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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF NATURAL RESOURCES (MNR)
SOLOMON ISLANDS ELECTRICITY AUTHORITY (SIEA)
THE SOLOMON ISLANDS

MASTER PLAN STUDY OF POWER DEVELOPMENT IN SOLOMON ISLANDS

FINAL REPORT

VOLUME Ⅰ SUMMARY

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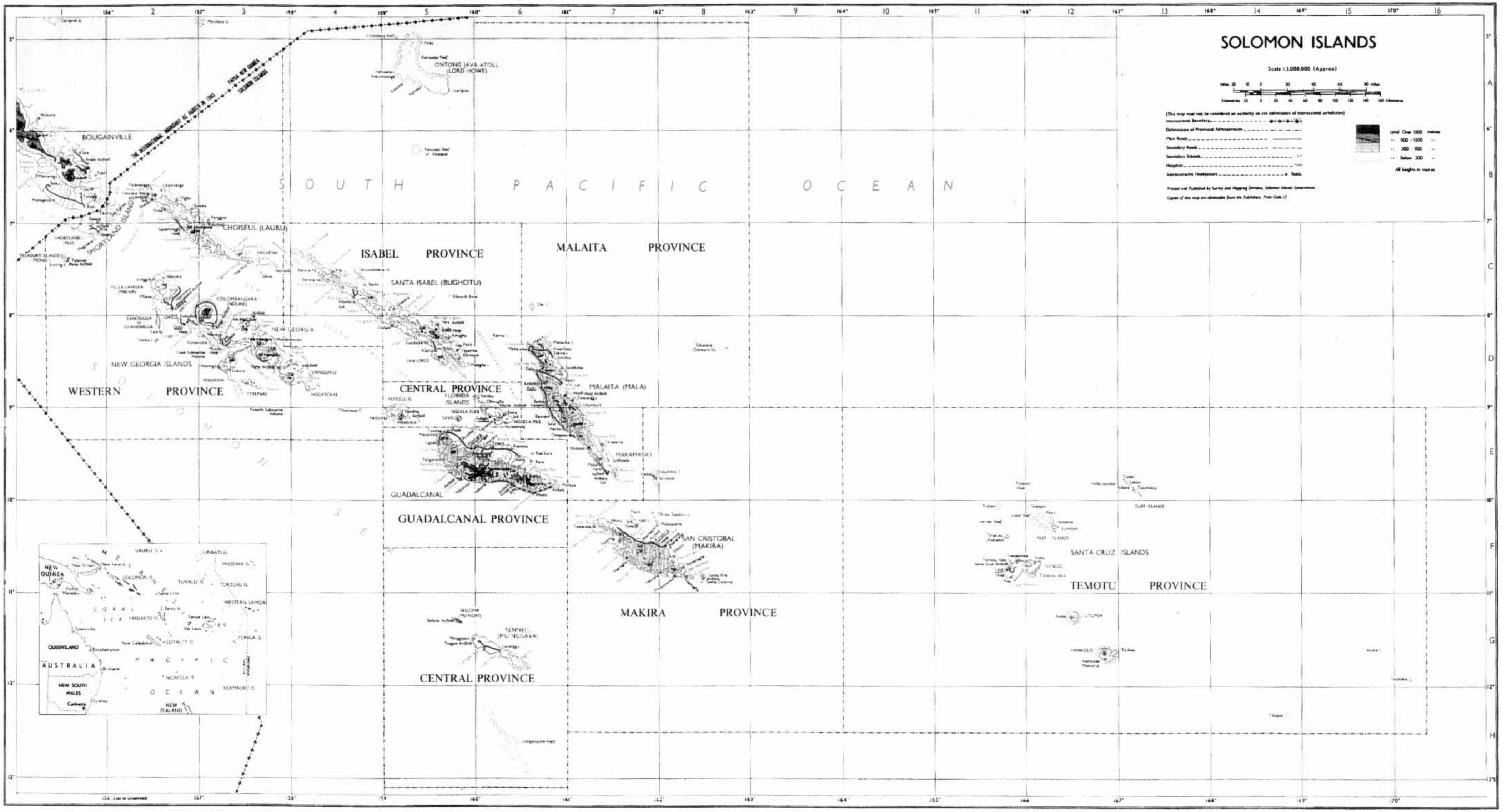

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Master Plan Study
of
Power Development
in
Solomon Islands

Draft Final Report

Contents (1)

Page

Location Map i
Contents ii
List of Tables iv
List of Figures v
Acronyms / Abbreviations vi
Units ix

CONCLUSIONS AND RECOMMENDATIONS

Conclusions 1
Recommendations 2

CHAPTER 1 INTRODUCTION

1.1 Background and Objectives 1-1
1.2 Contents of the Study 1-1

CHAPTER 2 OUTLINE OF THE M/P STUDY

2.1 Preparation Work in Japan 2-1
2.2 Related Institutions and Members 2-1
2.3 Provision of Equipment 2-1
2.4 Counterpart Training in Japan 2-2
2.5 Seminar in Solomon Islands 2-2

CHAPTER 3 GENERAL SITUATION OF SOLOMON ISLANDS

3.1 General Information 3-1
3.2 General Economic Situations 3-2
3.3 Situation of Power Supply 3-3

CHAPTER 4 POWER DEMAND

4.1 Power Demand Forecast 4-1
4.2 Estimated Condition of Power Demand Forecast 4-1
4.3 Result of Power Demand Forecast 4-2
4.4 Present Power Supply Area 4-2

CHAPTER 5 SMALL HYDROPOWER GENERATION

5.1 Objective 5-1
5.2 Hydro Potential Study 5-1
5.3 Hydropower Planning and Design 5-3

CHAPTER 6 TRANSMISSION AND DISTRIBUTION FACILITIES/ POWER SUPPLY SYSTEM

6.1 Power Development Plan and Transmission Line 6-1

Contents (2)

Page

CHAPTER 7 SOLAR POWER GENERATION
7.1 Solar Power Generation Development Methods 7-1
7.2 The Field Survey 7-1
7.3 Pyranometer and Sunshine Recorder Installation and Operation 7-2
7.4 Data Collection and Analysis 7-2
7.5 Design and Specifications 7-3
7.6 Systems and installation 7-3
7.7 Construction costs 7-4
7.8 Operation and maintenance costs 7-4
7.9 Training 7-5
7.10 Village Maintenance and Management Organization 7-5
7.11 Battery Disposal 7-6

CHAPTER 8 RURAL SOCIETY
8.1 Present State and Distinction 8-1
8.2 Village Structure 8-1
8.3 Village Livelihood 8-1
8.4 Sensitive Issue 8-3

CHAPTER 9 ENVIRONMENTAL CONSIDERATION
9.1 Environmental Assessment Scheme and Guideline 9-1
9.2 Environmental Impacts to be Considered 9-1
9.3 Measures of Environmental Consideration to be Taken 9-3

CHAPTER 10 POWER SUPPLY PLANNING
10.1 Basic Policy for Power Supply Planning 10-1
10.2 Existing Power Supply Facilities 10-1
10.3 The Power Supply Plan and Rural Electrification Plan 10-1
10.4 Evaluation of Power Supply Planning 10-6
10.5 Optimum Power Supply Plan 10-6

CHAPTER 11 INSTITUTIONAL BUILDING IN THE ELECTRICITY SECTOR
11.1 Overview of Stakeholders in Electricity Sector 11-1
11.2 Analysis of Planning Issues 11-1
11.3 Institutional Framework for Rural Electrification 11-4

CHAPTER 12 ECONOMIC AND FINANCIAL ANALYSIS
12.1 Calculation of LRMC and Examination of the Tariff 12-1
12.2 Economic and Financial Analysis of the Optimum Power Supply Plan 12-2
12.3 Economic and Financial Analysis for Rural Electrification Plan 12-3
12.4 Funding and Repayment Plan 12-4
12.5 Analysis of Financial Conditions in SIEA 12-5

List of Tables

Table No.	Title	Page
Chapter 3		
Table 3-1-1	Administrative Districts of Solomon Islands (1999)	3-1
Table 3-2-1	GDP data	3-2
Table 3-2-2	Exchange Rate	3-2
Table 3-3-1	Exisiting generators (Provincial wise/ Islands wise)	3-6
Table 3-3-2	Past electrical record 1990 - 1999 (Grid and Powerstation wise)	3-7
Chapter 4		
Table 4-3-1	Result of Power Demand Forecast of Solomon Islands	4-3
Chapter 5		
Table 5-1	Result of Hydropower Map study	5-1
Table 5-2	Summary of Hydropower Planning	5-3
Chapter 10		
Table 10-5-1	Optimum power supply development scheme in Solomon Islands	10-7
Chapter 11		
Table 11-2	Comparision of priority targets for rural electrification	11-2
Chapter 12		
Table 12-2-1	FIRR and EIRR for the small hydropower potential sites	12-2
Table 12-3-1	FIRR calculation of SHS in each tariff system	12-3

List of Figures

Fig No.	Title	Page
Chapter 5		
Fig. 5-1	Location of Hydropower Site	5-7
Chapter 6		
Fig. 6-1-1	Network System of Guadalcanal Island	6-1
Fig. 6-1-2	Network System of Choiseul Island	6-2
Fig. 6-1-3	Network System of Santa Cruz Island	6-2
Fig. 6-1-4	Network System of Malaita Island	6-3
Fig. 6-1-5	Network System of Santa Isabel Island	6-4
Fig. 6-1-6	Network System of San Cristobal Island	6-5
Chapter 8		
Fig. 8-1	Flow Chart for Land Acquisition	8-4
Chapter 11		
Fig. 11-1	Institutional framework of rural electrification	11-1
Fig. 11-2	Planning issues for rural electrification	11-2

ACRONYMS / ABBREVIATIONS

ADB	:	Asian Development Bank
AFPA	:	Automatic Fuel Price Adjustment
ANZ	:	Australia and New Zealand Banking Group Limited
APACE	:	Appropriate Technology Community and Environment, Sydney-based NGO
CAP	:	Chapter
CASO	:	Conservation Area Support Officer
CBSI	:	Central Bank of Solomon Islands
CEMA	:	Commodity Export Marketing Authority
CF	:	Conversion Factor
CI	:	Conservation International
CIF	:	Cost, Insurance and Freight
CO2	:	carbon dioxide
COD	:	Cash on Delivery
CRCD	:	Community Resource Conservation and Development
DB	:	Dry Battery
DBSI	:	Development Bank of Solomon Islands
E	:	east
EC	:	European Community.
ECD	:	Environment and Conservation Division
EDS	:	Every Day Stress
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
EIS	:	Environmental Impact Statement
EL	:	elevation
ELR	:	Solomon Islands Environmental Legal Review
EO	:	Environment Officer
F/S	:	Feasibility Study
FIRR	:	Financial Internal Rate of Return
FOB	:	Free On Board
GDP	:	Gross Domestic Product
GRDP	:	Gross Regional Domestic Product
GREA	:	Guadalcanal Rural Electrification Association
GTZ	:	Deutsche Gesellschaft fur Technische Zusammenarbeit
HRPI	:	Honiara Retail Price Index
ICSI	:	Investment Companies of Solomon Islands
ISFMT	:	Isabel Sustainable Forestry Management Trust
IUCN	:	International Union for Conservation of Nature and Natural
JICA	:	Japan International Cooperation Agency
Kr	:	kerosene, kerosine
LAR	:	Liquidity Asset Ratio
LRAIC	:	Long Run Average Incremental Cost
LRMC	:	Long Run Marginal Cost
M/P	:	Master Plan
MEMM	:	Ministry of Energy, Mines and Mineral Resources
MHP	:	Mini- Hydropower

ACRONYMS / ABBREVIATIONS

mil	: million
MNR	: Ministry of Natural Resources
MOF	: Ministry of Finance
MTDS	: Medium Term Development Strategy
N	: north
NBSI	: National Bank of Solomon Islands
NCP	: National Coalition Partners
NE	: northeast
NEMS	: Solomon Islands National Environmental Management Strategy
NGO(s)	: Non-Government Organization(s)
NNW	: north-northwest
NPF	: National Provident Fund
NW	: northwest
P/S	: Power Station
PAP	: People's Alliance Party
PEO	: Principal Environment Officer
PER	: Public Environmental Report
PPD's	: Project Preparation Documents
PS	: Power Station
PSIP	: Public Service Investment Program
PSRP	: Policy and Structure Reform Program
PV	: Photovoltaic
PVC	: polyvinyl chloride
REAC	: Rural Electrification Advisory Committee
RIPEL	: Russel Islands Plantation Enterprises
ROA	: Return on Asset
ROR	: Run of River
RTC	: Rural Training Center
S	: south
SCF	: Standard Conversion Factor
SDR	: Special Drawing Right
SE	: southeast
SELF	: Solar Electric Light Fund
SEO	: Senior Environment Officer
SHS	: Solar Home System
SIAC	: Solomon Islands Alliance for Change
SICHE	: Solomon Islands College of Higher Education
SIDT	: Solomon Islands Development Trust
SIEA	: Solomon Islands Electricity Authority
SIECD	: Solomon Islands Environment and Conservation Division
SIMS	: Solomon Islands Meteorological Service
SINURP	: Solomon Islands National Unity
SIPL	: Solomon Islands Plantation Limited
SIWA	: the Solomon Islands Water Authority
SMEC	: the Snowy Mountain Engineering Corporation
SOE	: State-Owned Enterprise

