Republic of Cape Verde
Ministry of Tourism, Industry and Energy

Power Transmission and Distribution System Development Project in The Republic of Cape Verde

Final Report (Summary)

July 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

Chubu Electric Power Co., Inc.

Preface

In response to the request from the Government of the Republic of Cape Verde, the Government of Japan decided to conduct the "Power Transmission and Distribution System Development Project in The Republic of Cape Verde" and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent a Study Team, led by Mr. Keiji SHIRAKI and organized by Chubu Electric Power Co., Inc. to Cape Verde three times from November 2009 to May 2010.

The Team held a series of discussions with officials from the Ministry of Tourism, Industry and Energy and conducted related field surveys. After returning to Japan, the Team conducted further studies and compiled the final results in this report.

I hope that the report will contribute to the development of power system facilities, stable power supply in Cape Verde, and the enhancement of amity between our two countries.

I would also like to express my sincere appreciation to the officials concerned for their close cooperation throughout the Study.

July 2010

Atsuo KURODA
Vice President
Japan International Cooperation Agency

July 2010

Atsuo KURODA
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the final report for the "Power Transmission and Distribution System Development Project in The Republic of Cape Verde".

The study was implemented by Chubu Electric Power Co., Inc. from October 2009 to July 2010 based on the contract with Japan International Cooperation Agency (JICA).

We formulated the feasibility study concerning improvement of the power transmission and distribution system, including the improvement of supply reliability by conditioning of the transmission and distribution system and rehabilitation of protection relay, and also, efficient reduction of distribution loss. The study was achieved with the cooperation of the Ministry of Tourism, Industry and Energy in Cape Verde.

We are convinced that the realization of the recommendations will lead to the acceleration of the power system development, which will surely contribute to the economic and social development in Cape Verde. We devoutly hope that the contents of this report can be reflected in the Power Transmission and Distribution System Development Project in Cape Verde.

Finally, we would like to express our deep gratitude to JICA, the Japanese Embassy in Senegal, the Ministry of Tourism, Industry and Energy in Cape Verde and other officials concerned for the close cooperation and assistance through the study.

Keiji SHIRAKI
Team Leader
Power Transmission and Distribution System Development Project in Cape Verde

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Acronyms

ADP	Águas de Portugal, SA
AfDB	African Development Bank
APP	Agua Ponta Preata
ARE	Agência de Regulação Económica
ARM	Agência de Regulação Multisectorial
BCA	Banco Comercial do Atlântico
CVE	Cape Verde Escudo 1.15227 JPY/CVE (2010.3.31)
DGA	Direcção Geral do Ambiente
DGPCP	Direcção-Geral do Património e de Contratação Pública
EBITDA	Earnings Before Interest, Tax, Depreciation, and Amortization
EDP	Energias de Portugal, SA
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GMT	Ground Mounted Transformer
IEA	International Energy Agency
IMF	International Monetary Fund
INE	Instituto Nacional de Estatística
MECC	Ministério da Economia, Crescimento e Competitividade
MTIE	Ministra do Turismo, Indústria e Energia(Ministry of Tourism, Industry, and Energy)
O&M	Operation and Maintenance
OHL	Over Head Line
PIU	Project Implementation Unit
PMT	Pole Mounted Transformer
UGL	Under Ground Line
UNDP	United Nations Development Programme
WEO	World Economic Outlook (of the IMF), （IMF）

Chapter 1 Introduction

1.1 Background of study

The Republic of Cape Verde is emphasizing improvement and development of its basic infrastructure as part of its strategy for mitigating poverty through economic growth set forth in its "Growth and Poverty Reduction Strategy (GPRS) 2004 - 2007". In the national five-year strategy (2006 - 2011), its aim is socioeconomic advancement and poverty mitigation based on infrastructural conditioning inclusive of the water and power sectors, around the pillars of sustained growth and improvement of the standard of living. The country depends heavily on tourism income, and its demand for power is rapidly increasing. There is an urgent need for conditioning of facilities for power generation, transmission, and distribution. As assistance to this end, a project for reinforcement of the power generation and transmission capacity on the island of Santiago began in March 2008 with yen loans. In Cape Verde, rural electrification is positioned as a priority policy agendum in the power sector. There are very wide interregional gaps in respect of access to electrical power. The electrification rate is 80 percent nationwide, but only 68 percent in Santiago island, which is home to about 60 percent of the population and is the center of economic activities. Furthermore, the operating voltage varies greatly (6, 10, and 20 kV), and is also the main cause of the high rate of transmission and distribution loss, which averages over 25 percent and is impeding optimization of the power network. This situation is having a huge negative impact on the finances of Empresa de Electriciadade e Agua SARL (ELECTRA), which is the seat of power supply in Cape Verde. ELECTRA does not have all the capabilities needed for conformance of the scope of protection (protection cooperation) and system design requiring technical expertise even for protection relays. It is apprehensive about phenomena such as the frequent incidence of breakdowns causing general outages on the Praia system supplying the national capital. Cape Verde is attaching great importance to resolution of such problems and preparation of a power supply setup with high levels of safety and reliability. This is vital not only for making a direct contribution to the stability of the national life but also for resolution of bottlenecks to the development of tourism in the country, whose economy depends on tourism income, and for assurance of sustained economic growth.

Under these circumstances and in response to a request from the Cape Verde Ministry of Economy, Growth and Competitiveness (MEGC), the Japan International Cooperation Agency (JICA) executed a preliminary study for assistance with conditioning of the water and system of power transmission and distribution in Cape Verde in February 2009, Based on the results of this study, it concluded an agreement with the national government in June 2009 on the basic terms for implementation of a feasibility study for conditioning of the transmission and distribution system.

1.2 Purpose of this study

This study was aimed improvement of supply reliability by conditioning of the transmission and distribution system and rehabilitation of protection relay, and also, purpose for implementation of a feasibility study that is aimed efficient reduction of distribution loss.

1.3 Study coverage area

The study was coverage six islands (Santiago, Santo Antao, Sao Vicente, Sal, Maio, Fogo) in total nine island of Cape Verde except uninhabited island.

Chapter 2 Situation in the Power Sector

2.1 Current Status of Power Facilities

The current status of the power facilities in Cape Verde is as follows.

2.1.1 Generation facilities

The majority of the power generation facilities in Cape Verde are diesel generators. Table 2.1 shows figures for the present generation capacity on the six islands.

Table 2.1 Available Generation Capacity for Each Islands

Island	System	Available Capacity (kW)	
		Thermal (Diesel)	Wind Turbine
Santo Antao	Porto Novo	2,480	
	Rebeira Grande	3,650	
	Total	6,130	
Sao Vicente		18,352	900
Sal		8,352	300
Maio		680	
Santiago	Praia	33,462	
	Santa Catarina	2,160	900
	Tarrafal	2,160	
	Santa Cruz	2,688	
	Total	40,470	
Fogo	Sao Fillipe	3,280	
	Ponta Verde	168	
	Mosteiros	800	
	Total	4,248	

At present, ELECTRA has a plan to concentrate the generation facilities on each island in a single location and install large-scale diesel generators for lower fuel costs. Large diesel generators have already been installed in certain power stations, such as those at Palmarejo on Santiago, Lazareto on Sao Vicente, and Palmeira on Sal. ELECTRA intends to consolidate generation in such stations and phase out other old stations.

2.1.2 Transmission and distribution facilities

(1) Voltage classes

Table 2.2 shows the voltage classes in Cape Verde. There are no transmission or distribution lines operated at high voltage at present, but there are plans for construction of new 60-kV transmission lines and transformers in the project for reinforcement of generation and transmission facilities on Santiago, as described below. Medium-voltage facilities are operated at 20 kV as the standard voltage, but in some districts they are actually operated at 6, 10, or 15 kV. There are needs for unified 20-kV operation for the purpose of higher efficiency in the aspects of operation and material procurement.

Table 2.2 Definition of voltage classes

Voltage type	Voltage	Main facilities
High Voltage	More than 35 kV	60 kV Transmission line and transformer (constructed in the future)
Medium Voltag	More than 1 kV and less than 35 kV	6kV, 10kV, 15kV, 20kV Transmission and distribution line, transformer, etc.
Low Voltage	Less than 1 kV	220V, 380 V distribution line, etc.

(2) Specifications of transmission and distribution facilities

The existing transmission and distribution facilities have a diversity of specifications. ELECTRA is pursuing the unification of specifications in the interest of more efficient material procurement and management. Table 2.3shows the specifications currently applied. In Cape Verde, there are many underground transmission and distribution lines; overhead lines are basically confined to mountainous areas and rural districts. The thickness of cable for transmission and distribution lines and the transformer capacity are chosen to suit the situation as regards the load supplied. Generally speaking, thicker cables are selected for trunk lines, and thinner cables, for feeders. Pole-mounted transformers (PMT) are installed in some rural electrification (RE) districts, but ground-mounted transformers (GMT) are installed in almost all other districts.

Table 2.3 Specifications of transmission and distribution facilities

Facilities			Use
Transmission or Distribution line (MV)	OHL	Al 54.6 mm2	Branch line or trunk line of rural electrification
		Al 148 mm2	Trunk line
		Al 228 mm2	Special line (Trunk line for heavy load area, etc)
	UGL	Al 70 mm2	Branch line or trunk line of rural electrification
		Al 120 mm2	Trunk line or connection line
		Al 240 mm2	Trunk line
Distribution line(LV)	OHL	Cu 6 mm2	Drop wire
		Al 16 mm2	Branch line or drop wire
		Al 35 mm2	Branch line
		Al 70 mm2	Trunk line
	UGL	Cu 10 mm2	Drop wire
		Al 50 mm2	Branch line
		Al 95 mm2	Trunk line
		Al 185 mm2	Trunk line or out-going line from GMT
Secondary Substation	PMT	50 kVA	Light load of rural electrification area
		100 kVA	
	GMT	160 kVA, 250 kVA, 400 kVA, 630 kVA	Except for mentioned above

2.1.3 Electrification rate

Cape Verde is promoting electrification toward its goal of raising the electrification rate to 95 percent by 2011 and 100 percent by 2015. As shown in Table 2.4, five of the nine islands have already been completely electrified.

The electrification rate is lowest on the islands of Santiago and Fogo. An increase in the rate on these two islands is the key to attainment of the target.

In Cape Verde, electrification means the installation of transmission and distribution facilities in villages to give residents access to electricity. The actual use of electricity is not in question. However, the MEGC is considering the payment of subsidies to enable access to electricity to villages electrified from now on.

The electrification rate is calculated as the percentage of all households occupied by those which have access to electricity.

Table 2.4 Electrification rate and future plan

	2008(Actual)	2009(Planning)	2010(Planning)	2011(Planning)
S.Antão	81%	85%	90%	95%
S.Vicente	100%			
S.Nicolau	100%			
Sal	100%			
Boavista	100%			
Maio	81%	86%	90%	95%
Santiago	68%	72%	76%	81%
Fogo	59%	65%	72%	80%
Brava	100%			
TOTAL	80%	85%	91%	98%

Chapter 3 Study of Project Scope

3.1 Definition of each type of construction

In making an examination on the project scope, the Study Team classified the types of construction for transmission and distribution lines into three categories to assist assessment of effect: expansion (through installation of new facilities), reinforcement (of existing facilities), and renewal (of existing superannuated facilities). The following kinds of attendant work are included in each.

