)	2011	122292	59568	43325	933705	668593
28)	2012	122292	59568	43325	933705	668593
29)	2013	122292	59568	43325	933705	668593
30)	2014	122292	59568	43325	933705	668593
31)	2015	122292	59568	43325	933705	668593
32)	2016	122292	59568	43325	933705	668593
33)	2017	122292	59568	43325	933705	668593
34)	2018	122292	59568	43325	933705	668593
35)	2019	122292	59568	43325	933705	668593
36)	2020	122292	59568	43325	933705	668593
37)	2021	122292	59568	43325	933705	668593
38)	2022	122292	59568	43325	933705	668593
39)	2023	122292	59568	43325	933705	668593
40)	2024	122292	59568	43325	933705	668593
41)	2025	122292	59568	43325	933705	668593
42)	2026	122292	59568	43325	933705	668593
43)	2027	122292	59568	43325	933705	668593
44)	2028	122292	59568	43325	933705	668593
45)	2029	122292	59568	43325	933705	668593

		COST SAVING	BENEFIT	COST	CASH FLOW
1)	Y-1985	0	0	999000	-999000
2)	Y-1986	0	0	1671000	-1671000
3)	Y-1987	0	0	179000	-179000
4)	1988	44857	119290	285000	-165710
5)	1989	48964	131223	0	131223
6)	1990	53394	143436	0	143436
7)	1991	58203	153319	0	153319
8)	1992	63423	163140	-305700	468840
9)	1993	69072	172831	0	172831
10)	1994	75215	178974	0	178974
11)	1995	81889	189776	0	189776
12)	1996	89165	197052	0	197052
13)	1997	97070	209300	100300	109000
14)	1998	97070	213944	0	213944
15)	1999	97070	219362	0	219362
16)	2000	97070	219362	0	219362
17)	2001	97070	219362	0	219362
18)	2002	97070	219362	0	219362
19)	2003	97070	219362	0	219362
20)	2004	97070	219362	0	219362
21)	2005	97070	219362	0	219362
22)	2006	97070	219362	0	219362
23)	2007	97070	219362	-305700	525062
24)	2008	97070	219362	0	219362
25)	2009	97070	219362	0	219362
26)	2010	97070	219362	0	219362
27)	2011	97070	219362	0	219362
28)	2012	97070	219362	0	219362
29)	2013	97070	219362	0	219362
30)	2014	97070	219362	0	219362
31)	2015	97070	219362	0	219362
32)	2016	97070	219362	0	219362
33)	2017	97070	219362	100300	119062
34)	2018	97070	219362	0	219362
35)	2019	97070	219362	0	219362
36)	2020	97070	219362	0	219362
37)	2021	97070	219362	0	219362
38)	2022	97070	219362	-305700	525062
39)	2023	97070	219362	0	219362
40)	2024	97070	219362	0	219362
41)	2025	97070	219362	0	219362
42)	2026	97070	219362	0	219362
43)	2027	97070	219362	0	219362
44)	2028	97070	219362	0	219362
45)	2029	97070	219362	131172	88190

INTERNAL RATE OF RETURN IS 1.056883005194288
PRESENT VALUE IS -1.3589859008789060-04
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@@@@@@@@@@@@@@@@@@@@@@@  FIRR CALCULATION  @@@@@@@@@@@@@@@@@@@@@@@@@@
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########################CASE2      EIRR--###############################