ACRONYMS / ABBREVIATIONS

SOPAC	: South Pacific Commission
SPBCP	: South Pacific Biodiversity Program
SPREP	: the South Pacific Regional Environment Program
SSE	: south-southeast
SW	: southwest
T&D	: Transmission and Distribution Line
TEPSCO	: Tokyo Electric Power Services Co., Ltd.
UNICEF	: the United Nations Children's Fund
UNIDO	: United Nations Industrial Development Organization
W	: west
WHO	: World Health Organization
WTP	: Willingness to Pay
WWF	: World Wide Fund for Nature

UNIT

Prefixes

μ	:	micro-	=	10^{-6}
m	:	milli-	=	10^{-3}
c	:	centi-	=	10^{-2}
d	:	deci-	=	10^{-1}
da	:	deca-	=	10
h	:	hecto-	=	10^{2}
k	:	kilo-	=	10^{3}
M	:	mega-	=	10^{6}
G	:	giga-	=	10^{9}

Units of Length

m	:	meter
km	:	kilometer

Units of Area

m^2	:	square meter
km^2	:	square kilometer

Units of Volume

m^3	:	cubic meter
l	:	liter
kl	:	kiloliter

Units of Mass

kg	:	kilogram
t	:	ton (metric)
oz	:	ounce

Units of Energy

kWh	:	kilowatt-hour
MWh	:	megawatt-hour
MJ	:	megajoule

Units of Temperature

℃	:	degree Celsius or Centigrade

Units of Electricity

W	:	watt
kW	:	kilowatt
MW	:	megawatt
Ah	:	ampere hour
V	:	volt
kV	:	kilovolt
kVA	:	kilovolt ampere

Units of Flow Rate

l/s	:	liter per second
m^3/s	:	cubic meter per second

Units of Currency

SB$	:	Solomon Dollar
US$	:	US Dollar
¥	:	Japanese Yen
AUcent	:	Australian Cent

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and Recommendations

The JICA Team recommended that the power supply plan, as shown in Table 10-5-1, shall be implemented as an optimum power supply plan for the Solomon Islands.

Also it is recommended that the rural electrification plan by SHS, as shown in Table 10-3-12, shall be implemented as an effective electrification plan for remote rural areas in order to disseminate SHS programs and rural electrification.

On the other hand, it is necessary the training of the provincial government engineers and the community people who will be in charge of the photovoltaic system maintenance, in order to rise villager's awareness and understanding and to strengthen the dissemination of PV . For these reasons, the establishment of a PV training center (in REAC), for theory and practice training on PV systems, is recommended.

1 Conclusions

It is concluded in this study that the optimum power supply plan by grid or hydro power and the rural electrification plan by PV would be feasible for realization. However, the total amount of US$319 million is needed for implementation of the optimum power supply development scheme until the year 2018 . Since the government development budget, which will be obtained from grant aid or loans by overseas donors, will not meet the above mentioned amount, the electricity charge must be increased.

The Solomon government should ask for a new source of funds, and should fulfil the cooperation support requested by the donor country. Also the amount of increase in electricity charges should be controlled as much as possible.

The organization and management of newly developed hydro power stations should be done by SIEA, because SIEA has been operating successfully two hydro power stations (Buala and Malu'u).

With regard to the institutional framework for rural electrification, the Rural Electrification Advisory Committee (REAC) should be established and should perform as a key organization for rural electrification implementation and for coordination of activities among ECC, MNR, SIEA, training institutions, provincial governments, aid donors and villages/communities (including NGO/private sector), following the national energy policy and guidelines.

1.1 Optimum power supply

The optimum power supply plan by grid or small hydro power is shown in Chapter 10, Table 10-5-1, Optimum power supply development scheme. A total amount of US$ 313 million is needed to implement the above scheme.

1.2 Rural electrification

The rural electrification plan by SHS should be implemented in two stages corresponding to the pilot scheme and nationwide scheme. First the pilot scheme should be implemented (the implementation period is three years for the pilot scheme).

The number of electrified houses by the end of 1998 was about 6,600, and would be about 16,100 by the end of 2018, to be supplied by electricity from grid, small hydropower and SHS.

2 Recommendations

2.1 Recommendation for the power supply plan

It is necessary to carry out the following tasks consciously before the power supply plan is implemented as explained in section 1 Conclusions.

(1) To review the power demand forecast for each province/island at least once per year.

(2) To carry out further surveys on the following topics before implementation or development of each hydro potential in each province or island.

- Guadalcanal Province: The possibility of an open channel shall be confirmed for Maotapuku 1 and Maotapuku 2. A leveling survey shall be carried out for confirmation of the effective head at Sasa.
- Malaita Province: Access roads and geology surveys shall be carried out at Silolo.
- Isabel Province: Discharge measurement shall be surveyed at Kubolata.
- Makira Province: Leveling survey and discharge measurement shall be carried out at Waimapuru.
- Choiseul Province: Level survey of the tailrace water shall be carried out at Sorave.
- Temotu Province: Leveling survey and discharge measurement shall be carried out at Luembalele.

The output capacity and energy generation should be reviewed based upon these surveys.

(3) The power supply plans should be reviewed based on updated power demand forecasts.

(4) The following environmental study should be carried out before implementation of the optimum power supply plan.

- Location of the structure in relation to the sites of conservation areas.
- Impacts on endemic or rare species of wildlife.
- Large scale reshaping of the slopes and rivers which could cause artificial or intensified landslides of floods.

In the past, there were some disputes on land ownership in Solomon Islands. If a dispute is focused only on land ownership, the land ownership and the project can be processed separately. Therefore the following matter should be stated clearly before the planning stage:

- The land acquisition and land ownership shall be definite and a written agreement should be signed for the project implementation.

2.2 Recommendations for rural electrification

2.2.1 Organization of the rural electrification

REAC shall be established in the Energy Division of the Ministry of Natural Resources as a primary organization for the rural electrification program implementation by SHS. REAC consists of several institutions that are related to ministry and departments, SIEA, NGO, overseas aid donors in addition to the Energy Division. REAC should have responsibility for the following functions:

1) Information dissemination of rural electrification
2) Establishment of a PV training center
3) Production of a PV training manual
4) Establishment of a revolving fund for rural electrification by SHS
5) Legislation of a regulatory framework
6) Evaluation and selection of petitions
7) Workshop at the village for SHS project to be implemented
8) Procurement and installation of SHS
9) Providing the aftercare service
10) Monitoring and evaluation

2.2.2 Implementation of rural electrification

The following environmental study should be carried out before rural electrification implementation by SHS.

1) Reduction in the use of dry cells and the amount of their disorderly disposal (positive impact)
2) Disposal of used batteries at the end of a lifecycle of SHS facilities (adverse impacts)
3) Disturbance of the surrounding landscape with distribution lines and SHS facilities (adverse impacts)
4) Safety issues of transmission lines and the likes in the cyclone and strong winds (adverse impacts)

The rural electrification plan shall be carried out by two schemes. Firstly, the pilot scheme shall be implemented, and then, the nationwide scheme shall be implemented. Any action to be taken from results of the pilot scheme should be evaluated, aiming to form a basis for the nationwide scheme.

The following issues shall be studied and reflected into the nationwide scheme:

Regarding operation and maintenance organization, a person to have responsibility of PV system in a community/village should be commissioned as a basic organization. This person should take care of the daily operation in the village, and the provincial engineer should take care of any trouble that cannot be solved by this commissioned person.

The SIEA engineer should be in charge of maintenance back up and should be able to solve any major trouble.

(1) Technical issues such as number of members, service level, service items, maintenance cycle, training subject and training periods
(2) Management issues such as number of members, amount of charge for services, rate of charges collection, rate of delinquency
(3) Disposal of batteries
When a stock amount of batteries is reached, batteries to be processed should be conveyed to Brisbane in Australia, to be processed at a certain factory, taking provision that disposal and treatment of batteries do not affect the environment of Solomon Islands.

2.3 Establishment of rural electrification funds by SHS

The social basic infrastructure may not be developed in remote rural area and in areaa far from the urban zones, the people living in such places will be being forced to live with neither water, electricity nor gas. It is recommended that the rural electrification funds by SHS shall be collected in addition to the present electricity charges in order to provide such people the benefit of lighting. The increased amount by SHS electrification funds is stated in section 2.4.

2.4 Electricity charge

2.4.1 Electricity charge by optimum power supply plan

For implementation of power supply plan by grid and small hydropower, the total amount of US$ 313 million for construction and O & M cost is needed to implement the optimum power supply plan. In order to attain this, it would be necessary to increase the present average electricity charge from 79.18 SBC/kWh to 94.03 SBC/kWh as final average charge.

2.4.2 Collection charge by rural electrification program

For implementation of rural electrification program by SHS, the total amount of US$ 6.2 million for construction and O & M cost is needed to implement the pilot scheme and nationwide scheme. In order to attain this, it would be necessary to collect the charge from 40 – 50 SB$/month/set. However, since the payable amount by people in rural areas would be 10 to 20 US$/month/set, the difference between this payable amount and the collection charge should be compensated from electricity charges for the rural electrification funds by SHS.

2.4.3 Total collection charge

It is recommended that the total increaseded amount be 16.67 SBC/kWh, which consists of two parts that correspond to the optimum power supply plan (increasing amount is 14.85 SBC/kWh) and rural electrification plan by SHS (increasing amount is 1.82 SBC/kWh), shall be carried out in order to implement the long term power supply master plan. This means that the rise of average electricity charge shall be from the present average charge of 79.18 SBC/kWh to 95.85 SBC/kWh as the final average electricity charge.

2.5 Funding

The fund for rural electrification program by SHS shall be established, and the fixed number of SHS shall be installed every year. The funds for SHS rural electrification shall be added to the present electricity charge and collected every month. The collection shall be carried out by SIEA, and the amount shall be transferred to certain account in DBSI. REAC shall utilize the funds for rural electrification by SHS.

2.5.1 Fund for optimum power supply plan by gird or small hydropower

Total construction cost of US$ 172 million will be funded by US$ 100million of loan, US$ 29million of grant and US$ 43million of own fund. The loan should be long repayment term and lowest interest. The projects cost over US$ 20million shall be procured by loan. The grant shall be applied only small sized project less than US$ 10million.

2.5.2 Fund for rural electrification plan by SHS

Total construction cost of US$ 0.37 million for the pilot scheme will be funded by grant aid, and the amount of US$ 5.2 million for nationwide scheme during the year 2005 to 2018 shall be funded by loan. However it is desirable to ask the grant for nationwide scheme taking account of dissemination of SHS and rural electrification program by SHS.

2.6 Training for the formation of Maintenance Personnel

Engineers, who belong to the provincial government, should be trained on PV at the training center in Honiara. People from the communities to be in charge of maintenance of photovoltaic systems, should be trained by the provincial engineer.

2.7 Establishment of PV training center

Since at present there is no training center for PV in the Solomon Islands, such training center should be established in the Solomon Islands College Higher Education (SICHE) or Rural Training Center (RTC). It is recommended that provincial engineers and young apprentices, who come from rural areas to Honiara or to the provincial capitals, should be trained and assigned as personnel in charge of photovoltaic maintenance.

2.8 Operational Improvement of SIEA

In order to improve operational management of SIEA, the following objectives should be achieved (Refer to Chapter 11, Section 11.1.5)

(1) Improvement of collection rate of electricity tariff

- Promotion of ongoing “Cash Power 2000” installation
- Expansion of compulsory electricity disconnection to default users (especially to statutory organizations)

(2) Efficiency of generation and distribution of electricity

- Introduction of remote supervisory system for outstations’ operation
- Improvement of maintenance work for generation and distribution facilities

(3) Strengthening of management capability

- Contract out of management; the Ministry of Finance is currently planning for tender
- Formulation of Corporate plan

(4) Increase of electricity tariff

- Increase of electricity charge to the reasonable level to produce operational profit

2.9 Electrification measure for low income communities

It is recommended that the village or communities that were not selected in these schemes, should be the object of some social development measure based on PV, to be taken by the Solomon Government.