3.1.1 Expansion (installation of new facilities)

(1) Installation of new transmission and distribution lines for development of housing tracts and resorts

Plans for development of resorts and other facilities on the islands of Sao Vicente and Sal are anticipated to result in additional demand on a substantial scale. New transmission and distribution lines are to be installed to meet this demand.

(2) Electrification of as yet unelectrified villages

Supply of electricity to villages still without it is being promoted under governmental leadership. This task has basically been completed on all islands except Santiago and Fogo. Even on these islands, there are plans to ascertain the situation in these villages and swiftly electrify them, but progress is being hindered by a shortage of funds. Even in districts that have been electrified, financial difficulties are holding back the reinforcement of facilities, such that some demand is on standby and does not have access to power. Such electrification plans were therefore included within the scope of this project.

3.1.2 Reinforcement of existing facilities

(1) Increase in medium-voltage

In Cape Verde, the standard voltage of medium-voltage lines is 20 kV, but some distribution lines are being operated at voltages including 6, 10, and 15 kV. The existence of different voltage classes does not cause any electrical problems, but it does leave issues in the aspect of facility operation. As such, voltage should be unified in the 20-kV class while taking account of factors such as the deterioration of distribution lines.

(2) Reinforcement of medium-voltage distribution lines

① Reinforcement of medium-voltage distribution lines

The existing medium-voltage distribution system consists of facilities with capacities sufficient for the load and basically have little need for reinforcement. As shown in Table 5.1, the drop in voltage on medium-voltage distribution lines is on an extremely low level. However, the results of the macroscopic demand forecast indicate that the voltage drop on some distribution lines will exceed 5 percent in supply of demand beginning in 2013. Factors such as this point to a need for some countermeasures, and related construction is therefore to be undertaken for these lines.

② Looping of medium-voltage distribution lines

Cape Verde has adopted policy to consolidate the power stations on each island in a single location on each, and to abolish superannuated power stations with a low efficiency. Although such stations are to remain at ready for backup use for the time being, their eventual removal will require the looping of transmission and distribution lines to form a system capable of reverse transmission in the event of failure, in order to assure reliability. Construction for looping is to be undertaken on the islands of Sao Vicente, Fogo, and Maio, where the system is not yet looped.

(3) Reinforcement of low-voltage distribution lines

Improvement of voltage on low-voltage distribution lines is highly important for contribution to reduction of power loss in addition to improvement of power quality.

ELECTRA has posted a target maximum length of 500 meters for low-voltage distribution lines, but in some places the length runs to about 2 kilometers. These places are also where trouble is occurring due to voltage drop, but improvement is lagging because the medium-voltage lines cannot be extended due to funding problems. Construction is therefore to be executed to reinforce low-voltage distribution lines..

(4) Installation of breakers with protection relays on long-distance distribution lines

Besides having a large scope of outage in the event of failure, long-distance distribution lines entail a long time for determination of faulty spots and resumption of service. They are consequently factors lessening system reliability. Avoidance of a low reliability demands the installation of breakers with protection relays en route along distribution lines to reduce the scope of outage and the time required for service resumption in the event of outage.

(5) Introduction of monitoring and control system

The ELECTRA power system is virtually unequipped for surveillance and communications. Quite often, even if trouble occurs with the system, the abnormality goes undetected until a call is received from a customer. Similarly, even system changeover in response to faults cannot be made until ELECTRA personnel arrive at the concerned substation. These drawbacks are magnified at places where the system is on a large scale, and require installation of SCADA or an analogous system for system surveillance and control.

(6) Installation of communication lines for protection relays

One of the problems with protection relays in the modal aspect is the application of simple current relays even in spots actually requiring more sophisticated relays, such as parallel circuits. Although carrier relays were installed during the period of privatization, the lack of funds prevented installation of communication lines for them, and the carrier relays consequently do not function. The requisite measure here is therefore installation of communication lines for these carrier relays so they can provide proper protection and heighten system reliability.

(7) Installation of fault locators

On many distribution lines in Cape Verde, it takes a long time to ascertain the problem locations in the event of failure because of installation underground or overhead on routes through mountainous areas. In addition, the overhead lines are installed with few switches en route, and this makes it difficult to isolate the faulty sections. As a result, resumption of service requires considerable time, and this is another factor lowering the system reliability. In response, distribution lines must be installed with units for locating faults and switches along the way to shorten the time required for resumption of service after distribution line failure.

3.1.3 Renewal of existing dilapidated facilities

(1) Renewal of medium-voltage lines

Some medium-voltage distribution lines were installed more than 40 years ago and have been left in operation instead of being replaced, due to the lack of funds. In some districts of Santo Antao and Maio, facilities have a high level of deterioration due to damage from salt and urgently require repair. In these districts, the supply of power is suspended for washing insulators, and this also detracts from supply reliability. On the occasion of replacement, measures such as the use of insulators with a high insulating strength should presumably be taken. Similarly, some of the facilities transferred from municipalities are of a poor quality below ELECTRA standards. As they often cause faults, these facilities must be repaired. In this project, salt-resistant insulators are to be installed to reduce salt damage on Santo Antao and Maio. The prospective types are insulators coated with silicon rubber or long-shaft insulators.

(2) Renewal of low-voltage distribution lines

Although the new low-voltage lines use ABC cable, bare cable was strung on new lines up until the early 1980s. These lines, which have been installed for more than 25 years, have a significant degree of deterioration, and must be replaced. Because thin cable is used on bare lines, technical loss could be reduced by replacement with cable of the optimal size. Similarly, replacement with insulated cable could be expected to reduce theft (non-technical loss) and help to prevent electric shocks.

(3) Replacement of watt-hour meters

In Cape Verde, periodic checking and replacement of watt-hour (electrical energy) meters were carried out in the past, but are not being executed at present, because of a shortage of technical capabilities and funds. As a result, not a few such meters have been in use for more than 40 years. Superannuated meters have a lower measurement precision and generally tend to make measurements on the short side. They are consequently thought to be one of the factors behind the high level of non-technical loss. This situation demands the reinstatement of a setup for periodic checking of watt-hour meters and replacement of particularly old meters to rationalize metering as a measure for the immediate future. The superannuated meters should be replaced with mechanical models, which have long been in use in Cape Verde, to assist procurement, checking, and maintenance.

Table 3.1 Calculation Result of Voltage Drop on Medium Voltage Distribution Lines

【Condition of analysis】

・Voltage drop of each nominal transmission & distribution(hereinafter T&D) system was analyzed with PSSE/ADEPT.
('α' means 'less than 0.5%')

・The maximam demand of each secondary substation was estimated with actual data measured by ELECTRA and the total demand of each island.

・The ongoing projects were reflected with the T&D system on 2013. The T&D system on 2018 is same components as the one on 2013 and using with the demand on 2018.

Island		PS / PST /SS	Feeder	Voltage (kV)	Feeder Capacity (A)	2008		2013		2018		Remark
						current (A)	Voltage drop	current (A)	Voltage drop	current (A)	Voltage drop	
Santo Antao		Port Novo PS	1	10	152	9	2%	17	3%	21	4%	*Assume the Porto Novo and Paul PS are stopped generating.
			2	10	152	34	1%	52	2%	65	2%	
		Riveira Grande PS	1	10	140	15	1%	21	4%	27	5%	
			2	10	130	15	1%	21	4%	27	4%	
			3	10	140	54	6%	21	2%	27	3%	
		Paul PTS	1	10	130	6	1%	7	α	8	1%	
			2	10	130	9	1%	15	1%	17	1%	
Sao Vicente		Matiota PS	1	6	196	100	1%	147	2%	202	2%	*Asuume the wind PS is stopped generating. *Overload on Matiota PS No.1 feeder in 2018 can be resolved by switching over some loads to No.2 feeder.
			2	6	196	44	1%	65	2%	89	3%	
			3	6	323	35	α	51	α	70	α	
			4	6	285	91	α	134	α	182	α	
			5	6	196	93	4%	139	5%	193	7%	
			6	6	317	109	4%	160	5%	221	8%	
		Matiota SS	1	20	196	9	α	12	α	16	1%	
			2	20	361	2	α	2	α	2	1%	
		Palacio PTS	1	20	196	33	α	48	1%	66	1%	
		Favorita PTS	1	20	196	17	α	25	1%	34	1%	
			2	20	196	23	α	34	1%	45	1%	
			3	20	252	10	1%	14	1%	19	2%	
		Lazareto PS	1	20	196	22	α	33	1%	45	1%	
			2	20	317	13	α	20	α	27	α	
Sal		Santa Maria PTS	1	20	152	21	1%	45	3%	79	5%	
			2	20	196	11	1%	23	2%	40	5%	
			3	20	367	31	1%	67	2%	116	4%	
		Espargos PS	1	20	252	18	1%	38	2%	67	3%	
			2	20	252	17	1%	37	2%	64	3%	
			3	20	252	31	1%	67	2%	115	3%	
			4	20	152	3	1%	7	2%	13	3%	
		Palmeira PS	1	20	252	11	α	22	α	37	α	
		Central Velha SS	1	20	252	0	α	0	α	0	α	
Maio		Torril PS	1	20	140	10	α	14	α	18	α	
			2	20	140	1	α	2	α	2	α	
			3	20	140	4	α	5	1%	7	1%	
Santiago	Praia	Palmarejo PS	1	20	196	23	1%	40	1%	58	2%	*Assume the Gamboa PS is stopped generating.
			2	20	367	–	–	31	α	44	α	
			3	20	367	–	–	68	1%	99	1%	
		Gamboa PS(20kV)	1	20	196	37	1%	64	2%	93	2%	
			2	20	196	23	1%	39	2%	56	2%	
			3	20	196	62	2%	108	2%	155	4%	
			4	20	196	27	1%	46	2%	67	3%	
			5	20	252	127	3%	133	3%	194	4%	
		Gamboa PS(15kV)	1	15	285	17	2%	22	2%	32	3%	
			2	15	252	86	2%	160	2%	234	4%	
			3	15	317	45	2%	58	2%	85	3%	
			4	15	196	41	2%	52	2%	77	3%	
			5	20	196	–	–	34	3%	50	5%	
		Terra Branca PT	1	20	196	66	2%	37	2%	54	3%	
			2	20	196	32	1%	54	2%	79	3%	
			3	20	252	30	1%	52	2%	76	2%	
			4	20	252	51	2%	64	2%	93	2%	
	Assomada	Santa Catarina PS	1	20	190	57	2%	98	4%	146	7%	
	Santa Cruz / Calheta	Santa Cruz PS	1	20	190	12	α	21	1%	31	2%	
			2	20	196	23	2%	39	3%	57	6%	
	Tarrafal	Tarrafal PS	1	10	190	7	1%	12	2%	17	3%	
			2	20	190	4	1%	7	1%	10	2%	
			3	20	190	14	1%	24	1%	35	2%	
			4	20	196	13	1%	22	2%	32	3%	
Fogo		Ponta Verde PS	1	20	196	0	α	0	α	1	1%	*Assume the Pnta Verde amd Mosteiros PS will be stopped generating after the completion of ongoing projects.
			2	20	196	2	α	2	α	2	1%	
			3	20	196	1	α	1	α	2	1%	
		P. Lapa PS (Mosteiros)	1	20	165	8	α	13	1%	17	1%	
			2	20	165	2	α	4	1%	5	1%	
		S. Filipe PS(15kV)	1	15	152	18	3%	29	3%	39	4%	
		S. Filipe PS(6kV)	1	6	186	20	2%	9	α	12	α	

(4) Renewal of protection relay systems

In Cape Verde, more than 60 percent of the switches and protection relays were installed beginning in 2000. Most of those installed earlier are scheduled for renewal under the ORET project and other projects. In some cases, ELECTRA itself is performing replacement of single protection relays, which can be done at comparatively low cost. However, there are no projects or plans especially for protection relay renewal. Moreover, some switches, whose replacement entails considerable expense, have been in service for more than 20 years. Switches of the old type at Gamboa and Matiota are marked by a degree of deterioration that is high enough to impair the switching action. This not only holds the risk of making normal exclusion of failures impossible and thereby widening the scope of outage but also could possibly cause fires and harm to people due to the continuation of ground-fault accidents. As such, countermeasures must be taken.