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No.	Year	HYDRO INV	DEISEL W/ HY	DIESEL ONLY	HYDRO OM	ELCTRICITY
1)	Y-1985	999000	0	0	0	0
2)	Y-1986	1671000	0	0	0	0
3)	Y-1987	210000	0	402800	0	0
4)	1988	0	0	0	49000	1731
5)	1989	0	0	0	49000	1913
6)	1990	0	0	0	49000	2094
7)	1991	0	0	0	49000	2212
8)	1992	0	0	265200	49000	2319
9)	1993	0	0	0	49000	2413
10)	1994	0	0	0	49000	2413
11)	1995	0	0	0	49000	2509
12)	1996	0	0	0	49000	2509
13)	1997	0	100300	0	49000	2610
14)	1998	0	0	0	49000	2718
15)	1999	0	0	0	49000	2844
16)	2000	0	0	0	49000	2844
17)	2001	0	0	0	49000	2844
18)	2002	0	0	322300	49000	2844
19)	2003	0	0	0	49000	2844
20)	2004	0	0	0	49000	2844
21)	2005	0	0	0	49000	2844
22)	2006	0	0	0	49000	2844
23)	2007	0	0	265200	49000	2844
24)	2008	0	0	0	49000	2844
25)	2009	0	0	0	49000	2844
26)	2010	0	0	0	49000	2844
27)	2011	0	0	0	49000	2844
28)	2012	0	0	0	49000	2844
29)	2013	0	0	0	49000	2844
30)	2014	0	0	0	49000	2844
31)	2015	0	0	0	49000	2844
32)	2016	0	0	0	49000	2844
33)	2017	0	100300	322300	49000	2844
34)	2018	0	0	0	49000	2844
35)	2019	0	0	0	49000	2844
36)	2020	0	0	0	49000	2844
37)	2021	0	0	0	49000	2844
38)	2022	0	0	265200	49000	2844
39)	2023	0	0	0	49000	2844
40)	2024	0	0	0	49000	2844
41)	2025	0	0	0	49000	2844
42)	2026	0	0	0	49000	2844
43)	2027	0	0	0	49000	2844
44)	2028	0	0	0	49000	2844
45)	2029	0	-46138	-244060	49000	2844

		ELCT REVENUE	MWH DSL ONLY	MWH DSL W/HY	D_ONLY OM	D_W/HY OM
1)	Y-1985	0	0	0	0	0
2)	Y-1986	0	0	0	0	0
3)	Y-1987	0	0	0	0	0
4)	1988	74433	19645	2289	280856	57232
5)	1989	82259	19645	2471	285247	60669
6)	1990	90042	19645	2652	289717	64202
7)	1991	95116	19645	2770	294267	66842
8)	1992	99717	19645	2877	298899	69384
9)	1993	103759	19645	2971	303615	71787
10)	1994	103759	19645	3067	308416	74295
11)	1995	107887	19645	3168	313303	76964
12)	1996	107887	19645	3276	318277	79835
13)	1997	112230	19645	3402	323342	83111
14)	1998	116874	19645	3402	323342	83111
15)	1999	122292	19645	3402	323342	83111
16)	2000	122292	19645	3402	323342	83111
17)	2001	122292	19645	3402	323342	83111
18)	2002	122292	19645	3402	323342	83111
19)	2003	122292	19645	3402	323342	83111
20)	2004	122292	19645	3402	323342	83111
21)	2005	122292	19645	3402	323342	83111
22)	2006	122292	19645	3402	323342	83111
23)	2007	122292	19645	3402	323342	83111
24)	2008	122292	19645	3402	323342	83111
25)	2009	122292	19645	3402	323342	83111
26)	2010	122292	19645	3402	323342	83111
27)	2011	122292	19645	3402	323342	83111
28)	2012	122292	19645	3402	323342	83111
29)	2013	122292	19645	3402	323342	83111
30)	2014	122292	19645	3402	323342	83111
31)	2015	122292	19645	3402	323342	83111
32)	2016	122292	19645	3402	323342	83111
33)	2017	122292	19645	3402	323342	83111
34)	2018	122292	19645	3402	323342	83111
35)	2019	122292	19645	3402	323342	83111
36)	2020	122292	19645	3402	323342	83111
37)	2021	122292	19645	3402	323342	83111
38)	2022	122292	19645	3402	323342	83111
39)	2023	122292	19645	3402	323342	83111
40)	2024	122292	19645	3402	323342	83111
41)	2025	122292	19645	3402	323342	83111
42)	2026	122292	19645	3402	323342	83111
43)	2027	122292	19645	3402	323342	83111
44)	2028	122292	19645	3402	323342	83111
45)	2029	122292	19645	3402	323342	83111