CHAPTER 1

INTRODUCTION

Chapter 1 Introduction

1.1 Background and objectives

The power supply to attend the electricity public demand in the Solomon Islands is achieved almost by diesel power plants. Fuel costs from the diesel power plants have deteriorated the financial situation of Solomon Island Electricity Authority (SIEA).

Under these circumstances, the Government of the Solomon Islands requested the Government of Japan to conduct a study for a long-term power development master plan. In response to this request, JICA, as the executing agency of the Japanese Government, with the mediation of the Project Formation Mission, agreed the scope of work and the minutes of meeting with the Solomon Government, and decided to dispatch the JICA Master Plan Study Team (JICA M/P Team).

The objectives of the Master Plan Study are:

- to formulate a long-term power supply plan and implementation plan, to be completed by 2015, based on the utilization of renewable energy, and
- to provide recommendations on institutional organization for the electric power sector in the Solomon Islands.

1.2 Contents of the study

1.2.1 Geographical scope and contents

The Master Plan (M/P) Study should cover the national territory of the Solomon Islands. However, the Master Plan is to be carried out based upon the next methodology, due to time constraints and limited human resources:

(1) Small hydro power development with transmission and distribution facilities

Potential sites on islands that could not be field surveyed, will be studied and considered in the report based upon analysis of maps and consultation with the Solomon Islands counterpart bodies.

(2) Solar energy generation development

Potential villages on islands that could not be field surveyed will be considered in the report after consultation with the Solomon Islands counterpart bodies.

(3) Rural society study

After the social survey covers six islands, with a total population equivalent to the 87 percent of the national population, it is considered that the survey leads to a good comprehension of social aspects that approach a scenario representative of the Solomon Islands.

The study target year is 2015 based on the S/W and M/M, and the study contents are as follows:

(1) Analysis of power supply methods for each area

(2) Establishment of a basic data collection system, to include rainfall, hydrologic, sunshine duration and solar irradiation data
(3) Field investigation
(4) Investigation of the power sector present situation and power demand forecast
(5) Rural society study and environmental study
(6) Economic and financial study
(7) Formulation of an optimum power supply plan
(8) Measures for an early realization of the implementation plan
(9) Recommendations on the future structure and organization of the electric power sector

CHAPTER 2

OUTLINE OF THE M/P STUDY

Chapter 2 Outline of the M/P Study

2.1 Preparation work in Japan

The M/P Study Team carried out the following activities in the Solomon Islands from December 1998 to June 2000.

- Three field surveys have been carried out, and the Inception Report (January 1999), Progress Report (March 1999) and Interim Report (March 2000) have been submitted, explained and discussed between MNR and SIEA.
- Two seminars for transfer of technology have been carried out.

2.2 Related institutions and members

The participating institutions and members are as follows:

- MNR (Ministry of Natural Resources)
- SIEA (Solomon Islands Electricity Authority)
- Ministry of National Planning
- Ministry of Finance
- Department of Commerce, Employment and Tourism
- Ministry of Provincial Government and Rural Development
- Eight Provinces
- APACE (Appropriate Technology for Community and Environment)
- GREA (Guadalcanal Rural Electrification Agency)
- Embassy of Japan
  M. Hideo Nomoto, Ambassador
  Mr. Yutaka Hirata, Ambassador
  Mr. Yousuke Miyamoto, Second Secretary and Vice Consul
- JICA/JOCV, Solomon Office
  Mr. Shinichi Hamada, Resident Representative
- JICA Master Plan Study Team
  10 members
- JICA Head Office

2.3 Provision of equipment

The team purchased a personal computer during the first field survey in Honiara. This was utilized for transfer technology on power demand forecast and power supply planning during the second and third field surveys. Measurement equipment and material was purchased in Japan and sent to Solomon Islands. The team confirmed the installation and operation of these equipment and materials during the second and third field surveys.

2.4 Counterpart training in Japan

During the master plan study, training of the counterpart in Japan was carried out with the purpose of instructing mainly about small hydro power development, but including also power demand, power supply, transmission and distribution lines and economic and financial analysis, during 28 days from 21 March 2000 to 17 April 2000.

2.5 Seminar in Solomon Islands

During the study, two seminars were carried out at Honiara for transfer technology, as described below:

(1) First seminar (22 October 1999 and 2 December 1999)

The first seminar was held for the purpose of instructing about power demand, small hydro power development, solar energy development, transmission and distribution line planning, rural society survey contents and importance, institutional organization of the electricity sector and economic and financial analysis methods, under the attendance of members of MNR, SIEA and related government institutions.

(2) Second seminar (19 May 2000)

The second seminar was held for the purpose of instructing about power demand, power supply planning, small hydro power design, solar energy systems design, transmission and distribution line design, procedure and result of rural society survey, institutional organization of the electricity sector and economic and financial analysis result, under the attendance of members of MNR, SIEA and related government institutions.

CHAPTER 3

GENERAL SITUATIONS OF SOLOMON ISLANDS

Chapter 3 General Situation of Solomon Islands

3.1 General Information

Country name : The Solomon Islands
Independent : 7 July 1978, from the British Commonwealth
Capital : Honiara
Land area : 28,370 km^2
Population : approximately 440,000 (1999,estimation)
Race structure: Melanesian (94%), Polynesian (4%), and Micronesian and others (2%)
Language : Pidgin English (common language), English (official languag e), and more than 80 different vernaculars
Religion : Christian (98%)
Constitution : constitutional monarchy with the British Queen as Head of the country represented by Solomon Governor-General
Government : August 1997- June 2000, united Cabinet headed by Mr. Ulfaal
30th June 2000 - , Mr. Sogavare was selected as a new Prime Minister among the ethnic tension.

Table 3-1-1 Administrative Districts of Solomon Islands (1999)

	Province	Main Land	Capital	Large City	Area (km^2)	Population
1	Western	New Georgia, Gizo Vella Lavella, Kolombangara	Gizo	Noro, Munda	5,475	77,573
2	Choiseul	Choiseul	Taro		3,837	25,858
3	Isabel	Santa Isabel	Buala		4,136	24,474
4	Central	Tulagi (Florida Islands)	Tulagi		615	29,165
5	Rennell & Bellona	Rennell, Bellona	Tingoa		671	3,241
6	Guadalcanal	Guadalcanal			5,336	65,847
7	Honiara	--	--	--	22	49,817
8	Malaita	Malaita	Auki	Malu'u	4,225	112,505
9	Makira	San Cristobal	Kirakira		3,188	31,322
10	Temotu	Nendo(Santa Cruz Islands)	Lata		865	22,603
	Total				28,370	442,404

* Population is estimated.

Organizations: In July 1998, the organization was restructured from 15 to 10 ministries.

Office of the Prime Minister
Ministry of Justice, Legal Affairs and Police Security
Ministry of Commerce, Industries, Employment and Tourism
Ministry of Transport, Works, Communications and Aviation
Ministry of Natural Resources (MNR)
Ministry of Home Affairs, Provincial Government and Rural Development
Ministry of Education and Human Resources Development
Ministry of Health and Medical Services
Ministry of Finance and Development Planning
Ministry of Land, Agriculture and Fisheries

3.2 General Economic Situations

Characteristics of the economy:

1) mixture of traditional self-supply economy and currency economy
2) high portion of the primary industry
3) high dependency on import products etc.

Gross Domestic Product (GDP): US$790.5 per capita (1999)

Table 3-2-1 GDP data

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Nominal GDP (SB$,mil)	598.3	763.1	901.2	1,052.5	1,249.9	1,461.5	1,612.1	1,728.1	1,738.7
Nomical GDP per Capita (US$)	666.6	763.8	798.7	873.9	968.1	1,050.0	1,065.1	853.7	790.5
Real GDP (at 1985 price, SB$)	248.5	276.7	281.4	304.1	334.8	340.1	337.0	341.3	339.4
Index of Real GDP (1985=100)	119.9	133.5	135.8	146.7	161.5	164.1	162.6	164.7	163.8
annual growth %	0.6%	11.4%	1.7%	8.1%	10.1%	1.6%	-0.9%	1.3%	-0.5%

Source: non-official data from Central Bank of Solomon Islands, May 2000

Industry : the primary industry (copra, coconut oil, fish, timber, and gold)

Export goods : timber, especially log timber, fish, coconut product, and gold

Import goods : daily goods, clothes, stationary, automobile, and foods

Exchange rate : SB$5.06/US$

(average 1999) approximately JP¥20/SB$

Table 3-2-2 Exchange Rate (year average)

	1991	1992	1993	1994	1995	1996	1997	1998	1999
SB$/US$	2.72	2.93	3.18	3.29	3.41	3.55	3.73	4.82	5.06
%		7.7%	8.5%	3.5%	3.6%	4.1%	5.1%	29.2%	5.0%

Source: Annual Report 1999, Central Bank of Solomon Islands

Inflation rate : 10.3% per year (average in 1991~ 1998), 7.8% (in the end of 1999)

Average rate : lending rate 14-15%, deposit rate 3.0-4.0% (September 1998)

Money supply : SB$457mil (in the end of 1999)

Government Budget : SB$592.9mil (2000)

Development budget SB196.2mil

(mostly relied on the external debt and grant aid (SB$182.3mil).

External debt : SB$563.5mil which is shared 70% by ADB and World bank loan

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*1 Fiscal year in Solomon Islands is from January to December.

3.3 Situation of power supply

Most of all power supply sources of Solomon Islands are diesel power, while two small hydropower plants are installed in Buala (Santa Isabel Island) and Malu'u (Malaita Island), and both diesel and hydro have been operating by SIEA. In addition, APACE, one of the NGO, is now developing micro hydropower in the Western Province by support of Australia Aid, and GREA, also a NGO, installed SHS in the south area of Guadalcanal Island and in Western Province, and systems are being operated. Operating performance of SIEA is in profit in Honiara-Lungga Grid and Noro-Munda Grid, and in loss in the rest. The existing powerstations as of June 2000 operated by SIEA are shown in Table 3-3-1, and the power supply situation of SIEA from 1990 to 1998 is shown in Table 3-3-2.

3.3.1 Existing powerstations

(1) Honiara-Lungga grid

The available rating of the Lungga powerstation is 14,000 kW (6 units), and that of the Honiara powerstation is 4,000 kW (5 units), the total available rating being 18,000 kW (11 units). The peak demand in October 1999 was 10,550 kW in the Honiara-Lungga Grid.

(2) Auki

The available rating in Auki powerstation, which has been operated since 1991, is 624 kW (3 units) and the peak load was 280 kW in October 1999.

(3) Malu'u

The available rating in Malu'u powerstation, which has been operated since 1984, is 30 kW (1 unit) and the peak load was 33 kW in October 1999, exceeding the supply capacity.

(4) Buala

The hydro powerstation was installed in 1996. The nominal rating of the hydro power is 150 kW (1 unit) and 62 kW (1 unit) for the diesel power. The peak load was 70 kW in October 1999.

(5) Kirakira

The available rating in Kirakira powerstation, which has been operated since 1992, is 170 kW (2 units) and the peak load was 61 kW in October 1999.

(6) Lata

The available rating in Lata powerstation, which has been operated since 1993, is 160 kW (3 units) and the peak load was 65kW in October 1999.

(7) Gizo

The available rating in Gizo powerstation, which has been operated since 1991, is 510 kW (3 units) and the peak load was 280 kW in October 1999.

(8) Noro-Munda system

The two outstations in Noro and Munda were connected by an 11 kV underground transmission line in 1996. The available rating of the Noro powerstation, which has been operated since 1987, is 2,700 kW (3 units) and the peak load was 1,790 kW in October 1999.

(9) Tulagi

No.1 diesel power unit was taken over to SIEA in December 1998.

(10) Diesel generating units

The efficiency of diesel power generation will be about 38 % at the initial stage, however, even if normal inspection or detailed inspections are carried out, it is said that decline of efficiency by about 2 - 3 % per year can not be avoided.

The present efficiency of SIEA diesel generators are calculated based upon the collected data from SIEA, showing that some powerstations have low efficiency. This is caused because maintenance is not carried out as specified in the maintenance manuals.

3.3.2 Existing Transmission and Distribution (T&D) Line

The existing T&D line facilities are follows.

(1) Honiara-Lungga Grid

The powerstations in Lungga and Honiara are connected by 33 kV and 11 kV overhead line and underground cable. In Honiara City, 11 kV distribution lines constitute the base grid, and the distribution to each user is provided by a distribution line after step down to 415V.