It may also be noted that, even when the year of installation is fairly recent, there are problems in the aspects of maintenance and installation control that have caused difficulties in some cases. This situation tends to appear in the case of facility installation in municipalities which lacked the requisite skills and experience and later transferred the facilities to ELECTRA, and in systems on islands that are small in size and cannot employ a sufficient number of engineers. Some of these facilities require renewal.

The majority of the equipment and materials used in the power system in Cape Verde date from the privatization of ELECTRA, and the types are virtually unified. Table 3.2 shows the main types of protection relay and switching equipment in use in the country.

Table 3.2 Main protection relay and switchgears

	Type Name	Manufacturer
Protection Relay	MRI-3	SEG
Circuit Breaker (for main power station)	VD4	ABB
Switchger (for substation)	Normafix	EFACEC

In countries such as Cape Verde, where the scale of the power enterprises is limited, such unification of types saves time and trouble in procurement of spare parts and maintenance. The Study Team consequently recommends the use of equipment and materials that have a high compatibility with the existing ones in the course of future equipment renewal and system expansion work.

3.2 Project scope in each category of work type

This section defines the specific scope of project work in each category. The scope considered in this study consisted of tasks deemed important for improvement of supply reliability through improvement of the transmission and distribution system, and rehabilitation of protection relays as well as reduction of distribution loss through construction of a more efficient distribution network on the six islands covered. The order of priority was set in accordance with the following standard.

In the table shown below, tasks with a priority in the A class are related to the projects of other donors, and would prevent the aid from these donors from taking full effect unless they are implemented in this project. Tasks in the B class require urgent execution because problems have already surfaced. Tasks in the C class are considered necessary in spite of the lack of problems at present, because problems are likely to arise in the near future. Tasks in the A class therefore have the highest priority. Those in the C class are important for Cape Verde, but have less priority than those in the A or B class.

Table 3.3 shows the cumulative base cost in accordance with the project priorities.

Table 3.3 Cumulative base cost in line with the project priorities

Priority	Category	Works	Base Cost million EUR	Cumulative Cost million EUR
A	Expansion	Extension of MV T&D line for town and resort development	17.2	17.2
A	Reinforcement	Connection of T&D networks (loop system)	3.9	21.1
A	Reinforcement	Installation of CB/ SCADA/ FL	8.3	29.4
B	Reinforcement	LV voltage development	0.8	30.2
B	Renewal	Rehabilitation of LV conductor	1.1	31.3
B	Reinforcement	Upgrading of MV voltage	3.0	34.3
B	Renewal	Rehabilitation of MV facility	0.8	35.1
B	Renewal	Replacement of WHM	1.2	36.3
C	Reinforcement	Reinforcement MV network	0.8	37.1
C	Expansion	Electrification	9.2	46.3

3.2.1 Expansion (installation of new facilities)

Table 3.4 shows the project scope of expansion.

Table 3.4 Project scope (Expansion)

	Outline of construction [order of priority]	Quantity of works (Approximate value)		Construction Cost (Approximate price) 【million EUR】
Santo Antao	Town development for Port Novo, Paul and Ponta do Sol in Santo Antao island[A]	Installation for MV UGL 120mm^{2}cable-1circuit	6.1 km	1.5
		240mm^2 cable-1circuit	0.2 km	
		Installation for LV UGL 95mm^2 cable	14 km	
		LV OHL(over head line) ABC70mm^2	12 km	
		GMT(ground mounted transformer)	8 units	
	Electrification for non-electrified town[C]	Quantity of PMT(pole mounted transformer) (Number of town)	6 units	0.7
Sao Vicente	Town and housing development for Mindelo[A]	MV UGL 240mm^2 cable 1 circuit	10.2 km	0.7
	Resort development for Salamansa area[A]	Installation for MV UGL 500mm^2 cable 1 circuit	27 km	3.3
		Installation for MV UGL 240mm^2 cable 1 circuit	3.5 km	
		Installation for secondary substation	2 units	
	Housing development[A]	Installation for MV UGL 120mm^2 cable 1 circuit	9 km	1.6
		Installation for GMT	13 units	
		Installation for LV UGL 95mm^2 cable	4 km	
		Installation for LV OHL ABC70mm^2	18 km	
Sal	Resort and town development for S.Maria and Pedra de Lume[A]	Installation for MV UGL 500mm^2 cable 2 circuit	52 km	6.9
		Installation for MV UGL 500mm^2 cable 1 circuit	12 km	
	Installation for Murdeira substation and outlet of lines from Palmeira power station[A]	Switch gear and protection relay for Murdeira	4 set	0.4
		Murdeira substation	1 unit	
		Switch gear and protection relay for Parmeira	2 set	
		communication line	22 km	

Santiago	Industrial area and resort development for Achada Grande Tras[A]	Installation for MV UGL 240mm^{2}cable-1circuit	8km	0.6
		Installation for circuitbreakers and protection relays	2 set	
		Installation for disconnecting switch	2 set	
		Construction for substation	1 unit	
	Housing development[A]	Installation for MV UGL 240mm^{2}cable-1circuit	7.0 km	1.2
		Installation for LV ABC	7.0 km	
		GMT	7 units	
	Electrification for non-electrified town[C]	Quantity of PMT (Number of town)	6 units	6.7
Fogo	Electrification for non-electrified town[C]	Quantity of PMT(pole mounted transformer) (Number of town)	15 units	1.8
	Housing development for Sao Filipe[A]	Installation for MV UGL 120mm^{2}cable-1circuit	2.6 km	1.0
		GMT	4 units	
		LV UGL 95mm^2 cable	8 km	
		LV OHL ABC70mm^2	17 km	

3.2.2 Reinforcement of facilities

Table 3.5 shows the project scope of reinforcement.

Table 3.5 Project scope (Reinforcement)

	Outline of construction [order of priority]	Quantity of works (Approximate value)		Construction Cost (Approximate price) [million EUR]
Santo Antao	Upgrading 10kV distribution line to 20kV[B]	Replacement of conductor	6.5km	0.8
		Replacement of transformers	6 units	
	Looping of medium-voltage distribution lines between Porto Novo and Ribeira Grande[A]	New additional line of 1 circuit 240mm^2 cable	37 km	3.1
		Installation for pole mounted switches	15 units	
	Installation of fault locator and pole mounted switches[A]	Fault Locator (for underground line)	15 pieces	0.3
		Fault Locator (for overhead line)	30 pieces	
		Installation for pole mounted switches	15 units	
Sao Vicente	Replacing the 6kV secondary transformers to 20kV ones Not necessary for replacing the conductors[A]	Replacement of transformers	12 units	0.8
		New additional line of 1 circuit 240mm^2 cable	4.0 km	
		Installation for secondary substation	1 units	
	Reinforcement of low-voltage distribution lines[B]	Replacement for LV	20.0 km	0.4
	Installation of SCADA system and fault locator[A]	SCADA Main Unit	1 unit	1.9
		Remote Terminal Unit	5 units	
		Communication Line(Underground)	31 km	
		Fault Locator (for underground line)	60 units	
Sal	Reinforcement for MV line between Espargos and Palmeira[C]	Installation for MV UGL 120mm^2 cable	3.0 km	0.3
		GMT	4 units	
	Installation of SCADA system and fault locator[A]	Installation of SCADA Main Unit	1 unit	1.6
		Installation of Remote Terminal Unit	6 units	
		Installation of Communication Line (Underground)	32.5 km	
		Fault Locator (for underground line)	30 units	

Maio	Looping of medium-voltage distribution lines between Figueira Seca and Alcatraz[A]	New additional line of 1 circuit 54.6mm^2 overhead line	9 km	0.5
		GMT	2 units	
		Installation for pole mounted switches	5 units	
		Construction for substation	· 1 unit	
	Reinforcement for MV line for Airport development[C]	New additional line of 1 circuit 240mm2 cable	5.8 km	0.5
		Construction for substation	1 unit	
	Installation of Fault Locator and pole mounted switches[A]	Fault Locator (for overhead line)	10 units	0.1
		Pole Mounted Switch	5 units	
Santiago	Replacing the 10kV secondary transformers to 20kV ones (Replacing the insulators Not necessary for replacing the conductors)[B]	Replacement of transformers	6 units	0.4
		Replacement of insulators	160 pieces	
	Reinforcement of low-voltage distribution lines[B]	Replacement for LV	21.0 km	0.4
	Installation of SCADA system, Fault Locator and pole mounted switches[A]	Installation of SCADA Main Unit	1 unit	4.1
		Installation of Remote Terminal Unit	10 units	
		Installation of Communication Line (Underground)	22 km	
		Installation of Communication Line(Overhead)	60 km	
		Fault Locator (for underground line)	100 units	
		Fault Locator (for overhead line)	50 units	
		Pole Mounted Switch	50 units	
Fogo	Upgrade voltage on the Sao Filipe 15 kV system to 20 kV[B]	Installation for MV UGL 240mm^2 cable 1 circuits	2.5 km	1.0
		Installation for MV UGL 120mm^2 cable 1 circuits	0.8 km	
		Replacement for MV OHL 148mm^2	8.0 km	
		Replacement for MV OHL 54.6mm^2	5.6 km	
		Replacement for transformers (15kV→20kV)	8 units	
	Looping of medium-voltage distribution lines between Tinteiras and Relvas[A]	New additional line of 1 circuit 148mm^2 overhead line	7 km	0.3
	Installation of Fault Locator and pole mounted switches[A]	Fault Locator (for underground line)	10 units	0.3
		Fault Locator (for overhead line)	20 units	
		Pole Mounted Switch	6 units	

3.2.3 Renewal of existing dilapidated facilities

Table 3.6 shows the project scope of renewal.