		COST SAVING	BENEFIT	COST	CASH FLOW
1)	Y-1985	0	0	999000	-999000
2)	Y-1986	0	0	1671000	-1671000
3)	Y-1987	0	0	-192800	192800
4)	1988	174624	249057	0	249057
5)	1989	175578	257837	0	257837
6)	1990	176515	266557	0	266557
7)	1991	178425	273541	0	273541
8)	1992	180516	280233	-265200	545433
9)	1993	182828	286587	0	286587
10)	1994	185120	288879	0	288879
11)	1995	187338	295225	0	295225
12)	1996	189443	297330	0	297330
13)	1997	191230	303460	100300	203160
14)	1998	191230	308104	0	308104
15)	1999	191230	313522	0	313522
16)	2000	191230	313522	0	313522
17)	2001	191230	313522	0	313522
18)	2002	191230	313522	-322300	635822
19)	2003	191230	313522	0	313522
20)	2004	191230	313522	0	313522
21)	2005	191230	313522	0	313522
22)	2006	191230	313522	0	313522
23)	2007	191230	313522	-265200	578722
24)	2008	191230	313522	0	313522
25)	2009	191230	313522	0	313522
26)	2010	191230	313522	0	313522
27)	2011	191230	313522	0	313522
28)	2012	191230	313522	0	313522
29)	2013	191230	313522	0	313522
30)	2014	191230	313522	0	313522
31)	2015	191230	313522	0	313522
32)	2016	191230	313522	0	313522
33)	2017	191230	313522	-222000	535522
34)	2018	191230	313522	0	313522
35)	2019	191230	313522	0	313522
36)	2020	191230	313522	0	313522
37)	2021	191230	313522	0	313522
38)	2022	191230	313522	-265200	578722
39)	2023	191230	313522	0	313522
40)	2024	191230	313522	0	313522
41)	2025	191230	313522	0	313522
42)	2026	191230	313522	0	313522
43)	2027	191230	313522	0	313522
44)	2028	191230	313522	0	313522
45)	2029	191230	313522	197922	115600

INTERNAL RATE OF RETURN IS 1.100588888454755
PRESENT VALUE IS -.0166581869125366?

@@@@@@@@@@@@@@@@@@@@@@@ FILE PRINT OUT @@@@@@@@@@@@@@@@@@@@@@@@@@@@DATE/59/07/07 TIME/17:31:07 FILE NAME/PA1A F3

######################### CASE 3 EIRR--################################

		HYDRO INV	DEISEL W/ HY	DIESEL ONLY	HYDRO OM	ELCTRICITY
1)	Y-1985	999000	0	0	0	0
2)	Y-1986	1671000	0	0	0	0
3)	Y-1987	179000	562600	1227500	0	0
4)	1988	285000	0	0	49000	1731
5)	1989	0	0	0	49000	1913
6)	1990	0	0	0	49000	2094
7)	1991	0	0	0	49000	2212
8)	1992	0	250000	363700	49000	2319
9)	1993	0	0	0	49000	2413
10)	1994	0	0	0	49000	2413
11)	1995	0	0	0	49000	2509
12)	1996	0	0	0	49000	2509
13)	1997	0	0	0	49000	2610
14)	1998	0	0	0	49000	2718
15)	1999	0	0	0	49000	2844
16)	2000	0	0	0	49000	2844
17)	2001	0	0	0	49000	2844
18)	2002	0	450000	1091100	49000	2844
19)	2003	0	0	0	49000	2844
20)	2004	0	0	0	49000	2844
21)	2005	0	0	0	49000	2844
22)	2006	0	0	0	49000	2844
23)	2007	0	250000	363700	49000	2844
24)	2008	0	0	0	49000	2844
25)	2009	0	0	0	49000	2844
26)	2010	0	0	0	49000	2844
27)	2011	0	0	0	49000	2844
28)	2012	0	0	0	49000	2844
29)	2013	0	0	0	49000	2844
30)	2014	0	0	0	49000	2844
31)	2015	0	0	0	49000	2844
32)	2016	0	0	0	49000	2844
33)	2017	0	450000	1091100	49000	2844
34)	2018	0	0	0	49000	2844
35)	2019	0	0	0	49000	2844
36)	2020	0	0	0	49000	2844
37)	2021	0	0	0	49000	2844
38)	2022	0	250000	363700	49000	2844
39)	2023	0	0	0	49000	2844
40)	2024	0	0	0	49000	2844
41)	2025	0	0	0	49000	2844
42)	2026	0	0	0	49000	2844
43)	2027	0	0	0	49000	2844
44)	2028	0	0	0	49000	2844
45)	2029	0	-271000	-407350	49000	2844