(2) Auki

In Auki, the capital of the Malaita Province, 11 kV distribution lines constitute the base grid, and the distribution to each user is provided by a distribution line after step down to 415V.

(3) Malu'u

In Malu'u, the second capital in the Malaita Province, the power is distributed to each user by a distribution line after step down to 415 V.

(4) Buala

The generated power in the hydro powerstation is distributed to each user in Buala, the main city of Isabel Province, and Jejevo City, close to Buala, directly by distribution lines without transformation.

(5) Kirakira

Because the city area is small in Kirakira, the capital of Makira Province, the generated power is distributed to each user directly by distribution lines without transformation.

(6) Lata

Because the city area is small in Lata, the capital of Temotu Province, the generated power is distributed to each user directly by distribution lines without transformation.

(7) Gizo

In Gizo, one of the main cities in the Western Province, 11 kV distribution lines constitute the base grid, and the distribution to each user is provided by distribution lines after step down to 415 V .

(8) Noro-Munda system

The powerstations in Noro and Munda were connected by an 11 kV underground transmission line in 1996, and in both Noro and Munda, 11 kV distribution lines constitute the base grid, and the distribution to each user is provided by distribution lines after step down to 415 V.

(9) Tulagi

In Tulagi, the capital of the Central Province, the generated power is distributed to each user by a distribution line after step down to 415 V.

Table 3-3-1 Existing generators (Provincial wise/Islands wise)

As of Jun. 2000

Name of Province/Island	Name of P/S	Type of P/S	Unit No.	Name plate Rating (kVA)	Name plate Rating (kW)	De-Rated (kW)	Installed Year	Remarks
Guadalcanal P. /Guadalcanal				27,270	24,540	18,000		
	Lungga			19,390	18,040	14,000		
		Diesel	4	1,900	1,900	1,000	1971	Mirrless-Blachstone
			5	1,900	1,900	1,000	1971	Mirrless-Blachstone
			6	2,840	2,840	2,200	1998	Mirrless-Blachstone
			7	3,000	3,000	2,300	1987	W.H.Allen
			8	4,500	4,200	3,600	1993	Wartsila
			9	5,250	4,200	3,900	1999	Mitsubishi
	Honiara			7,880	6,500	4,000		
		Diesel	1	1,875	1,500	1,000	1997	Perkins
			2	1,875	1,500	1,000	1997	Perkins
			3	1,875	1,500	1,000	1997	Perkins
			5	1,128	1,000	500	1984	Mirrless-Blachstone
			6	1,128	1,000	500	1984	Mirrless-Blachstone
Malaita P. /Malaita				818	818	654		
	Auki			780	780	624		
		Diesel	1	260	260	208	1991	Perkins
			2	260	260	208	1991	Perkins
			3	260	260	208	1991	Perkins
	Malu'u			37.5	37.5	30		
		Hydro	1	37.5	37.5	30	1984	
Isabel P. /Santa Isabel				310	238	212		
	Buala			310	238	212		
		Diesel	1	110	88	62	1993	Perkins
		Hydro	1	200	150	150	1996	
Makira P. /San Cristobal				294	235	170		
	Kirakira			294	235	170		
		Diesel	1	100	80	60	1992	Catepillar
			2	114	91	50	1993	Perkins
			3	80	64	60	Out of service	Lister
Temotu P. /Nendo				330	264	160		
	Lata			330	264	160		
		Diesel	1	110	88	60	1993	Perkins
			2	110	88	40	1993	Perkins
			3	110	88	60	1995	Perkins
Western P. /New Georgia				5,333	4,277	3,252		
	Gizo			780	624	510		
		Diesel	1	260	208	170	1991	Perkins
			2	260	208	170	1991	Perkins
			3	260	208	170	1991	Perkins
	Noro			4,500	3,600	2,700		
		Diesel	1	1,500	1,200	900	1987	W.H.Allen
			2	1,500	1,200	900	1987	W.H.Allen
			3	1,500	1,200	900	1987	W.H.Allen
	Munda			53	53	42		Interconnected with Noro by 11kV
		Diesel	1	53	53	42	Out of service	
Central P. /Tulagi				400	320	244		
	Tulagi			400	320	244		
		Diesel	1	150	120	84	1999	Catepillar
			2	250	200	160	1999	Perkins
Choiseul P. /Choiseul								Not applicable

Source: The data provided by SIEA at the general meeting during third field survey (May 17-June 2, 2000)

Table 3-3-2 Past electrical record 1990-1999 (Grid and Powerstation wise)

As of End of Oct. '99

Name of Grid	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
Honiara (Guadalcanal)	D											1999-1990
Installed capacity	kW	11,190	11,190	11,190	11,190	15,390	13,062	13,000	13,000	13,000	24,540	11 units
Name plate capacity	kW	8,690	8,690	8,690	8,690	11,390	11,390	11,390	9,800	15,000	19,200	
Peak load	kW	6,100	6,500	7,030	7,800	8,850	9,400	9,740	9,650	10,450	10,550	
Generated energy	MWh	29,438,000	32,381,000	35,258,313	38,275,190	42,665,561	47,181,303	49,474,690	50,051,249	53,799,102	45,773,756	
Sold energy	MWh	26,108,000	29,416,683	31,822,019	34,759,553	35,759,553	42,798,420	44,556,611	44,537,995	44,940,027	38,107,758	
Total loss	%	11.3%	9.2%	9.7%	9.2%	16.2%	9.3%	9.9%	11.0%	16.5%	16.7%	
Nos. of consumers		4,625	4,863	4,975	5,124	5,239	5,556	5,793	5,957	6,194		
Growth of peak load	%		6.6%	8.2%	11.0%	13.5%	6.2%	3.6%	-0.9%	8.3%	1.0%	6.28%
Growth of Sold energy	%		12.7%	8.2%	9.2%	2.9%	19.7%	4.1%	0.0%	0.9%	-15.2%	4.29%
Auki (Malaita)	D											1999-1990
Installed capacity	kW	624	624	624	624	624	624	624	624	600	624	
Name plate capacity	kW	624	624	624	624	624	654	654	654	654	654	
Peak load	kW	176	181	185	180	230	320	260	260	240	280	
Generated energy	kWh	1,046,000	1,055,000	1,010,120	1,067,410	1,189,650	1,368,020	1,414,940	1,475,910	1,500,600	1,335,860	
Sold energy	kWh	874,000	924,642	931,349	985,141	1,031,470	1,231,040	1,374,541	1,651,473	1,587,815	1,419,361	
Total loss	%	16.4%	12.4%	7.8%	7.7%	13.3%	10.0%	2.9%	-11.9%	-5.8%	-6.3%	
Nos. of consumers		549	448	475	489	506	532	576	563	492	590	
Growth of peak load	%		2.8%	2.2%	-2.7%	27.8%	39.1%	-18.8%	0.0%	-7.7%	16.7%	5.29%
Growth of Sold energy	%		5.8%	0.7%	5.8%	4.7%	19.3%	11.7%	20.1%	-3.9%	-10.6%	5.54%
Malu'u (Malaita)	H											1999-1990
Installed capacity	kW	30	30	30	30	30	30	30	30	30	30	
Name plate capacity	kW	30	30	30	30	30	30	30	30	30	30	
Peak load	kW	10	10	14	15	19	22	25	28	29	33	
Generated energy	kWh	36,000	28,000	31,073	48,121	66,813	67,180		82,976	89,510	93,631	
Sold energy	kWh	32,000	27,236	24,774	38,663	56,270	58,820	79,771	73,281	81,718	83,743	
Total loss	%	11.1%	2.7%	20.3%	19.7%	15.8%	12.4%		11.7%	8.7%	10.6%	
Nos. of consumers		65	64	67	73	74	89	96	98	102	113	
Growth of peak load	%		0.0%	40.0%	7.1%	26.7%	15.8%	13.6%	12.0%	3.6%	13.8%	14.19%
Growth of Sold energy	%		-14.9%	-9.0%	56.1%	45.5%	4.5%	35.6%	-8.1%	11.5%	2.5%	11.28%
Buala (Isabel)	H/D											1999-1990
Installed capacity	kW			132	132	132	132	270	270	270	248	
Name plate capacity	kW							248	248	248	248	
Peak load	kW	29	30	32	32	44	59	62	47	70	70	
Generated energy	kWh	170,000	179,000	182,220	157,810	204,430	232,225	262,409	287,700	329,109	293,380	
Sold energy	kWh	146,000	161,677	160,157	160,760	182,370	224,890	246,837	247,139	289,836	252,057	
Total loss	%	14.1%	9.7%	12.1%	-1.9%	10.8%	3.2%	5.9%	14.1%	11.9%	14.1%	
Nos. of consumers		72	88	100	108	110	112	108	134	133	142	
Growth of peak load	%		3.4%	6.7%	0.0%	37.5%	34.1%	5.1%	-24.2%	48.9%	0.0%	10.29%
Growth of Sold energy	%		10.7%	-0.9%	0.4%	13.4%	23.3%	9.8%	0.1%	17.3%	-13.0%	6.26%
Kirakira (Makira)	D											1999-1990
Installed capacity	kW			192	192	192	215	300	300	300	262	
Name plate capacity	kW			171	171	171	171	171	171	171	171	
Peak load	kW	81	80	54	55	47	56	59	59	55	61	
Generated energy	kWh	216,000	254,000	236,880	241,530	226,890	255,600	274,980	289,710	300,780	242,500	
Sold energy	kWh	206,000	230,891	231,863	234,129	215,670	247,640	412,727	298,926	299,533	233,965	
Total loss	%	4.6%	9.1%	2.1%	3.1%	4.9%	3.1%	-50.1%	-3.2%	0.4%	3.5%	
Nos. of consumers		187	192	199	203	203	200	221	208	204	212	
Growth of peak load	%		-1.2%	-32.5%	1.9%	-14.5%	19.1%	5.4%	0.0%	-6.8%	10.9%	-3.10%
Growth of Sold energy	%		12.1%	0.4%	1.0%	-7.9%	14.8%	66.7%	-27.6%	0.2%	-21.9%	1.4%
Lata (Temotu)	D											1999-1990
Installed capacity	kW				176	176	176	176	176	450	187	
Name plate capacity	kW				186.6	186.6	186.6	186.6	186.6	186.6	186.6	
Peak load	kW	44	47	48	43	43	59	63	46	65	65	
Generated energy	kWh	197,000	198,000	195,000	161,441	216,961	248,970	252,441	194,420	127,731	127,793	
Sold energy	kWh	188,000	185,356	180,409	163,158	198,260	238,530	246,098	250,745	257,342	263,567	
Total loss	%	4.6%	6.4%	7.5%	-1.1%	8.6%	4.2%	2.5%	-29.0%	-101.5%	-106.2%	
Nos. of consumers		105	106	118	120	119	131	147	136	172	212	
Growth of peak load	%		6.8%	2.1%	-10.4%	0.0%	37.2%	6.8%	-27.0%	41.3%	0.0%	4.43%
Growth of Sold energy	%		-1.4%	-2.7%	-9.6%	21.5%	20.3%	3.2%	1.9%	2.6%	2.4%	3.83%