Table 3.6 Project scope (Renewal)

	Outline of construction [order of priority]	Quantity of works (Approximate value)		Construction Cost (Approximate price) 【million EUR】
Santo Antao	Renewal of medium-voltage distribution line[B]	Replacement of 240mm2 Cable	5.5 km	0.6
		Rehabilitation for secondary substation	3 units	
	Replacement of watt-hour meters[B]	Replacement of watt-hour meters	2,100 pieces	0.1
Sao Vicente	Renewal of Low-voltage distribution line [B]	Replacement of bare conductor with ABC Cable	14.2 km	0.3
	Replacement of watt-hour meters[B]	Replacement of watt-hour meters	4,900 pieces	0.3
Sal	Renewal of Low-voltage distribution line[B]	Replacement of bare conductor with ABC Cable	7.0 km	0.1
	Replacement of watt-hour meters[B]	Replacement of watt-hour meters	1,500 pieces	0.1
Maio	Renewal of medium-voltage distribution line[B]	Replacement of 54 mm^2 line	51 km	0.2
	Renewal of Low-voltage distribution line[B]	Replacement of bare conductor with ABC Cable	9.0 km	0.2
	Replacement of watt-hour meters[B]	Replacement of watt-hour meters	400 pieces	0.02
Santiago	Renewal of Low-voltage distribution line[B]	Replacement of bare conductor with ABC Cable	20.0 km	0.4
	Replacement of watt-hour meters[B]	Replacement of watt-hour meters	10,200 pieces	0.6
Fogo	Renewal of Low-voltage distribution line[B]	Replacement of bare conductor with ABC Cable	7.0 km	0.1
	Replacement of watt-hour meters[B]	Replacement of watt-hour meters	1,100 pieces	0.1

Chapter 4 Packaging of the project scope

4.1 Composition of the package

The results presented in Chapter 3 provided the basis for packaging the project scope on each island. The packaging results are shown in Table 4.1. For more efficient construction, supervision, and management of equipment and materials, as well as in light of the project scale, the basic units of the project shall be the islands. The portion related to SCADA systems will be conducted as a separate project to enable interconnection testing (connection of on-site facilities and SCADA systems etc.) to be implemented after completion of the distribution line construction on each island.

Table 4.1 Packaging of the project scope

Project [order of priority]	Contents	Construction Cost (Million EUR)
Santo Antao T&D line construction	Construction work of expansion, reinforcement, renewal and electrification for transmission & distribution lines	6.8
Sao Vicente T&D line construction	Construction work of expansion, reinforcement and renewal for transmission & distribution lines	7.4
Sal T&D line construction	Ditto	7.8
Maio T&D line construction	Ditto	1.4
Santiago T&D line construction	Construction work of expansion, reinforcement, renewal and electrification for transmission & distribution lines	10.3
Fogo T&D line construction	Ditto	4.3
SCADA, fault locator and pole mounted switches installation	Design and installation for SCADA & Fault locator	8.3
Total		46.3

4.2 Packaged project for targeted islands

Appendix 1 shows system planning maps for each island.

4.2.1 Santo Antao island

【Contents of construction works】

	Outline of construction [order of priority]	Quantity of works (Approximate values)		Construction Cost (Approximate price) 【million EUR】
Expansion	Town development for Port Novo, Paul and Ponta do Sol[A]	Installation for MV UGL(under ground line) $120mm^2$cable-1circuit	6.1 km	1.5
		$240mm^2$ cable-1circuit	0.2 km	
		Installation for LV UGL $95mm^2$ cable	14 km	
		LV OHL(over head line) $ABC70mm^2$	12 km	
		GMT(ground mounted transfor mer)	8 units	
Expansion	Electrification for non-electrified town[C]	Quantity of PMT(pole moun ted transformer) (Number of town)	6 units	0.7
Reinforce ment	Upgrade voltage on the Rebeira Garnde / Ponta do Sol 10 kV system to 20 kV[B]	Replacement for MV	6.5 km	0.8
		Replacement for transformers (10kV→20kV)	6 units	
Reinforce ment	Looping of MV distribution line from Porto Novo to Ribeira Grande[A]	Installation for MV OHL $240mm^2$ cable 1 circuits	37 km	3.1
Reinforce ment	Rehabilitation for MV line[B]	Replacement for MV line $240mm^2$	5.5 km	0.6
		Replacement for secondary substation	3 units	
Reinforce ment	Replacement for watt hour meters[B]	Replacement for watt hour meters	2,100 pieces	0.1
Total				6.8

【Main materials】

Materials		Quantity
MV UGL	$AL240mm^2$	49 km
	$AL120 mm^2$	6 km
LV line	UGL	14 km
	OHL	12 km
Secondary substation	GMT	21 unit
Watt hour meter		2,100 pieces

4.2.2 Sao Vicent island

【Contents of construction works】

	Outline of construction [order of priority]	Quantity of works (Approximate values)		Construction Cost (Approximate price) 【million EUR】
Expansion	Town development for Mindelo[A]	Installation for MV UGL $240mm^2$ cable 1 circuit	10.2 km	0.7
	Resort development for Salamansa area[A]	Installation for MV UGL $500mm^2$ cable 1 circuit	27 km	3.3
		Installation for MV UGL $240mm^2$ cable 1 circuit	3.5 km	
		Installation for secondary substation	2 unit	
Expansion	Housing development[A]	Installation for MV UGL $120mm^2$ cable 1 circuit	9 km	1.6
		Installation for GMT	13 unit	
		Installation for LV UGL $95mm^2$ cable	4 km	
		Installation for LV OHL $ABC70mm^2$	18 km	
Reinforcement	Upgrade voltage on the Matiota 6kV system to 20kV[B]	Replacement for transformers (10kV→20kV)	12 unit	0.8
		Replacement for MV line $240mm^2$ UGL 1 circuit	4.0 km	
		Installation new secondary substation	1 unit	
Reinforcement	Reinforcement for LV line[B]	Replacement for LV line	20.0 km	0.4
Renewal	Rehabilitation for LV line[B]	Replacement for LV bare conductor	14.2 km	0.3
Renewal	Replacement for watt hour meters[B]	Replacement for watt hour meters	4900 pieces	0.3
Total				7.4

【Main materials】

Materials		Quantity
MV UGL	$AL500mm^2$ cable	27km
	$AL240mm^2$ cable	18km
	AL120 mm^2 cable	9km
LV line	UGL	4km
	OHL	52km
Secondary substation	GMT	27 unit
Watt hour meter		4,900 pieces

4.2.3 Sal island

【Contents of construction works】

	Outline of construction [order of priority]	Quantity of works (Approximate values)		Construction Cost (Approximate price) 【million EUR】
Expansion	Resort and town development for S.maria and Pedra de Lume[A]	Installation for MV UGL 500mm^2 cable 2 circuit	52 km	6.9
		Installation for MV UGL 500mm^2 cable 1 circuit	12 km	
	Installation for Murdeira substation and outlet of lines from Palmeira power station[A]	Switch gear and protect ion relay for Murdeira	4 set	0.4
		Murdeira substation	1 unit	
		Switch gear and protect ion relay for Parmeira	2 set	
		communication line	22 km	
Reinforcement	Reinforcement for MV line between Espargos and Palmeira[C]	Installation for MV UGL 120mm^2 cable	3.0 km	0.3
		GMT	4 unit	
Renewal	Rehabilitation for LV line[B]	Replacement for LV bare conductor	7.0 km	0.1
Renewal	Replacement for watt hour meters[B]	Replacement for watt hour meters	1500 pieces	0.1
Total				7.8

【Main materials】

Materials		Quantity
MV UGL	AL500mm^2 cable	64 km
	AL240mm^2 cable	4 km
	AL120 mm^2 cable	3 km
LV OHL	ABC	7 km
Communication line	UGL	22 km
Secondary substation	GMT	4 unit
Watt hour meter		1,500 pieces

4.2.4 Maio island

【Contents of construction works】

	Outline of construction [order of priority]	Quantity of works (Approximate values)		Construction Cost (Approximate price) 【million EUR】
Reinforcement	Looping of MV distribution line from Figueira Seca to Alcatraz[A]	Installation for MV OHL 54.6mm^2	9 km	0.5
		GMT	2 unit	
		Installation for substation	1 unit	
Reinforcement	Reinforcement for MV line for Airport development[C]	Installation for MV UGL 240mm2 cable	5.8 km	0.5
		Installation for substation	1 unit	
Renewal	Rehabilitation for MV line[B]	Replacement for MV OHL 54.6mm^2	51km	0.2
Renewal	Rehabilitation for LV line[B]	Replacement for LV bare conductor	9.0km	0.2
Renewal	Replacement for watt hour meters[B]	Replacement for watt hour meters	400 pieces	0.02
Total				1.4

【Main materials】

Materials		Quantity
MV UGL	AL240mm^2 cable	6 km
MV OHL	Aster54.6mm^2	61 km
LV OHL	ABC	9 km
Secondary substation	GMT	2 unit
Watt hour meter		400 pieces

4.2.5 Santiago island

【Contents of construction works】

	Outline of construction [order of priority]	Quantity of works (Approximate values)		Construction Cost (Approximate price) 【million EUR】
Expansion	Industrial area and resort development for Achada Grande Tras[A]	Installation for MV UGL 240mm^{2}cable-1circuit	8km	0.6
		Installation for circuitb reakers and protection relays	2 set	
		Installation for disconn ecting switch	2 set	
		Construction for substa tion	1 unit	
Expansion	Housing development[A]	Installation for MV UGL 240mm^{2}cable-1circuit	7.0 km	1.2
		Installation for LV ABC	7.0 km	
		GMT	7 unit	
Expansion	Electrification for non-electrified town[C]	Quantity of PMT (Number of town)	6 unit	6.7
Reinforcement	Upgrade voltage on the Sao Jorge dos Orgaos do Sol 10 kV system to 20 kV [B]	Replacement for transformers (10kV→20kV)	6 unit	0.4
		Replacement for insulators (10kV→20kV)	160 pieces	
Reinforcement	Reinforcement for LV[B]	Replacement for LV	21.0 km	0.4
Renewal	Rehabilitation for LV line[B]	Replacement for LV bare conductor	20.0 km	0.4
Renewal	Replacement for watt hour meters[B]	Replacement for watt hour meters	10,200 pieces	0.6
Total				10.3

【Main materials】

Materials		Quantity
MV UGL	AL500mm^2 cable	8 km
	AL240mm^2 cable	7 km
MV OHL	Aster54.6 mm^2	7 km
LV OHL	ABC	67 km
Secondary substation	GMT	8 unit
	PMT	6 unit
Watt hour meter		10,200 pieces

4.2.6 Fogo island

【Contents of construction works】

	Outline of construction [order of priority]	Quantity of works (Approximate values)		Construction Cost (Approximate price) 【million EUR】
Expansion	Electrification for non-electrified town[C]	Quantity of PMT(pole mounted transformer) (Number of town)	15 unit	1.8
Expansion	Housing development for Sao Filipe[A]	Installation for MV UGL $120mm^2$cable-1circuit	2.6 km	1.0
		GMT	4 unit	
		LV UGL $95mm^2$ cable	8 km	
		LV OHL ABC$70mm^2$	17 km	
Reinforcement	Upgrade voltage on the Sao Filipe 15 kV system to 20 kV [B]	Installation for MV UGL $240mm^2$ cable 1 circuits	2.5 km	1.0
		Installation for MV U GL $120mm^2$ cable 1 circuits	0.8 km	
		Replacement for MV OHL $148mm^2$	8.0 km	
		Replacement for MV OHL $54.6mm^2$	5.6 km	
		Replacement for transformers (15kV→20kV)	8 unit	
Reinforcement	Looping of MV distribution line from Tinteiras to Relvas[A]	Installation for MV OHL 148 mm^2 Aster	7.0 km	0.3
Renewal	Rehabilitation for LV line[B]	Replacement for LV bare conductor	7.0 km	0.1
Renewal	Replacement for watt hour meters[B]	Replacement for watt hour meters	1,100 pieces	0.1
Total				4.3