		ELCT REVENUE	MWH DSL ONLY	MWH DSL W/HY	D ONLY OM	D W/HY OM
1)	Y-1985	0	0	0	0	0
2)	Y-1986	0	0	0	0	0
3)	Y-1987	0	0	0	0	0
4)	1988	74433	6150	252	107369	13512
5)	1989	82259	6339	252	111552	13587
6)	1990	90042	6542	252	116058	13664
7)	1991	95116	6762	252	120945	13742
8)	1992	99717	7000	252	126244	13821
9)	1993	103759	7256	252	131974	13901
10)	1994	103759	7533	252	138199	13984
11)	1995	107887	7832	252	144956	14067
12)	1996	107887	8156	252	152318	14152
13)	1997	112230	8505	252	160309	14239
14)	1998	116874	8505	252	160309	14239
15)	1999	122292	8505	252	160309	14239
16)	2000	122292	8505	252	160309	14239
17)	2001	122292	8505	252	160309	14239
18)	2002	122292	8505	252	160309	14239
19)	2003	122292	8505	252	160309	14239
20)	2004	122292	8505	252	160309	14239
21)	2005	122292	8505	252	160309	14239
22)	2006	122292	8505	252	160309	14239
23)	2007	122292	8505	252	160309	14239
24)	2008	122292	8505	252	160309	14239
25)	2009	122292	8505	252	160309	14239
26)	2010	122292	8505	252	160309	14239
27)	2011	122292	8505	252	160309	14239
28)	2012	122292	8505	252	160309	14239
29)	2013	122292	8505	252	160309	14239
30)	2014	122292	8505	252	160309	14239
31)	2015	122292	8505	252	160309	14239
32)	2016	122292	8505	252	160309	14239
33)	2017	122292	8505	252	160309	14239
34)	2018	122292	8505	252	160309	14239
35)	2019	122292	8505	252	160309	14239
36)	2020	122292	8505	252	160309	14239
37)	2021	122292	8505	252	160309	14239
38)	2022	122292	8505	252	160309	14239
39)	2023	122292	8505	252	160309	14239
40)	2024	122292	8505	252	160309	14239
41)	2025	122292	8505	252	160309	14239
42)	2026	122292	8505	252	160309	14239
43)	2027	122292	8505	252	160309	14239
44)	2028	122292	8505	252	160309	14239
45)	2029	122292	8505	252	160309	14239

		COST SAVING	BENEFIT	COST	CASH FLOW
1)	Y-1985	0	0	999000	-999000
2)	Y-1986	0	0	1671000	-1671000
3)	Y-1987	0	0	-485900	485900
4)	1988	194803	269236	285000	-15764
5)	1989	196382	278641	0	278641
6)	1990	197960	288002	0	288002
7)	1991	200351	295467	0	295467
8)	1992	202903	302620	-113700	416320
9)	1993	205652	309411	0	309411
10)	1994	208399	312158	0	312158
11)	1995	211102	318989	0	318989
12)	1996	213728	321615	0	321615
13)	1997	216111	328341	0	328341
14)	1998	216111	332985	0	332985
15)	1999	216111	338403	0	338403
16)	2000	216111	338403	0	338403
17)	2001	216111	338403	0	338403
18)	2002	216111	338403	-641100	979503
19)	2003	216111	338403	0	338403
20)	2004	216111	338403	0	338403
21)	2005	216111	338403	0	338403
22)	2006	216111	338403	0	338403
23)	2007	216111	338403	-113700	452103
24)	2008	216111	338403	0	338403
25)	2009	216111	338403	0	338403
26)	2010	216111	338403	0	338403
27)	2011	216111	338403	0	338403
28)	2012	216111	338403	0	338403
29)	2013	216111	338403	0	338403
30)	2014	216111	338403	0	338403
31)	2015	216111	338403	0	338403
32)	2016	216111	338403	0	338403
33)	2017	216111	338403	-641100	979503
34)	2018	216111	338403	0	338403
35)	2019	216111	338403	0	338403
36)	2020	216111	338403	0	338403
37)	2021	216111	338403	0	338403
38)	2022	216111	338403	-113700	452103
39)	2023	216111	338403	0	338403
40)	2024	216111	338403	0	338403
41)	2025	216111	338403	0	338403
42)	2026	216111	338403	0	338403
43)	2027	216111	338403	0	338403
44)	2028	216111	338403	0	338403
45)	2029	216111	338403	136350	202053