Name of Grid	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
Gizo (Western)	D											1999-1990
Installed capacity	kW	624	624	624	624	624	624	624	624	624	624	
Name plate capacity	kW	624	624	624	624	624	624	624	624	624	624	
Peak load	kW	240	245	220	220	235	275	283	280	270	280	
Generated energy	kWh	1,214,000	1,100,000	1,171,964	1,188,470	1,293,849	1,490,570	1,501,386	1,531,180	1,583,960	1,319,375	
Sold energy	kWh	1,094,000	999,622	1,075,904	1,125,425	1,234,096	1,327,170	1,354,461	1,459,235	1,835,414	1,299,717	
Total loss	%	9.9%	9.1%	8.2%	5.3%	4.6%	11.0%	9.8%	4.7%	-15.9%	1.5%	
Nos. of consumers		468	463	475	460	486	509	554	520	490	583	
Growth of peak load	%		2.1%	-10.2%	0.0%	6.8%	17.0%	2.9%	-1.1%	-3.6%	3.7%	1.73%
Growth of Sold energy	%		-8.6%	7.6%	4.6%	9.7%	7.5%	2.1%	7.7%	25.8%	-29.2%	1.93%
Noro (Western)	D											1999-1990
Installed capacity	kW	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	3,600	
Name plate capacity	kW	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	
Peak load	kW	1,210	1,410	1,400	1,290	1,950	1,720	1,800	1,820	1,790	1,790	
Generated energy	kWh	5,970,000	7,280,000	7,055,637	7,602,966	8,556,809	10,246,780	9,952,864	9,639,904	10,269,313	8,321,334	
Sold energy	kWh	5,506,000	7,041,385	6,852,338	7,517,168	8,071,610	9,222,850	9,173,414	8,742,284	9,470,155	7,912,116	
Total loss	%	7.8%	3.3%	2.9%	1.1%	5.7%	10.0%	7.8%	9.3%	7.8%	4.9%	
Nos. of consumers		129	127	130	194	204	230	256	255	267	290	
Growth of peak load	%		16.5%	-0.7%	-7.9%	51.2%	-11.8%	4.7%	1.1%	-1.6%	0.0%	4.45%
Growth of Sold energy	%		27.9%	-2.7%	9.7%	7.4%	14.3%	-0.5%	-4.7%	8.3%	-16.5%	4.11%
Munda (Western)	D											1997-1990
Installed capacity	kW				106	106	106	(Decommissioned in 1996)				
Name plate capacity	kW											
Peak load	kW	41	45	46	47	56	66					
Generated energy	kWh	190,000	209,000	227,181	276,526	278,732	312,526	122,358	0	0	0	
Sold energy	kWh	174,000	191,595	200,546	218,460	242,160	267,670	294,451	328,150	368,507	0	
Total loss	%	8.4%	8.3%	11.7%	21.0%	13.1%	14.4%	-140.6%				
Nos. of consumers		99	111	115	121	126	137	157	160	182	208	
Growth of peak load	%		9.8%	2.2%	2.2%	19.1%	17.9%	-100.0%				0.02%
Growth of Sold energy			10.1%	4.7%	8.9%	10.8%	10.5%	10.0%	11.4%	12.3%	-100.0%	-100.00%
Tulagi (Central)	D											1999-1993
Installed capacity	kW									400	344	
Name plate capacity	kW									344	344	
Peak load	kW										49	
Generated energy	kWh											
Sold energy	kWh				73,783	96,158	166,970	198,468	215,627	157,960	683,515	
Total loss	%											
Nos. of consumers					30	31	32	34	35		190	
Growth of peak load	%											
Growth of Sold energy	%											44.92%
Solomon Islands												1999-1990
Installed capacity	kW	18,468	18,468	18,792	19,074	23,274	20,969	21,024	21,024	21,674	30,459	
Name plate capacity	kW	13,568	13,568	13,739	13,926	16,626	16,656	16,904	15,314	20,858	25,058	
Peak load	kW											
Generated energy	kWh	38,477,000	42,684,000	45,368,388	49,019,464	54,699,695	61,403,174	63,256,068	63,553,049	68,000,105	57,507,629	
Sold energy	kWh	34,328,000	39,179,087	41,479,359	45,276,240	47,087,617	55,784,000	57,937,379	57,913,791	59,388,149	50,355,641	
		34,328.0	39,179.1	41,479.4	45,276.2	47,087.6	55,784.0	57,937.4	57,913.8	59,388.1	50,355.6	
Total loss	%	10.8%	8.2%	8.6%	7.6%	13.9%	9.2%	8.4%	8.9%	12.7%	12.4%	
Nos. of consumers		6,299	6,462	6,654	6,922	7,098	7,528	7,942	8,066	8,236		
Growth of peak load	%											
Growth of Sold energy	%		10.9%	6.3%	8.0%	11.6%	12.3%	3.0%	0.5%	7.0%	-15.4%	4.35%

Source: SIEA Engineering Report Statistics Summary 1990-1997, and SIEA Engineering Report September, 1999
SIEA Head Quarter Data 1983-1998
SIEA Lungga P/S OIC statistical data 1983-1998
Figures for 1999 are until the end of October.

CHAPTER 4

POWER DEMAND

Chapter 4 Power Demand

4.1 Power Demand Forecast

The power demand forecast for the Solomon Islands was carried out based on data and information collected during the first and second field surveys, corresponding to the number of consumers by electricity tariff category and growth rates and to the annual power consumption per consumer by electricity tariff category and growth rates, for each load center during 10 years (1989 - 1999).

4.2 Estimated Condition of Power Demand Forecast

The estimated conditions of the power demand forecast for areas served by existing grid power, existing independent isolated power sources or where future independent power sources are planned, are presented in this section.

As an example, the estimated condition of power demand forecast for Honiara – Lungga Grid is shown below:

The power demand forecast (kWh) for the grid system of Honiara – Lungga is estimated based upon the annual power consumption per consumer by electricity tariff category and growth rates and upon the annual power consumption per consumer by electricity tariff category and growth rates, derived from power usage for 10 years. The peak demand (kW) is estimated from the future power demand (kWh), future power constituent ratio and estimated future load factor which is assumed based upon past records.

Category \ Year	1998	1998-2003	2004-2008	2009-2013	2014-2018
Residential					
Annual power consumption per customer (kWh)	2,339				
Annual average growth rate (%)		3.3	2.8	2.3	2.0
Number of customers	4,879				
Annual average growth rate (%)		3.1	2.6	2.1	2.0
Commercial					
Annual power consumption per customer (kWh)	22,755				
Annual average growth rate (%)		4.0	3.5	3.0	2.5
Number of customers	981				
Constituent factor *		*	*	*	*
Public (Government, Street lighting, others)					
Annual power consumption per customer (kWh)	34,185				
Annual average growth rate (%)		0.05	0.05	0.05	0.05
Number of customers	185				
Constituent factor *		*	*	*	*
Industry					
Annual power consumption per customer (kWh)	33,491				
Annual average growth rate (%)		8.5	6.5	4.5	4.0
Number of customers	149				
Annual average growth rate (%)		0.5	0.5	0.5	0.5

Note: ENERGY & LOAD FORECAST BY CATEGORY WISE IN EACH LOAD CENTER shall be refereed for the constituent factor of number of customers.

4.3 Result of Power Demand Forecast

The power demand forecast is shown in Table 4-3-1.

4.4 Present Power Supply Area

The present power supply areas by SIEA are shown in the Appendix 4-2-1 to Appendix 4-2-6.

Gudalcanal Province,	Honiara-Lungga system	Appendix 4-2-1
Malaita Province,	Auki area and Malu'u area	Appendix 4-2-2
Isabel Province,	Buala area	Appendix 4-2-3
Makira Province,	Kirakira area	Appendix 4-2-4
Temotu Province,	Lata area	Appendix 4-2-5
Western province,	Gizo area	Appendix 4-2-6
Western Province,	Noro-Munda system	Appendix 4-2-6

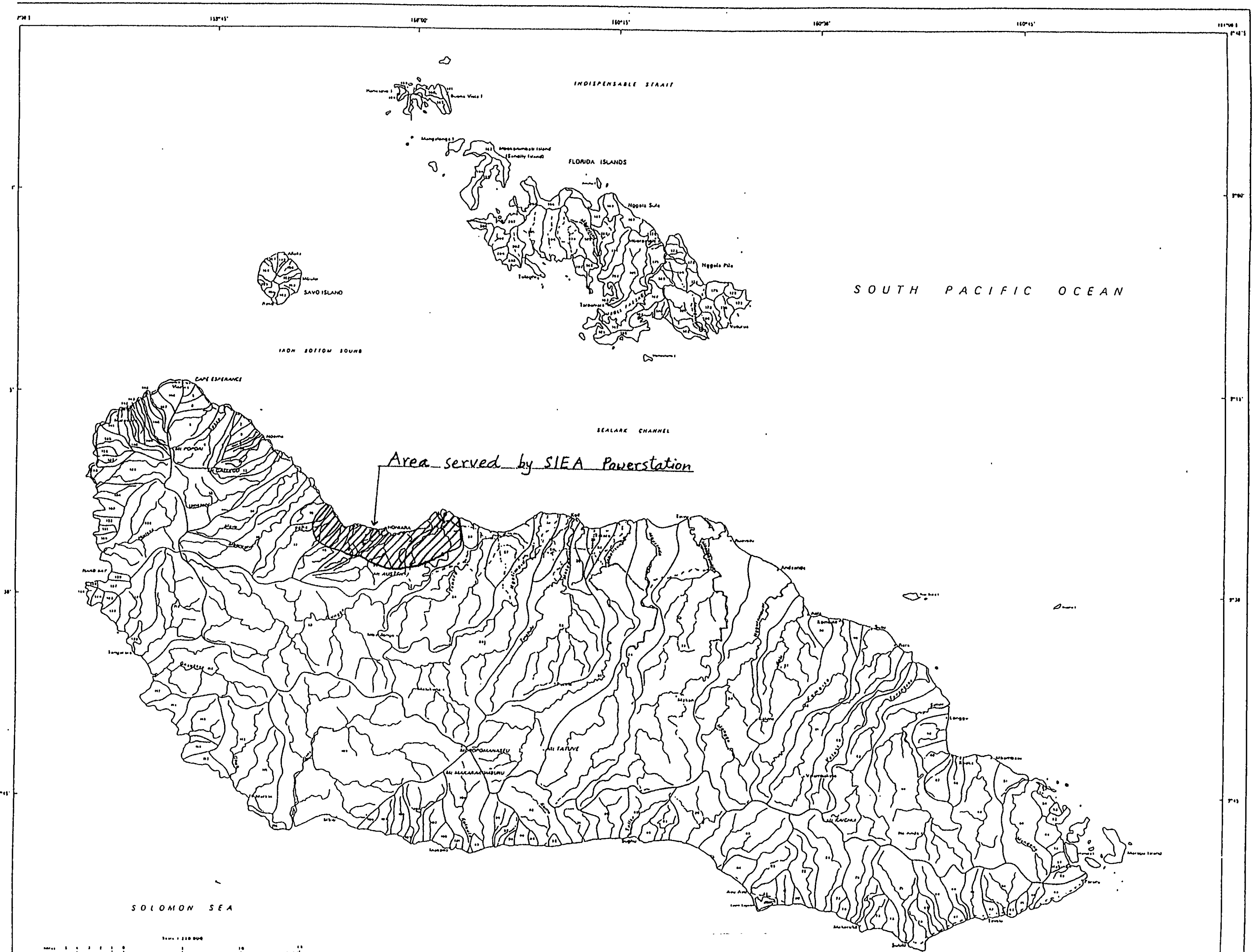
Table 4-3-1　Result of Power Demand Forecast for Solomon Islands

Power Demand Forecast (MWh)