【Main materials】

Materials		Quantity
MV UGL	AL240mm^2	3 km
	AL120 mm^2	3 km
MV OHL	Aster148 mm^2	15 km
	Aster54.6 mm^2	6 km
LV line	UGL	8 km
	OHL	24 km
Secondary substation	GMT	12 unit
Watt hour meter		1,100 pieces

4.2.7 SCADA & Fault locator installation (6 islands)

【Contents of construction works】

	Outline of construction [order of priority]	Quantity of works (Approximate values)		Construction Cost (Approximate price) 【million EUR】
Reinforcement	Installation of fault locator and pole mounted switches for Santo Antao island[A]	Fault locator (UGL)	15 unit	0.3
		Fault locator (OHL)	30 unit	
		Pole mounted switch	15 unit	
Reinforcement	Installation of SCADA system and fault locator for Sao Vicente island[A]	SCADA	1 unit	1.9
		Communication line (UGL)	31 km	
		Fault locator (UGL)	60 unit	
Reinforcement	Installation of SCADA system and fault locator for Sal island[A]	SCADA	1 unit	1.6
		Communication line (UGL)	33 km	
		Fault locator (UGL)	30 unit	
Reinforcement	Installation of Fault Locator and pole mounted switches for Maio island[A]	Fault locator (OHL)	10 unit	0.1
		Pole mounted switch	5 unit	
Reinforcement	Installation of SCADA system, Fault Locator and pole mounted switches for Santiago island[A]	SCADA	1 set	4.1
		Communication line (UGL)	26 km	
		Communication line (OHL)	60 km	
		Fault locator (UGL)	100 unit	
		Fault locator (OHL)	50 unit	
		Pole mounted switch	50 unit	
		Improvement for substation	1 unit	
Reinforcement	Installation of Fault Locator and pole mounted switches for Fogo island[A]	Fault locator (UGL)	10 unit	0.3
		Fault locator (OHL)	20 unit	
		Pole mounted switch	6 unit	
		Improvement for substation	1 unit	
Total				8.3

【Main materials】

Materials		Quantity
Communication line	UGL	90 km
	OHL	60 km
Fault locator	UGL	215 unit
	OHL	110 unit
Pole mounted switch		76 unit
SCADA		3 set

4.3 Estimation of total project cost

Table 4.2 shows the rough cost estimation for this project.

Table 4.2 Rough Cost Estimation for the Project

(Million EURO)

Item		Total
A. ELIGIBLE PORTION		
I)	Procurement / Construction	51
	1. Santo Antao	7
	2. Sao Vicente	7
	3. Sal	8
	4. Maio	1
	5. Santiago	10
	6. Fogo	4
	7. SCADA and Fault Locator	8
	8. Soft Componet	0
	Base cost for JICA financing	46
	Price escalation	2
	Physical contingency	2
II)	Consulting services	1
	Base cost	1
	Price escalation	0
	Physical contingency	0
Total (I + II)		52
B. NON ELIGIBLE PORTION		
a	Administration cost	3
b	VAT	0
c	Import Tax	0
Total (a+b+c)		3
TOTAL (A+B)		55
C. Interest during Construction		1
	Interest during Construction(Const.)	1
	Interest during Construction (Consul.)	0
D. Commitment Charge		0
GRAND TOTAL (A+B+C+D)		56
E. JICA finance portion incl. IDC (A + C + D)		53

<Calculate Condition>

Price Escalation = 2.0%

Physical Contingency = 5%

Administration Cost = 5%

Interest During Construction = 0.65%

VAT and Import TAX are not considered

Comittment charge is not considered

4.4 Project schedule

(1) Schedule

The schedule for implementation of the project shall be as Table 4.3.

Table 4.3 Project schedule

No.		Item	Month
		Pledge	0.0
		E/N	0.0
		Signing of Loan Agreement	0.0
		DPP Approval	0.0
1		**Selection of Consultant (All)**	6.0
2		**Design Stage**	0.0
		Review of design documents / Detail Design	6.0
		EIA Study / Review	0.0
3		**Tendering Stage**	0.0
		Preparation of construction / procurement schedule	1.0
	Pre-Qualification	Preparation of pre-qualification documents for Turn-key Works	1.0
	Pre-Qualification	Review of bidding documents	3.0
	Pre-Qualification	Evaluation of pre-qualification of bidders	1.0
	Pre-Qualification	Bids floating	2.0
	Pre-Qualification	Bids evaluation	3.0
	Pre-Qualification	Concurrence of Donor on Bids evaluation results	0.5
	Pre-Qualification	Assist for contract negotiation	1.5
	ICB/LCB	Bids floating	1.5
	ICB/LCB	Bids evaluation	3.0
	ICB/LCB	Concurrence of Donor on Bids evaluation results	0.5
	ICB/LCB	Assist for contract negotiation	1.0
4		**Construction Monitoring Stage**	0.0
		Preparation of power interruption and construction plan	4.0
		Checking and approval of drawings and documents	6.0
		Monitoring of construction work	40.0
		Monitoring / Evaluation of social development	47.0
5		**Manufacturing, Transportation, Installation etc.**	0.0
		Manufacturing of equipment and materials	36.0
		Transportation to the site	34.0
		Installation / construction work in Santo Antao	24.0
		Installation / construction work in Sao Vicente	20.0
		Installation / construction work in Sal	20.0
		Installation / construction work in Maio	10.0
		Installation / construction work in Santiago	31.0
		Installation / construction work in Fogo	11.0
		Installation / construction work for SCADA & Fault locator	24.0
		Final test / commissioning	32.0
			0.0

(2) Funding plan
Table 4.4 shows the funding plan for the project, based on the schedule for its implementation.

Table 4.4 Funding plan

Unit; million EUR

Project	1st year	2nd year	3rd year	Total
Santo Antao T&D line construction	3.4	3.4	0.0	6.8
Sao Vicente T&D line construction	4.4	3.0	0.0	7.4
Sal T&D line construction	4.7	3.1	0.0	7.8
Maio T&D line construction	1.4	0.0	0.0	1.4
Santiago T&D line construction	4.0	4.0	2.3	10.3
Fogo T&D line construction	4.3	0.0	0.0	4.3
SCADA, Fault locator and pole mounted switches installation	1.0	4.2	3.1	8.3
Total	23.2	17.7	5.4	46.3

Chapter 5 Reduction of Transmission & Distribution loss and green house gas

5.1 Reduction of transmission and distribution loss

5.1.1 Reduction of technical loss

As noted in Chapter 2, technical loss in Cape Verde is enough low (0.8% for medium voltage line, and 3.7% for low voltage line). But, transmission and distribution loss will increase if there is no reinforcement. For example, loss of medium voltage line will be 3.0 % at 2013 without any countermeasure. If the project scope of this study has done, loss of medium voltage line at 2013 will be 1.3%[1], and it has 1.7% loss reduction effect although it is aimed to improve reliability of power system, not aimed for loss reduction.

On the other hand, loss of low voltage line will be 3% (0.7% reduction) if the scope of voltage improvement for low voltage line has performed.

5.1.2 Reduction of non-technical loss

Non-technical loss is reduced not only by facility measures but also by routine surveillance and warnings. In this study, it is estimated that non-technical loss could be reduced to the level of 15 percent by a switch to insulated cable for low-voltage lines currently strung with bare cable, replacement of superannuated watt-hour meters, reinforcement of action to reduce non-technical loss at ELECTRA, and a rise in the morals of the populace along with economic advancement.

5.1.3 Reduction of GHG emissions

Reduction of emissions of greenhouse gases (GHG) by project scope of this study has considered. The reduction of GHG accompanying reduction of loss will derive from reduction of technical loss. As noted above, however, the reduction of technical loss will be limited in extent, and the corresponding GHG emission reduction is consequently put at only about 4,300 tons per year at 2013. The conditions applied in the related calculation are as follows.

* Unit calorific value: 41.7 GJ/kl
* Emission coefficient: 0.0195 tC/GJ
* Fuel consumption: 220 g/kWh
  (equivalent level of consumption by the Palmarejo generator)
* Specific gravity: 0.94 kg/l
* Technical loss reduction: 2.4% of energy sales
* Energy sales: 308,772 MWh (Demand forecaset in FY2013)

[1] Loss of medium voltage line will increase than present loss (0.8%), but it is very low than normal system because of small load, and loss of 1.3% is also enough low.

Chapter 6 Project Economic and Financial Analyses

6.1 Perspectives on the prospective investment project

- Categorization of types of facility construction. We divided the work of the anticipated facility construction into the following three categories based on differences of purpose: renewal of existing facilities, reinforcement of existing facilities, and expansion through installation of new facilities.
- Definition of project units and grouping of projects. In making economic and financial calculations, we treated each island as a single investment project unit. We also set the year of the start of the investment project (i.e., Year 0) at 2009.
- Project term. The calculations in the economic and financial analyses also assumed that the project life would be 20 years counting from the start of facility operation.
- Facility construction cost and annual cost. It was assumed that orders would be placed with construction companies for construction on the turnkey basis, based on the calculated (added-up) totals for each construction work. Of the annual costs, the fuel cost was used for the generation cost. The transmission and distribution facility operation and maintenance (O&M) costs were put at 3% of the investment cost.
- Power retail prices. The average power tariffs on each island at present were used for the retail prices (the 2009 price was taken as the zero-year price).

6.2 Result of economic analysis

The economic internal rates of return (EIRR) in the projects on each island are shown in Figure 6-1. However, it is necessary for the government to hold a perspective regarding the entire country as the subject of the investment project. We consequently obtained the EIRR when the aggregate of all construction (covering the whole country) is viewed as a single investment project, and assumed that the result could be used to assess the investment efficacy. Taking a hurdle rate of 12% as the assessment criterion, calculation of cost to benefit for the project as a whole yielded an EIRR of 20.7%, indicating that the investment would be effective.

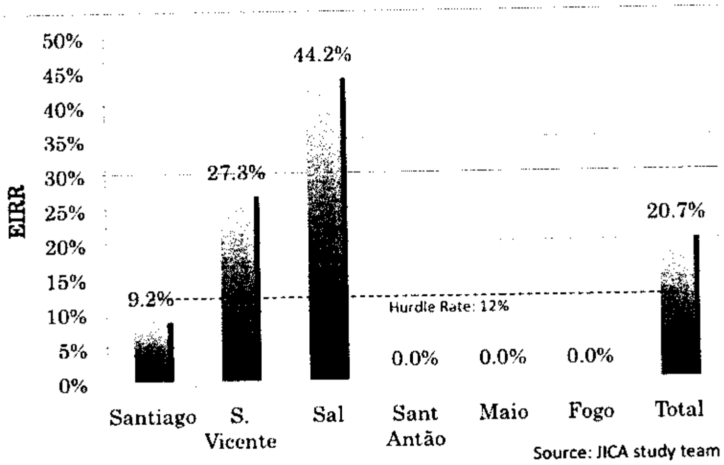

Figure 6-1 Economic internal rate of return (EIRR) of each project

Cautions regarding the results

The analysis results indicate that the project as a whole will clear the hurdle rate (12%), but it should be noted that one of the major premises of the economic calculation is the fuel conversion to fuel oil 380 for power sources and reduction of transmission and distribution loss as envisioned in the business planning. This is to say that the analysis results will change substantially if efforts to improve the business do not achieve the results anticipated.