INTERNAL RATE OF RETURN IS 1.11584908005984
PRESENT VALUE IS -.03648769855499268

IX. INDIRECT PROJECT EFFECTS

CHAPTER IX INDIRECT PROJECT EFFECTS

9.1 Introduction

One of the major disparities between the life styles of people in developed countries versus those in developing countries is the wide distribution of domestic electrical networks in the former which serve not only urban but rural areas as well. Electrification and rural development are closely interrelated. The Philippines however is presently highly dependent on oil as an energy source which, due to world inflation, hinders reduction in electrical utility fees and thus the spread of electrical facilities to less affluent rural areas. To reduce costs and promote rural electrification therefore, it is necessary to develop domestic energy sources such as hydropower, geothermal power, etc. The proposed Project will accordingly be designed to have substantial effects on rural communities as described below.

9.2 Effect on Productivity of Plain, Mountain and Fishing Villages

Upon review of local data and spot field survey, the possible effect on productivity of plain, mountain and fishing villages by extension of the power network can be listed as follows:

a) overall improvement in agricultural system management through use of well and irrigation pumps;

b) preservation of perishable agricultural produce by refrigeration;

c) development of fish farms by installation of pump facilities;

d) development of light industries such as lumber mills, flour mills, etc. through electricity; and,

e) storage of catched fish by refrigeration.

The increase in income and stabilization of the rural economy resulting from the above effects will in turn contribute to increased employment opportunities.

9.3 Improvement of Non-Agricultural Sector and Socio-Economy

It is also apparent that with the provision of adequate power supply, improvement of the non-agricultural sector and socio-economy would occur in the following ways:

a) increased development of industries and income from the same through use of electricity;

b) increased participation of women in society and the work force as a result of electrification and consequent decrease in time required for housework, etc.; and

c) intensification of production from light industries and commerce.

9.4 Improvement of Living Environment in Rural Areas

The following improvements in the conditions of rural areas are also expected:

a) potential use of limited educational facilities for evening classes;

b) increased use of audio-visual materials in educational programs, and expansion of media and information transfer;

c) improved public sanitation and medical services through electrical illumination and refrigeration of medicines; and,

d) reduction in crime due to electrical lighting at night.

9.5 Effect on National Economy

The effect on the national economy can be estimated as follows:

a) increased national stability and reduction of dependency on foreign capital due to decreased oil imports;

b) promotion of rural development and improvement of the service sector for rural residents due to strengthened rural economy and increased income; and,

c) decreased migration of rural population to urban areas.

9.6 Effect of Dam Construction on Erosion

At present, devastation of downstream lowland areas is a major problem in the Project area due to annually increasing riverbed deposits. Construction of the proposed regulating pondage dam upstream will arrest sediment deposits arising from flood discharge and result in a drop in the riverbed and increased river stabilization. This will in turn allow possible agricultural development of a larger level area downstream.

Although it is difficult to measure the above effects numerically, EIRR calculations were carried out with all figures calculated on the safe side.

APPENDIX

A P P E N D I X I

TECHNICAL REPORT

CONTENTS

Page

ILLUSTRATIONS

LIST OF TABLES