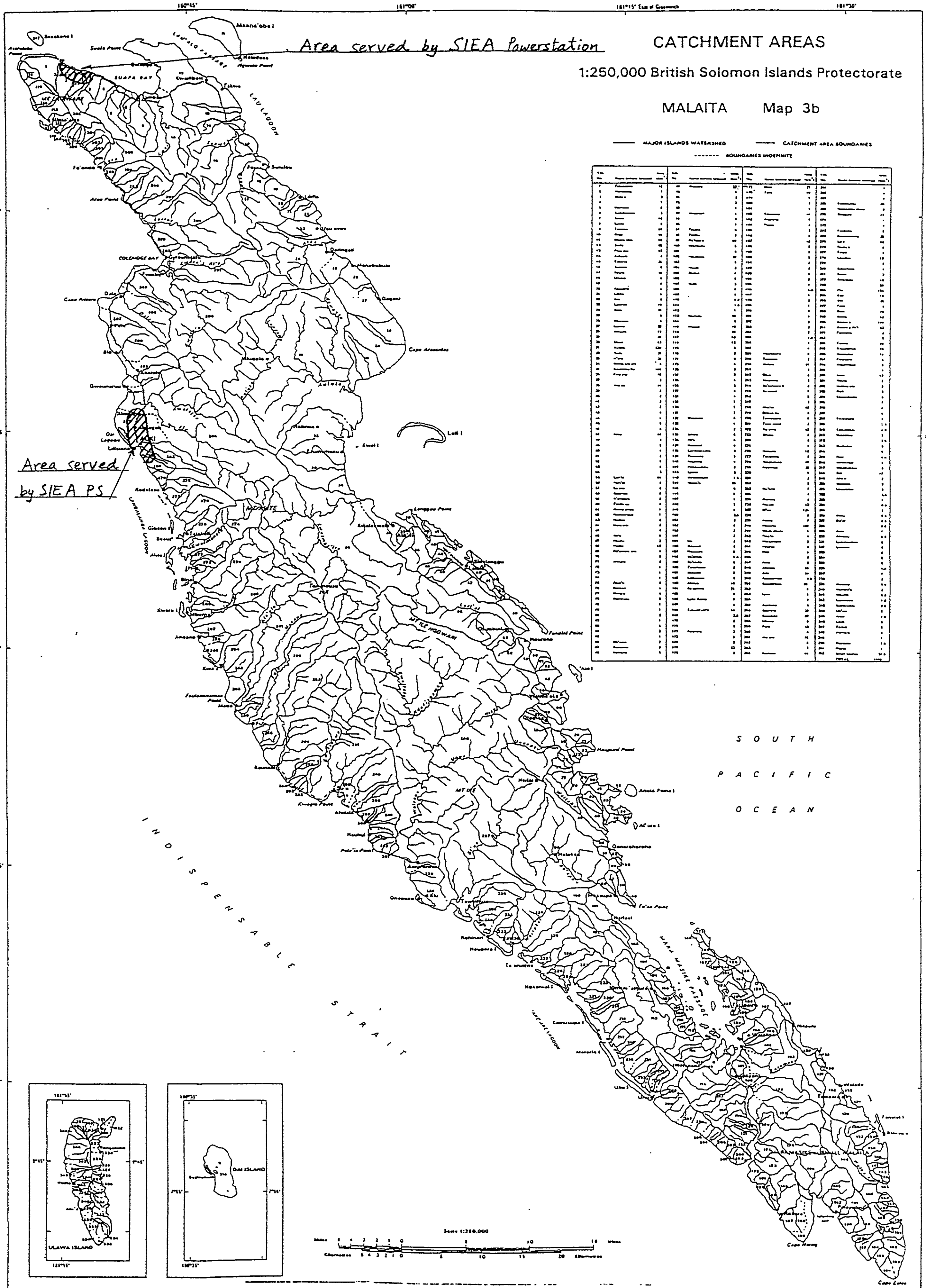
Name of Demand Center \ Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Honiara	45,048	47,841	50,274	52,834	56,289	59,990	63,299	66,805	70,522	74,462	78,639	84,487	88,567	92,598	96,971	101,557	105,851	110,330	115,004	119,880	124,968
Auki-Malu'u	1,670	1,885	2,014	2,152	11,499	11,660	21,072	21,248	21,438	21,641	21,859	22,074	22,304	22,550	22,813	23,094	23,371	32,863	33,176	33,510	33,866
Buala	293	339	375	414	458	506	551	601	655	714	778	891	958	1,031	1,110	1,195	1,275	1,360	1,452	1,551	1,656
Kirakira	299	313	343	376	413	454	493	537	584	635	692	796	855	918	986	1,060	1,130	1,204	1,284	1,370	1,462
Lata	269	319	340	363	387	413	437	462	489	518	548	575	604	635	667	701	730	761	794	828	865
Tulagi	158	215	228	241	255	270	285	300	317	334	353	370	388	408	428	450	470	491	514	537	562
Gizo	1,836	2,550	2,673	2,803	2,939	3,083	3,206	3,335	3,469	3,609	3,755	3,873	3,996	4,123	4,254	4,389	4,489	4,592	4,698	4,806	4,916
Noro-Munda	9,992	10,701	11,838	13,104	14,513	16,083	17,651	19,382	21,294	23,409	25,748	27,879	30,196	32,714	35,452	38,432	41,202	44,183	47,391	50,847	54,569
Choiseul	32	74	82	91	101	112	123	134	146	159	174	243	257	273	290	308	322	338	354	372	390
Rennell	22	24	26	29	32	35	37	40	43	46	50	52	55	58	61	65	67	69	71	74	76
Solomon Islands	59,618	64,260	68,193	72,407	86,887	92,606	107,155	112,844	118,957	125,527	132,595	141,241	148,180	155,306	163,032	171,251	178,907	196,192	204,739	213,774	223,330

Peak Demand Forecast (kW)

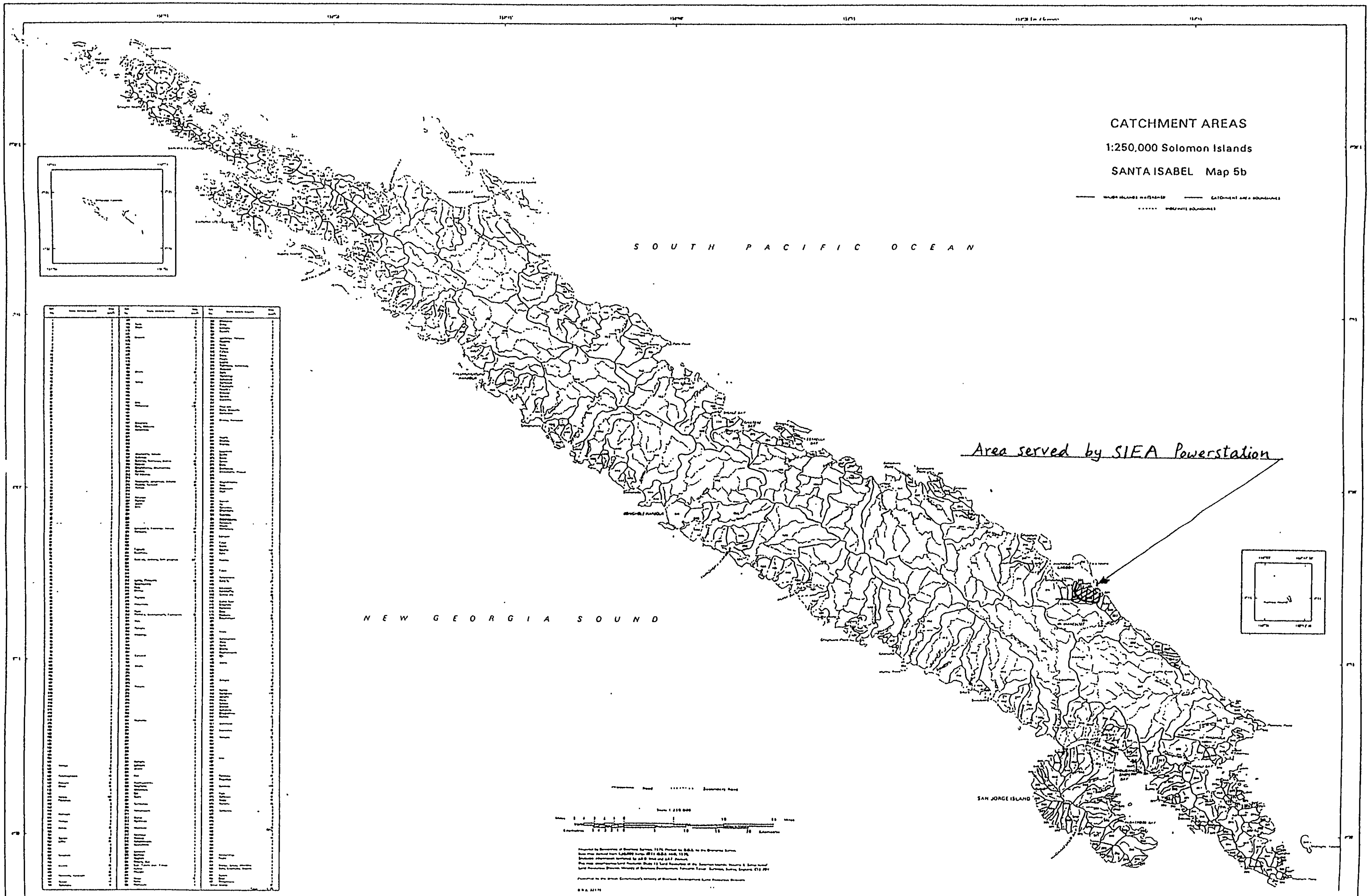
Name of Demand Center \ Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Honiara	10,450	10,604	11,144	11,711	12,477	13,298	14,168	14,953	15,785	16,667	17,602	18,727	19,632	20,525	21,495	22,511	23,237	24,221	25,247	26,317	27,434
Auki-Malu'u	470	487	481	478	2,387	2,164	3,538	3,578	3,622	3,668	3,717	3,765	3,816	3,871	3,929	3,990	4,051	5,715	5,788	5,866	5,948
Buala	70	81	89	98	108	119	129	139	151	164	177	202	216	231	247	265	281	298	316	336	357
Kirakira	55	69	76	84	92	101	110	120	131	143	155	179	193	207	223	240	256	274	292	312	334
Lata	65	66	70	75	80	86	91	96	102	108	115	121	128	134	141	149	156	163	170	178	186
Tulagi	49	61	65	68	71	75	79	82	86	91	95	99	103	108	113	118	122	127	132	137	143
Gizo	270	485	512	541	571	603	632	662	694	727	763	793	824	856	891	926	955	984	1,015	1,046	1,079
Noro-Munda	1,790	1,930	2,150	2,397	2,673	2,983	3,297	3,647	4,036	4,469	4,951	5,401	5,893	6,433	7,024	7,673	8,289	8,957	9,683	10,470	11,326
Choiseul	14	19	21	23	25	28	30	32	35	38	41	57	60	63	66	70	73	76	79	82	86
Rennell	6	6	7	7	8	9	9	10	10	11	12	12	13	13	14	15	15	16	16	16	17



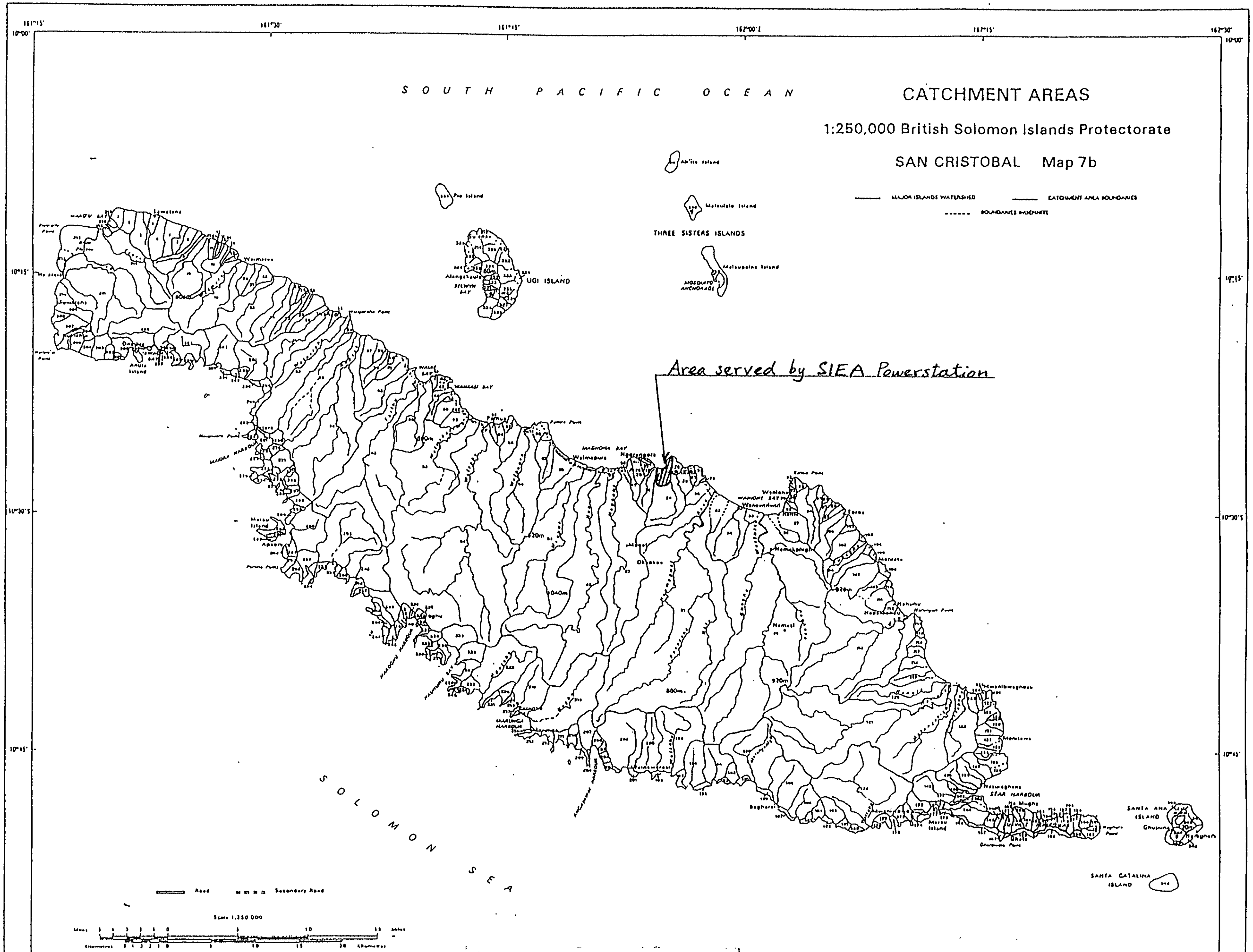
Appendix 4-2-1 Area served by the existing SIEA's powerstation (Guadalcanal)