In addition, one of the factors of uncertainty is the pace of resort development. There are many plans for development of resorts on the island of Sao Vicente and Sal, and the calculations assume that the demand for power will increase considerably as a result of this development. It must be borne in mind that the high EIRR values on these two islands are pulling up the overall project EIRR value.

6.3 Results of financial analysis

The results of financial analysis based on premises shown in Table 6.1 are as follows:

Figure 6-2 presents basic figures for the financial internal rate of return (FIRR) obtained in the financial analysis of investment projects on each island. In such overall terms, the project FIRR is projected at 20.1%. This is definitely not a low rate of return for a project.

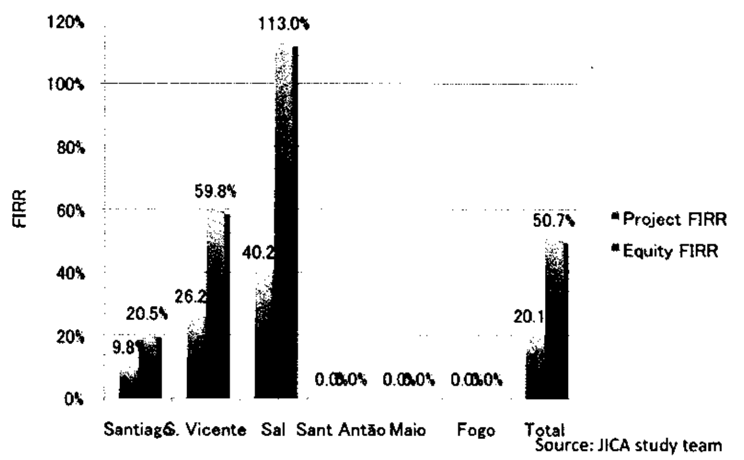

Figure 6-2 Internal rates of return (project and equity FIRRs) for each project

Table 6.1 Condition of fund procurement

Financing rate	80% of the project investment (20% equity)
Financing conditions	Interest: 0.65% p.a. Repayment period: 40 years Included grace period: 10 years

Source: Prepared by the JICA study team based on the on-going financing conditions.

6.4 Indicators of operating efficiency

The following presents an account of figures obtained by the financial analysis for three indicators:

- Debt service coverage ratio (DSCR). If the overall project is operated as a single enterprise, the DSCR would constantly be over 10 and the cash flow would be maintained on a sufficient level. This indicates that there would not arise a situation in which the loans could not be repaid.
- Return on assets (ROA). The ROA value is low immediately after the start of the project, but could basically stay on approximately equal or more than 10% toward the final year beginning around Year 7 (the sixth year after the start of facility operation).
- Return on rate base (RORB). The RORB would initially be in the area of 7% and eventually increase to just under 27%.

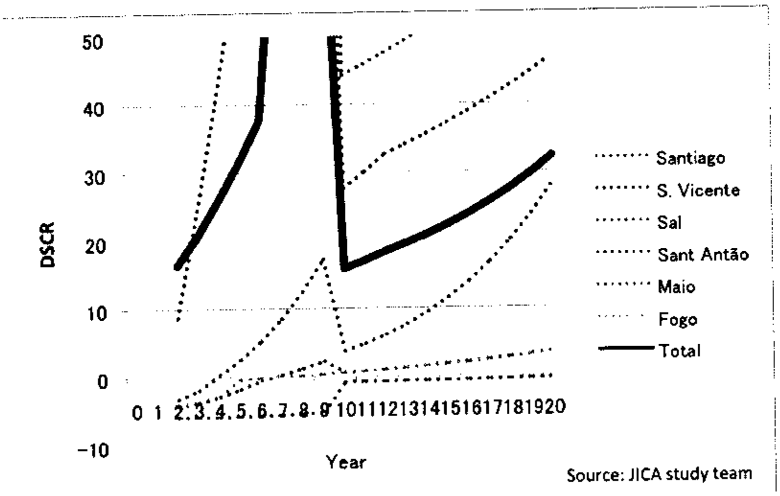

Figure 6-3 Trend of DSCR during the project life

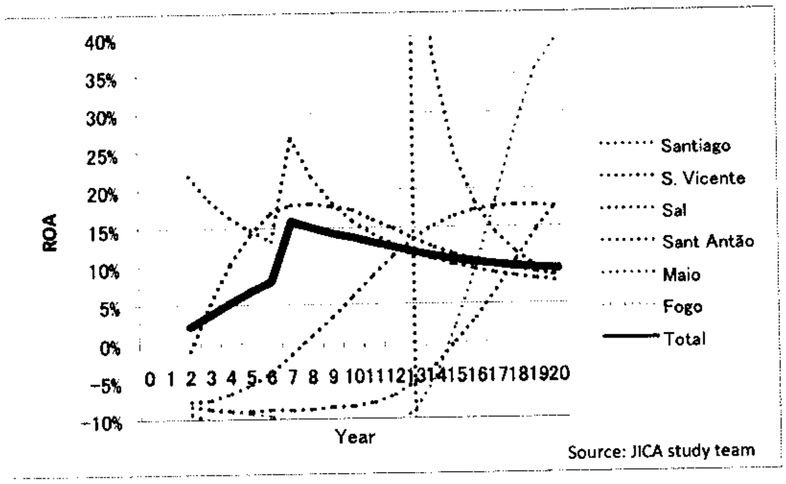

Figure 6-4 Trend of ROA during the project life

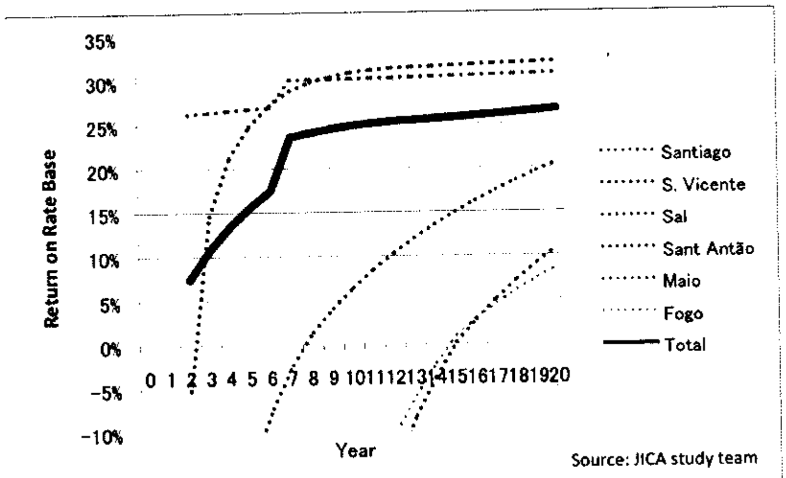

Figure 6-5 Trend of RORB during the project life

Setting of target values for operating efficiency indicators

The values for operating efficiency indicators obtained in the calculation are all favorable. As noted in the section on the economic analysis, however, it must be borne in mind that the calculation rests on several assumptions, and specifically the smooth conversion from gas oil to fuel oil 380 for fuel; a reduction of transmission and distribution loss is reached; and development of resorts on the islands of Sao Vicente and Sal as planned.

In other words, the indicator values obtained from the calculation may be regarded as representing the best results following from effective management efforts and smooth demand growth.

For this reason, in this investment project as well, it would be overly optimistic to take the calculation results as target values. Therefore, it would probably be necessary to take aim at these values--DSCR of 1.3, ROA of 8%, and RORB of 8%--that international institutions often suggest as minimum requisite conditions.

6.5 Setup for project implementation

Although it went through two major changes of management setup in the form of privatization in 2000 and renationalization in 2006, ELECTRA has continued to post net deficits each year up to the present. In this sense, it clearly could not expect to achieve a sustainable management merely by maintaining its current business setup.

For clarification of costs and accurate response to issues in each business, it would be advisable to divide business functions into units. Units could be formed by making a separation in accounts between the water and power businesses, which are the profit centers. It would also be possible to establish business units in terms of islands or island groups, and to manage costs separately for each. However, the treatment of all islands as separate, independent units could possibly detract seriously from economy of scale. To avoid this problem, it would be advisable to establish two units with Santiago and Sao Vicente at the cores.

Cautions regarding reform of the business setup

The aforementioned perspectives on reform of the business setup at ELECTRA proceed from the objective of managing costs, clearly defining responsibility for the same, and improvement of management efficiency, but this would not be enough to resolve the problems saddling ELECTRA.

In the first place, resolution of chronic deficits at ELECTRA requires investment not only in facilities to reduce costs but also in human resources. Although funding is needed for such investment, ELECTRA currently does not have any funds to direct to it. Even if ELECTRA were to get loans from banks, the poor state of its finances would undoubtedly make it impossible for the company to obtain credit easily. As such, to procure the funds needed for the coming management reform, it would have to get assistance from the government.

In the second place, ELECTRA depends on diesel generation, and its balance of business payments fluctuates greatly along with fuel costs.

As related in connection with the economic analysis, the economic feasibility of projects for investment in the transmission and distribution system considered in this study depends heavily on the reduction of fuel costs (through the switch to fuel oil 380). The fuel conversion is consequently an urgent and vital task, and the government should swiftly construct the domestic storage and transport facilities needed for fuel supply as a part of the efforts to rebuild the power sector.

In the third place, ELECTRA does not have enough personnel for facility operation and maintenance (O&M), and must reinforce its staff in order to assure a stable supply of power into the future.

It goes without saying that personnel expenses will inevitably rise, but this may be considered extra cost required for improvement of business efficiency. Of the total expenditures by ELECTRA in 2008, personnel expenses accounted for 17%. Instead of cutting back on personnel expenses, it is much more important to make the business more efficient and reduce other costs (especially for fuel) and expand revenue (by reducing transmission and distribution loss).