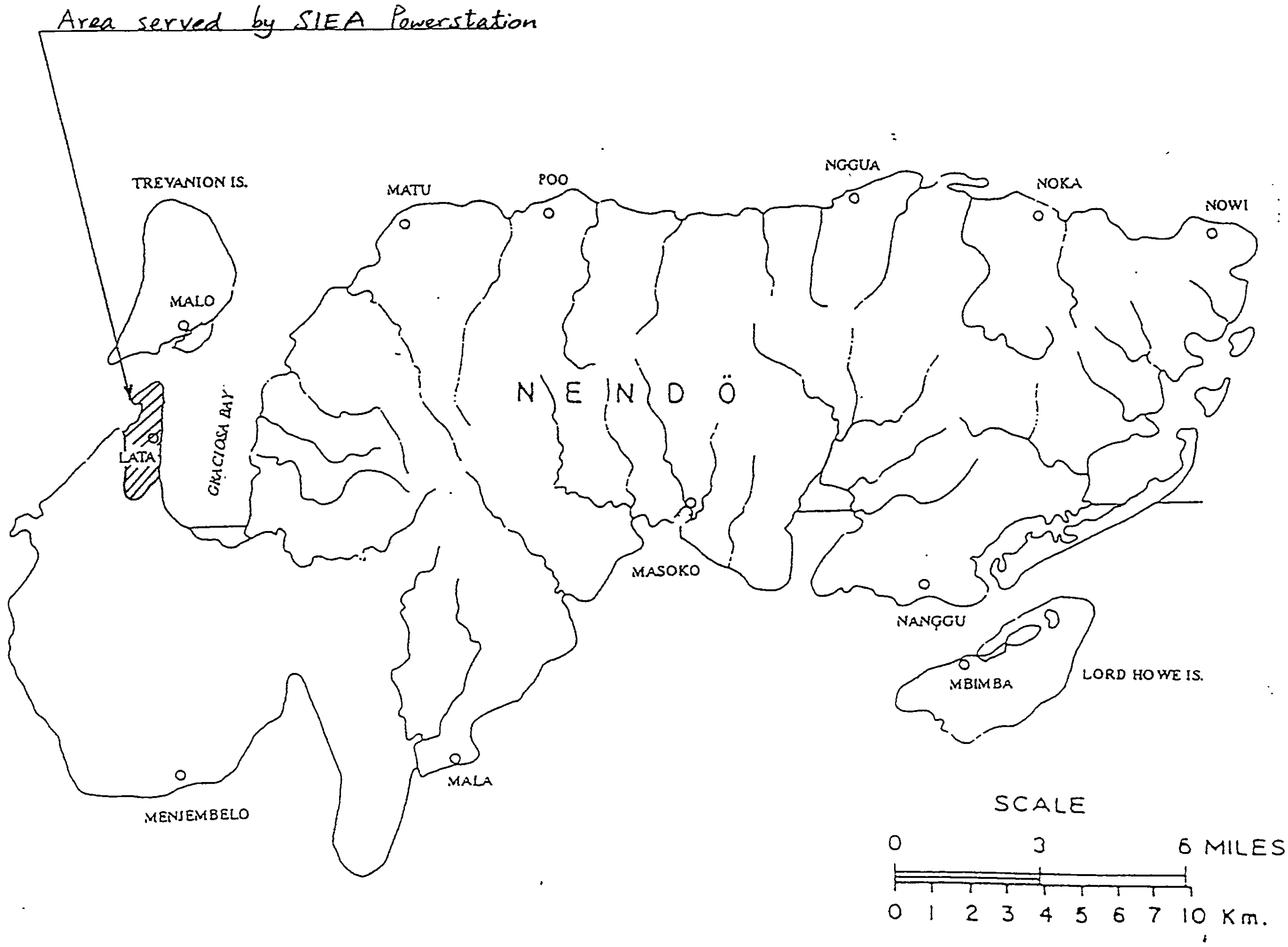
Appendix 4-2-2 Area served by the existing SIEA's powerstation (Auki, Malu'u)



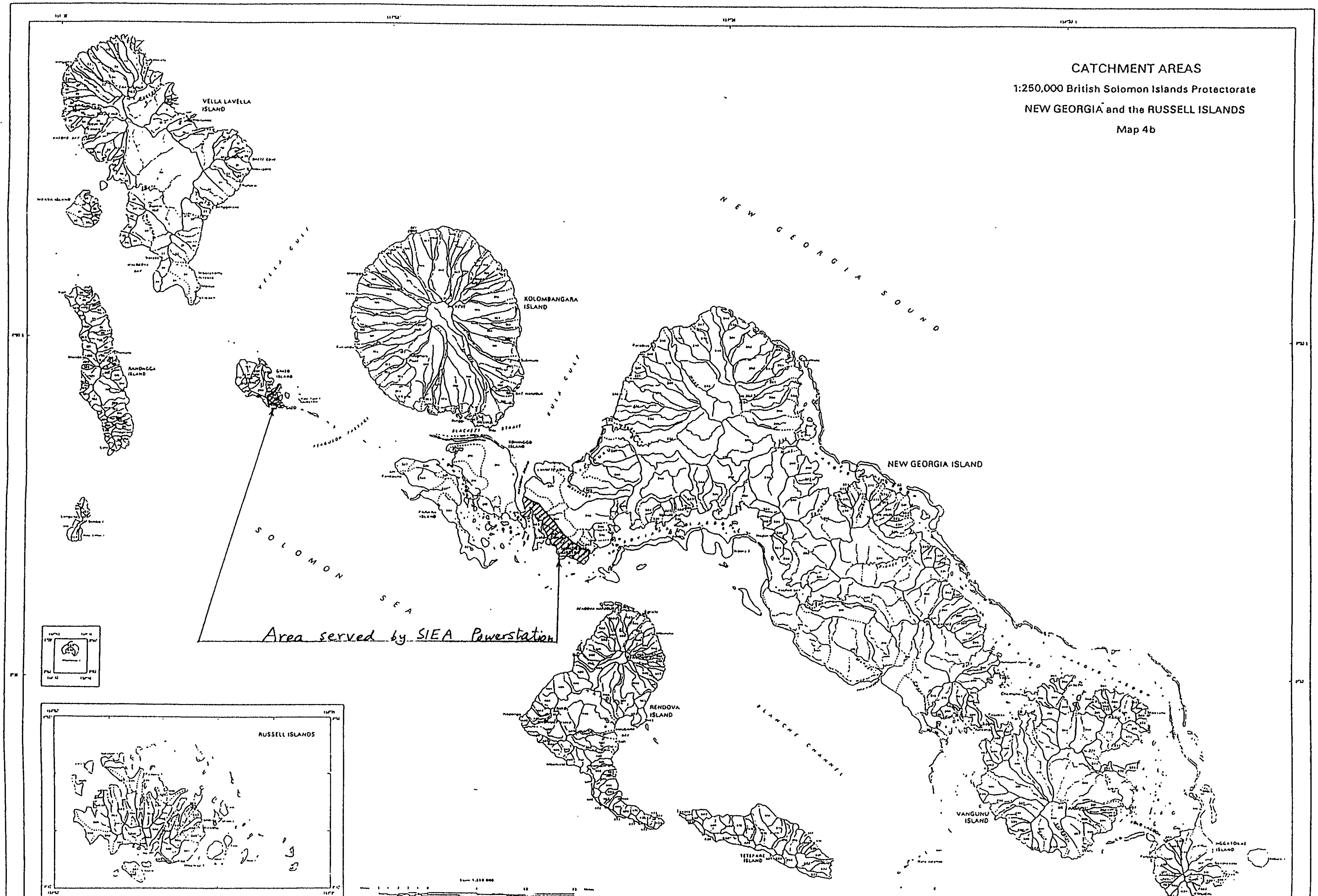
Appendix 4-2-3 Area served by the existing SIEA's powerstation (Buala)



Appendix 4-2-4 Area served by the existing SIEA's powerstation (Kirakira)



Appendix 4-2-5 Area served by the existing SIEA's powerstation (Lata)



Appendix 4-2-6 Area served by the existing SIEA's powerstation (Gizo, Munda-Noro)

CHAPTER 5

SMALL HYDROPOWER GENERATION

Chapter 5 Small Hydropower Generation

5.1 Objective

The hydropower generation plan included in the Master Plan Study for Power Development in the Solomon Islands has two main objectives, which are:

① To quantify the hydropower potential in the Solomon Islands for water resource development, and

② To select prospective hydropower sites to be developed within the next 15 years until 2015.

In order to achieve the objectives, the JICA Team conducted the following studies and surveys.

(1) Field Survey

Field surveys were carried out to collect the information for hydropower development and to check the hydropower site conditions as follows.

First survey : from January to March, 1999.

Second survey : from October to December, 1999.

Third survey : from May to June, 2000.

(2) Data Collection

During the three field surveys, topographic maps, meteorological and hydrological data, geological information and construction cost data were collected as a data base to assist with the hydropower planning.

(3) Hydro Potential Study

A Total 130 potential sites were identified on 1/50,000 maps with hydrological data.

(4) Hydropower Planning and Design

Based on the hydro potential study and the field survey results, ten hydropower sites were studied to prepare design and cost estimates.

5.2 Hydro Potential Study

A total of 130 potential hydropower sites were identified in the Solomon Islands, with a total hydro potential amount of 326 MW, including Lungga and Komarindi hydropower projects and other previous studies.

Table 5-1 Result of Hydropower Map Study

	Islands	Number of Sites	Micro Hydro (kW)	Mini Hydro (kW)	Small Hydro (kW)	Total (kW)	Remarks kW/site
1	Guadalcanal	49		1,210	236,100	237,310	4,800
2	Malaita	23	90	2,700	28,000	30,790	1,300
3	Santa Isabel	6		610	4,100	4,710	800
4	New Georgia	23	320	4,840		5,160	200
5	San Cristobal	12	20	371	25,500	25,891	2,200
6	Choiseul	15	140	2,030	20,030	22,200	1,500
7	Santa Cruz	2	50	260		310	200
	Total	130				326,371	

Micro Hydro : Energy Output P＜100kW

Mini Hydro : 100kW≦P＜1,000kW

Small Hydro : P≧1,000kW

The result of the hydropower potential study is as follows.

(1) Guadalcanal

The hydro potential sites in Guadalcanal totals 237 MW that accounts for 73% of the country's hydro potential. The average capacity of each site is 4,800 kW, the largest among the islands.

Remoteness of the sites makes project survey, design and construction difficult. Improvement of access is indispensable for further hydropower development.

(2) Malaita

The hydro potential totals 30,790 kW, the second largest in the Solomon Islands.

The northwest area of the island shows favorable conditions for hydropower development such as steep terrains with high rainfall and easy access from the provincial road. In this area, the Rori, Silolo, Tamba, and Aero hydro projects are proposed to generate 2,770 kW.

Moreover, the Malaita province has been expanding its road system that can accelerate hydropower development.

(3) Santa Isabel

Although on Santa Isabel Island the hydro potential is as small as 4,710 kW, the Buala area has favorable conditions such as a steep slope creek with high rainfall. Further mini hydro development, like the existing Buala hydro, is possible in the Kubolata hydro site.

(4) New Georgia

The Western province comprises several islands where mini and micro hydro projects are possible. The average capacity of the hydro sites is as small as 200 kW. Inland access to the hydro sites are very limited, therefore power will be supplied to isolated areas.

(5) San Cristobal

The rivers in San Cristobal have a large catchment with mild slope of rivers, and as a consequence a storage project is a possible layout. A large hydro scheme, however, makes immediate construction impractical, because the current electricity demand on the island is small.

(6) Choiseul

The hydro potential sites are situated around the Central Highland, except the Sorave site which is in the north west of the island.

The existing provincial road is accesible only for 12 km on the south coast near Kolombangara River, therefore the logging roads are alternate access to the sites.

(7) Santa Cruz

Although Lata, which is situated in the far east islands, needs a stable hydropower supply, hydropower sites are limited.

The advantages for hydropower on the island are high rainfall and the existence of provincial roads and volcanic rocks for construction material.

5.3. Hydropower Planning and Design

A total of ten selected sites were studied for design and cost estimates, as shown in Table 5-2 and Fig.5-1.