Appendix

Appendix 1. System Planning Map for Each Islands

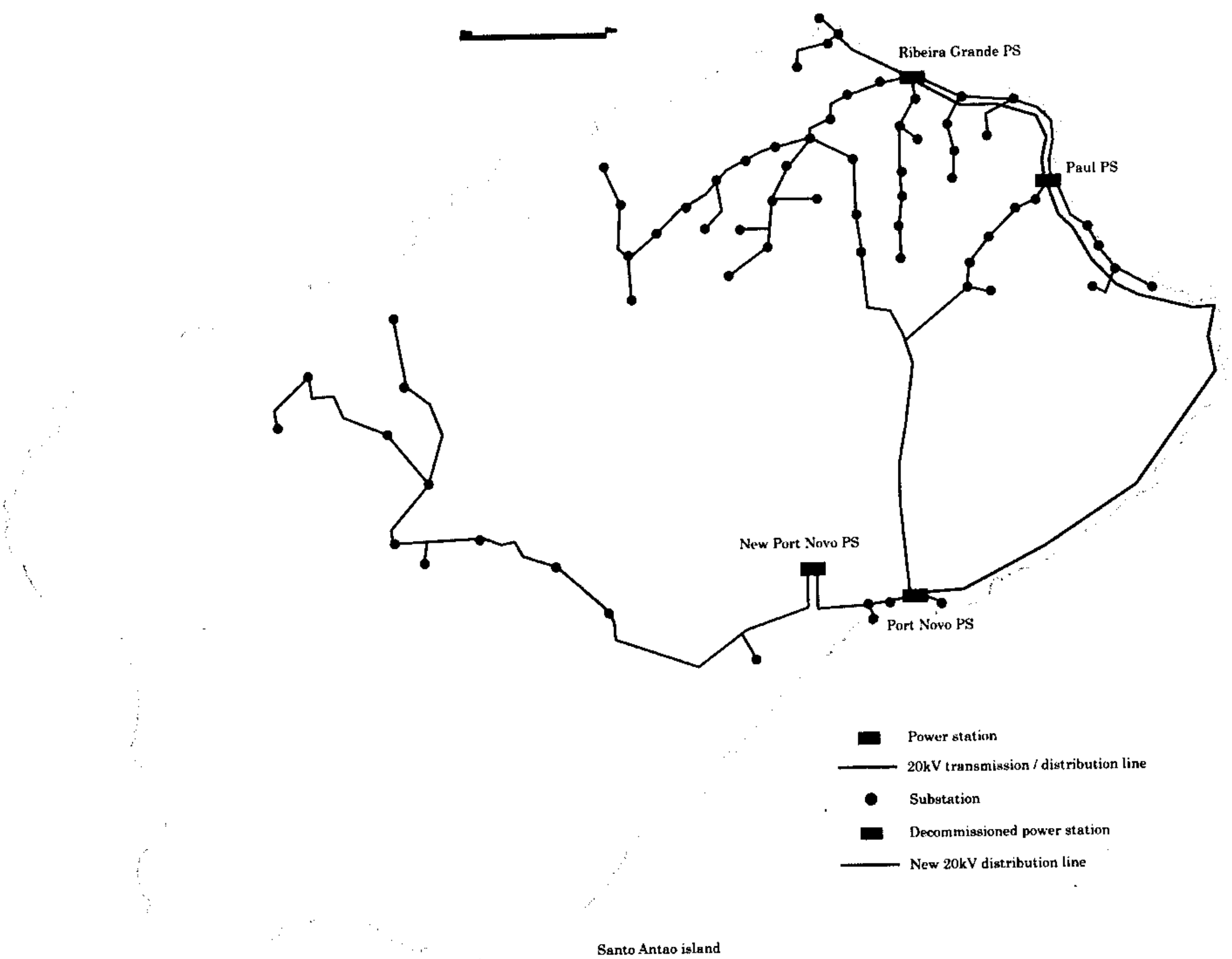

Figure A- 1.1 System Planning Map for Santo Antao Islands

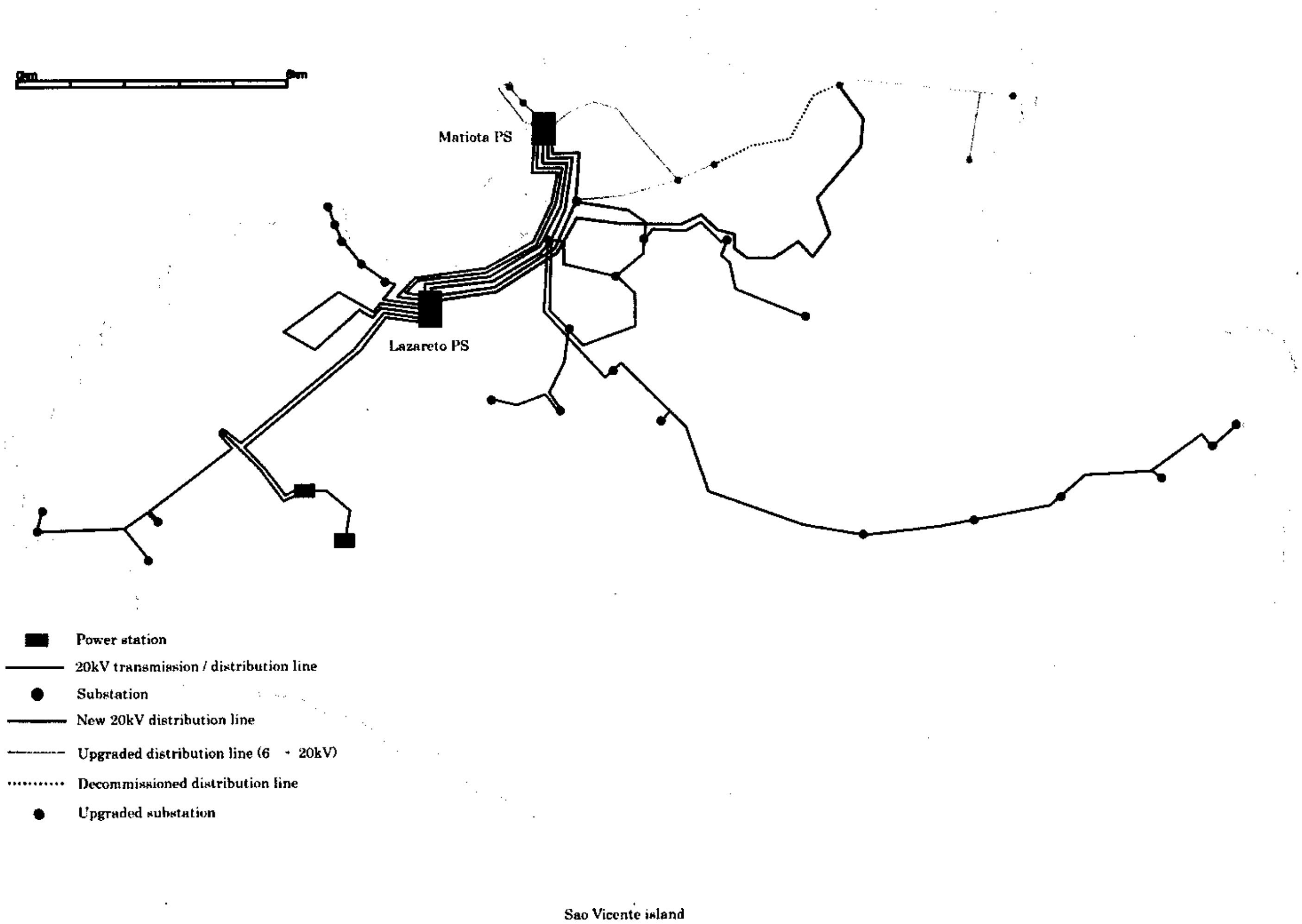

Figure A- 1.2 System Planning Map for Sao Vicente Islands

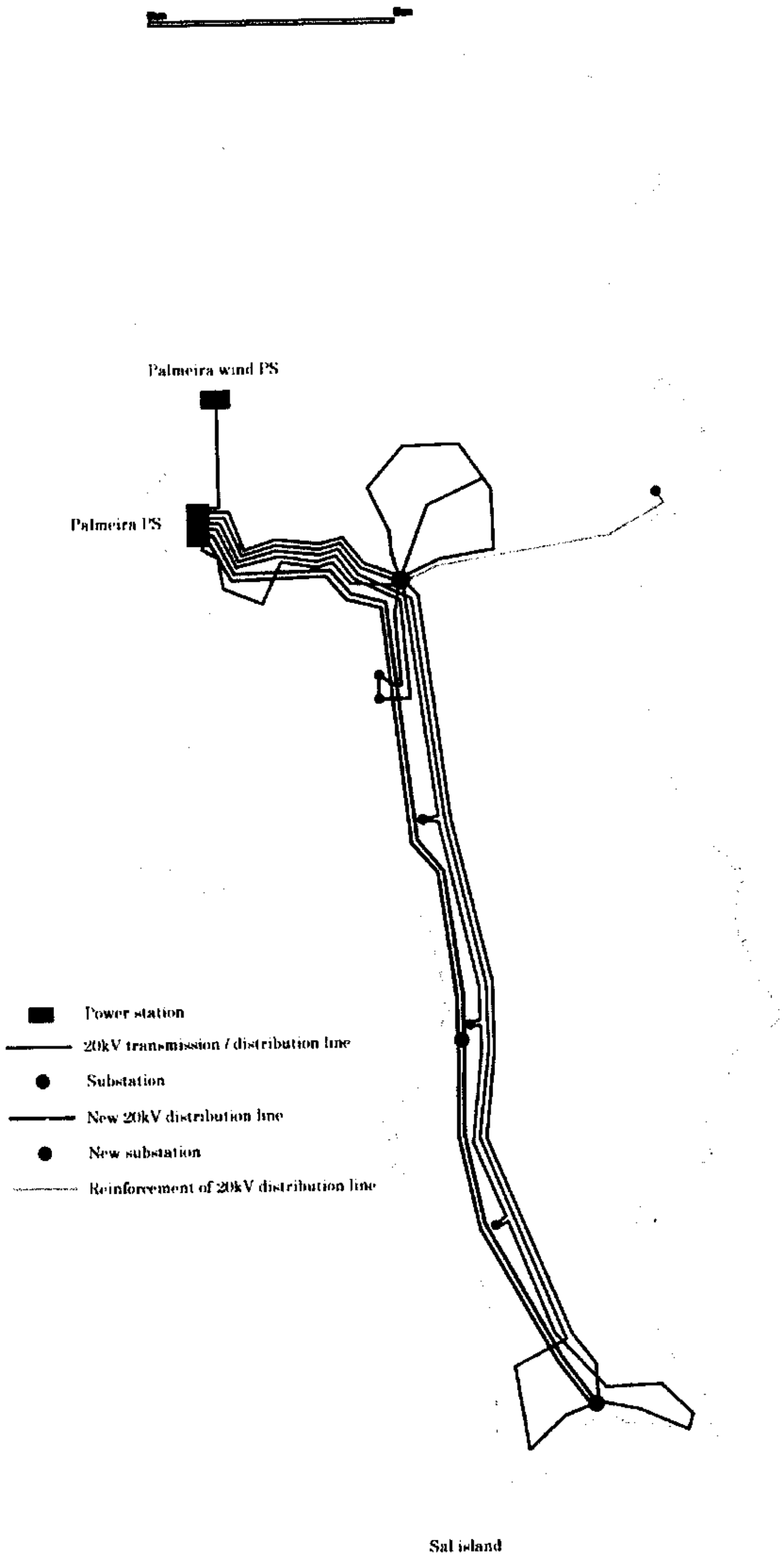

Figure A- 1.3 System Planning Map for Sal Islands

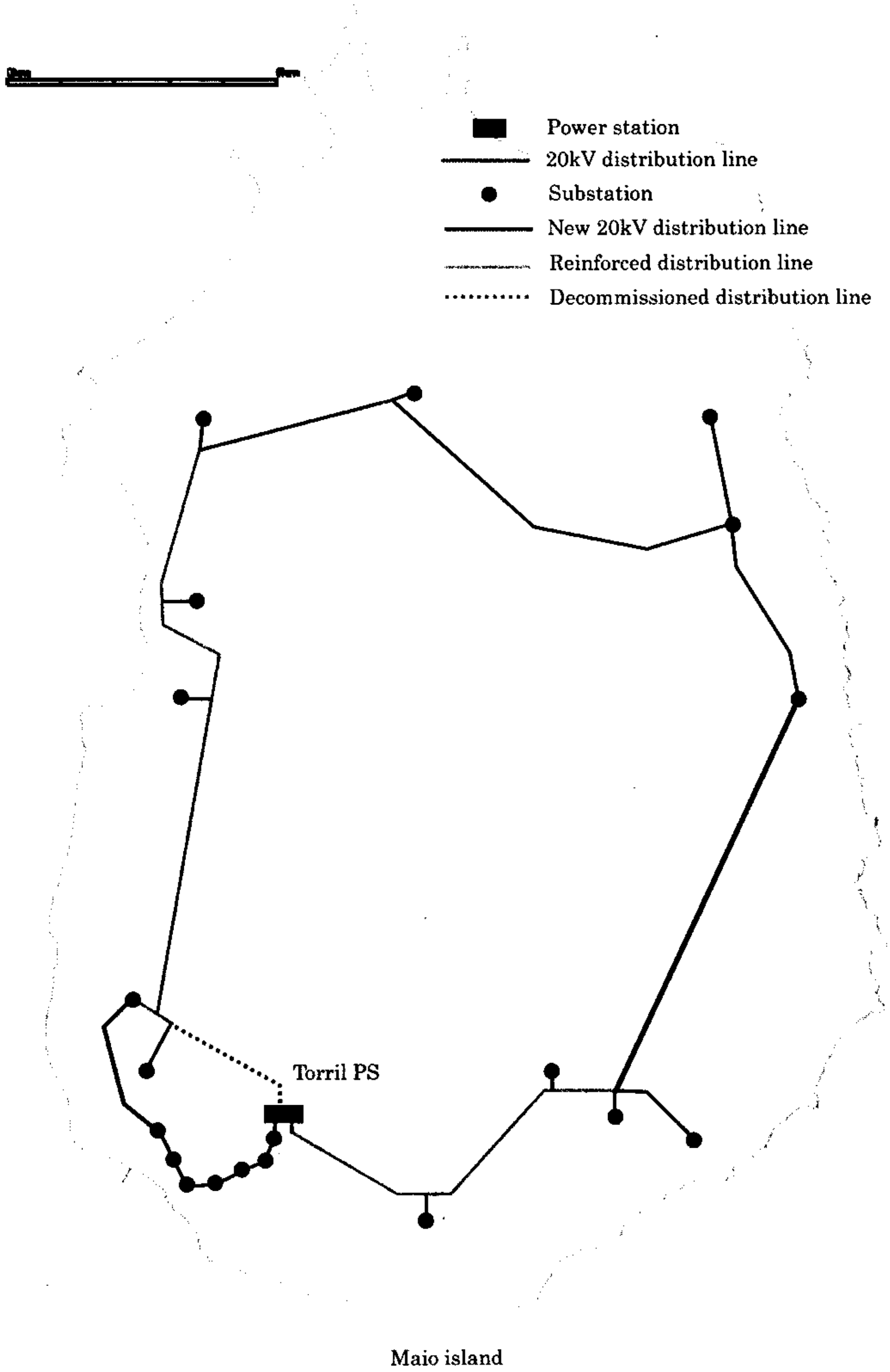

Figure A- 1.4 System Planning Map for Maio Islands

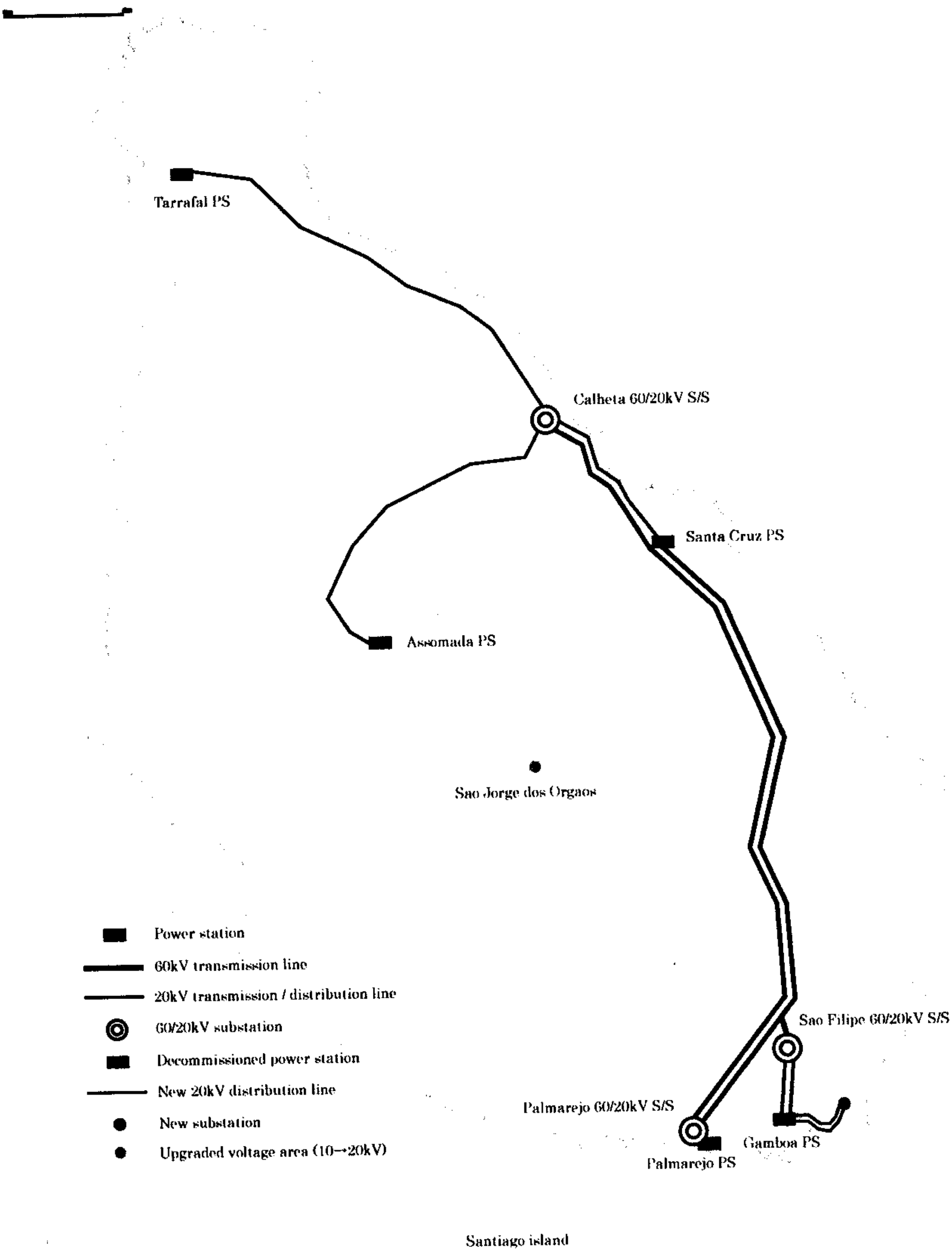

Figure A- 1.5 System Planning Map for Santiago Islands

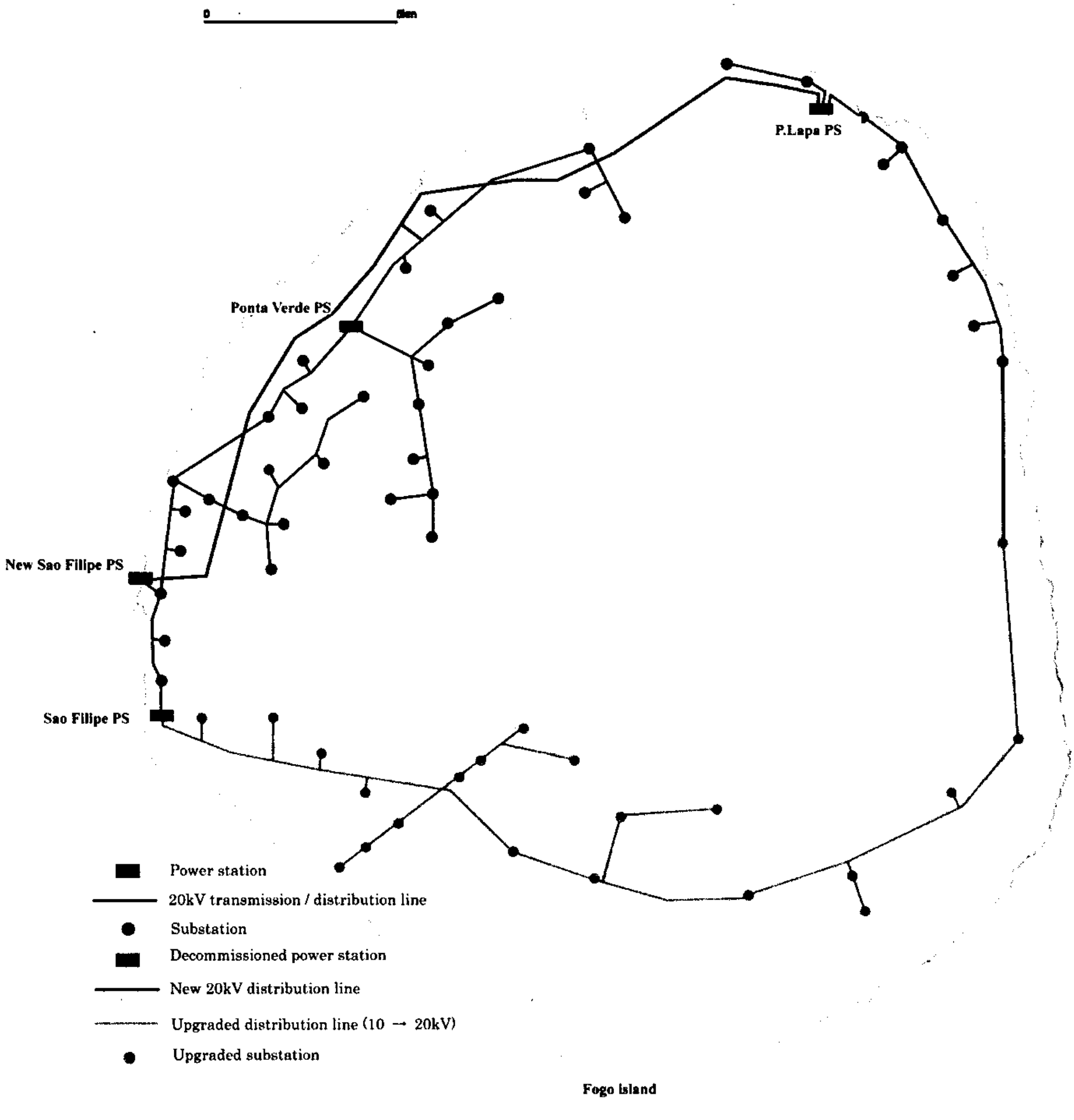

Figure A- 1.6 System Planning Map for Fogo Islands