Table 5-2 Summary of Hydropower Planning

Site	Installed Capacity (kW)	Energy Output (MWh)	Effective Head (m)	Maximum Discharge (m3/s)	Transmission Line (km) /Voltage (kV)	Access Road (km)	Supply Area	Project Cost (millionUS$)
Maotapuku 1 (Gudalcanal)	1,600	7,838	150.5	1.3	6.5km/33kV (Maotapuku 1-Maotapuku2)	3.5	Honiara	24.870
Maotapuku 2 (Guadalcanal)	1,400	6,619	58.5	2.9	32.5km/33kV (Maotapuku2-Lungga P/S)	5.8	Honiara	27.027
Sasa (Guadalcanal)	280	2,396	58.0	0.66	15.0km/11kV (Sasa-Mamara)	1.7	Honiara	6.211
Silolo (Malaita)	2,100	10,495	155.0	1.7	8.0km/33kV (Silolo-Fausande)	6.3	Malu'u-Auki	28.261
Rori (Malaita)	300	2,526	37.0	1.1	22.0km/11kV (Malu'u-Andau'a)	0.9	Malu'u-Auki	5.989
Kware'a (Malaita)	600	2,541	15.5	5.0	14.0km/11kV (Kware'a-Dala)	1.1	Dala-Auki	18.185
Kubolata (Santa Isabel)	80	563	229.0	0.05	2.5km/415V (Kubolata-Buala)	2.0	Buala	1.649
Waimapuru (San Cristbal)	20	170	30.0	0.1	2.0km/415V (Waimapuru-secondary school)	2.0	Waimapuru secondary school	0.912
Sorave (Choiseul)	70	592	9.0	1.1	6.0km/11kV (Sorave-Secondary School)	0.4	Choiseul secondary school	1.859
Luembalele (Lata)	50	432	31.0	0.24	22.0km/11kV (Luembalele-Lata)	2.8	Lata	4.117

(1) Guadalcanal

The Maotapuku 1 and 2 sites together with Sasa hydropower sites are situated in a favorable location to supply their power to the Honiara system that is currently supplied by the Lungga and Honiara diesel plants. The proposed run-of river hydropower plants will supply base load energy that can reduce a considerable amount of fuel consumption from diesel plants.

Since these project sites were not surveyed during the second field survey, site surveys should be carried out before any further stage of the projects.

<u>Maotapuku 1 Hydropower</u>

The Maotapuku 1 hydropower site is proposed near the Gold Ridge Mining site, situated at

28 km to the southeast of Honiara in the central area of Guadalcanal Island.

The project is aimed to exploit discharge from the catchment area of 10 km^2 and head of the steep river by a run-of-river hydro plant to generate 1,600 kW and 7,838 MWh per year.

The project requires the construction of a tunnel for 1,620 m that accounts for 44% of the total project cost. Construction cost will be reduced considerably if an open channel is adopted, thus a site survey to study the possibility of construction of this kind of channel will be necessary.

Maotapuku 2 Hydropower

The Maotapuku 2 is located in the downstream area of the Maotapuku 1 site. The project is aimed to exploit discharge from the catchment area of 22 km^2 and head of the steep river course, by a run-of-river hydro plant to generate 1,400 kW and 6,619 MWh per year.

The project also requires the construction of a tunnel for 1,400 m that accounts for 34% of the total project cost. The possibility of an open channel should be examined for cost reduction. The Maotapuku 2 needs a project cost higher than the Maotapuku 1, since the cost of the transmission line for 32.5 km, that accounts for 15% of the total project cost, is included.

Sasa Hydropower

The Sasa hydropower site is proposed on the Sasa River in the northwest area of Guadalcanal Island. The project is aimed to exploit the water resource of the Sasa River, with a discharge from a catchment area of 22 km^2 and river head, by using a run-of-river hydro plant that generates 280 kW and 2,396 MWh per year.

The site access condition is good and construction equipment can be transported to the site without much difficulty.

Leveling survey shall be done to confirm the head between the intake and the tailrace, since the river slope is not steep.

(2) Malaita

The northern part of the Malaita Island has suitable conditions for hydropower development, such as steep terrain and heavy rainfall, and also the provincial road allows easy access to each project site.

Several prospective hydropower sites, such as Silolo (2,100 kW), Rori (300 kW), Tamba (240 kW) and Aero (130 kW), exist especially around the Malu'u area.

Once transmission lines are installed in this area, all these hydro sites can be developed to supply their power not only to the local villages but also to Auki, the provincial capital.

Silolo Hydropower

The project site is situated 44 km north of Auki in the northwest of the Malaita Island. The project is proposed to exploit discharge from the catchment of 13 km^2, a head of the steep river course and the Talifu waterfall, by a run-of-river hydro plant that generates 2,100 kW and 10,495 MWh per year.

The key issues for implementation of the project are the construction of a tunnel for 1,730 m and an access road for 6.3 km in the mountainous terrain. The tunnel requires US$11.4 million or 46% of the total project cost, and therefore a detailed study of the tunnel and open channel is needed.

The access to the intake site, head tank and penstock is also a technically difficult task since the topography of the access route is in the gorge covered with densely forested jungle.

In spite of these difficulties, the Silolo is considered to be an economical and powerful plant that can supply 2,100 kW to the Auki system.

Rori Hydropower

The Rori hydropower site is situated at 47 km north of Auki in the northwest of the Malaita Island. The project is to exploit discharge from the springs and head of the cascade, by a run-of-river hydro plant that generates 300 kW and 2,526 MWh per year.

The project has several advantages for its implementation such as:

- -River flow duration is stable, because of spring fed river.
- -Flood discharge is low, since the catchment is only 2 km^2.
- -Short access road of only 900 m, from the provincial road to the intake.
- -Powerhouse site is only 100 m from the provincial road.
- -Construction of the waterway is easy in the hilly area.
- -The water level gauging station has been operated to obtain the river flow data.

Judging from the above, the project is appropriate for implementation in the near future.

Kware'a Hydropower

The project site is situated near the Kware'a bridge which is located 14 km from the Dala village in the north part of Malaita. The project is aimed to exploit discharge from the catchment of 28 km^2 and head created by the Kware'a dam, using a pondage type hydro plant to generate 600 kW and 2,541 MWh per year.

Although site access is easy, the potential of the river cannot justify construction of the dam that requires a concrete volume of 25,000 m^3. Therefore the hydropower generation is possible only if the dam is constructed for other purposes.

(3) Kubolata Hydropower

The site is situated at 2 km to the northwest of Buala, the provincial capital of Isabel province. The project is aimed to exploit the spring water of the Kubolata River, discharge from the three springs and head of the creek, by using a run-of-river hydro plant to generate 80 kW and 563 MWh per year.

The Kubolata project will be more economical if available water is more than the current maximum discharge of 0.05 m^3/s, because of a high head scheme. Any increase in plant discharge will directly increase the installed capacity and benefit the project, therefore, a detailed study of the hydrological analysis is essential.

With regard to the project implementation, the Buala hydropower project will be an appropriate reference for design and construction of the Kubolata project. As for design, the embedded pipe can be adopted as a penstock. Labor based construction method can be applied to the intake, head tank and penstock construction.

(4) Waimapuru Hydropower

The Waimapuru hydropower site is situated at 12 km to the west of Kirakira on the north coast of San Cristobal Islands. The project is aimed to exploit the hydro potential of the Waimapuru River, head and discharge of the waterfalls, by using a run-of-river hydro plant that generates 20 kW and 170 MWh per year.

Although the project is not economical, the electricity demand in the Waimapuru is high. The national secondary school was once closed by water shortage caused by the school diesel plant shut down, since the water supply system totally relies on pumps. Any increase in head and discharge will make the project more economical. Therefore, detailed investigations of leveling survey between the intake and tailrace as well as flow measurement are essential to examine the size of the project.

(5) Sorave Hydropower

The Sorave hydropower site is proposed at the Sorave waterfall on the Sorave River, a tributary of the Sui River in the northwest of the Choiseul Island. The project is aimed to exploit head and discharge of the Sorave waterfall, by using a run-of-river hydro plant to generate 70 kW and 592 MWh per year. The Sorave hydropower is rated at 10 m head with 1.1 m^3/s discharge, being a low head plant with relatively high discharge for a mini hydropower site. The maximum discharge of 1.1 m^3/s requires a large size of waterway structures that result in high cost of the headrace, head tank and penstock.

Since any increase in head will make the project more economical, a detailed study of the tailwater level of the Sui River is essential to determine the rated head of the turbine.

(6) Luembalele Hydropower

The Luembalele hydropower site is situated at 9 km southeast of Lata, in Nendo Island, Santa Cruz Islands. The project is aimed to exploit head and discharge from the cascade, by a run-of-river hydro plant to generate 50 kW and 432 MWh per year.

The project requires construction of an open channel for 1,900 m that accounts for 31% of the total project cost. Moreover, 22 km of the 11 kV-transmission line, which account for 29%, is also required. Although construction cost is not economical, the project would be more attractive if it is implemented with a water supply project, currently planned by USAID. Since any increase in head and discharge will make the project more economical, a detailed survey of the leveling and discharge is essential to determine the size of the project.

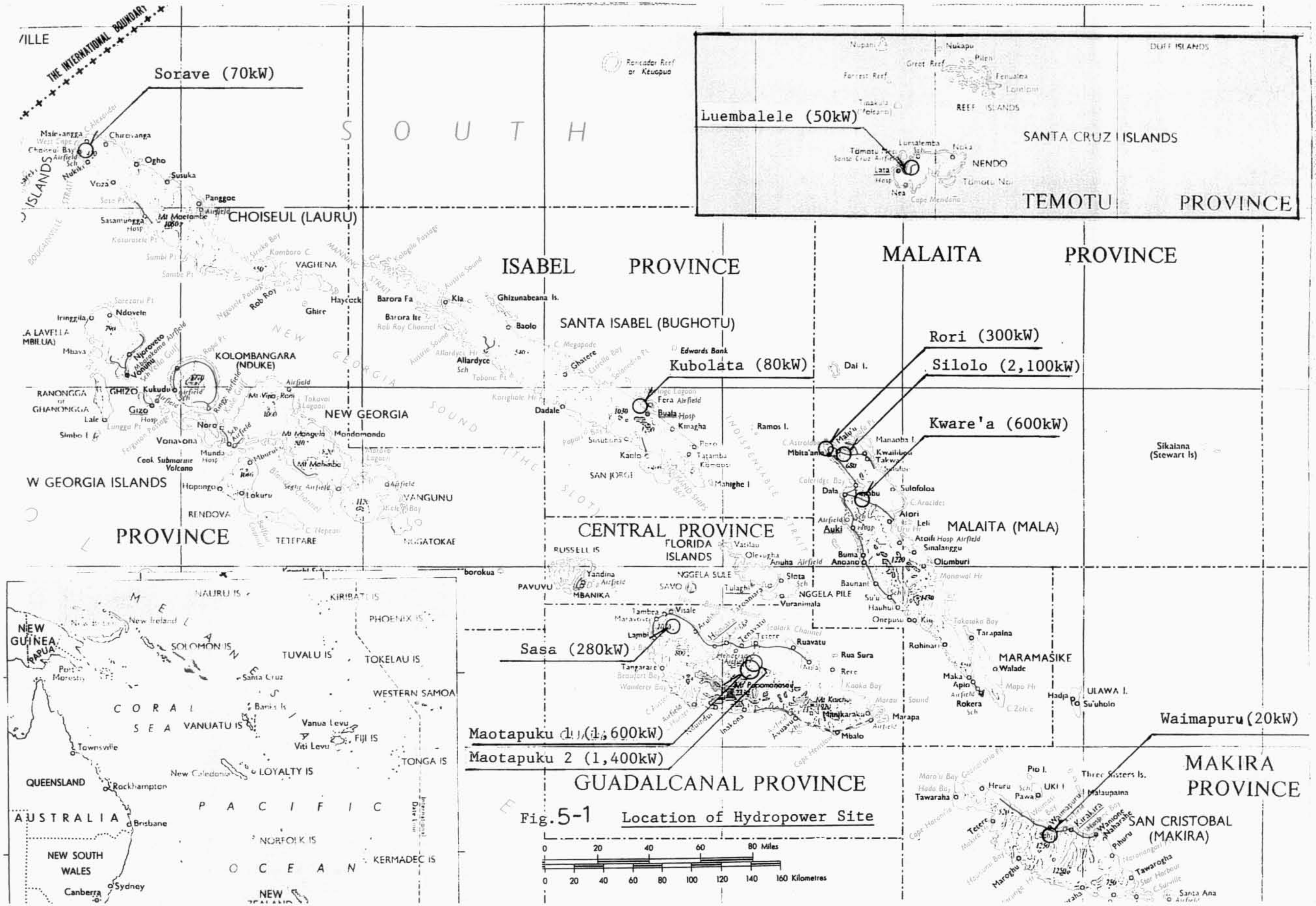


Fig.5-1 Location of Hydropower Site

CHAPTER 6

TRANSMISSION AND DISTRIBUTION FACILITIES / POWER SUPPLY SYSTEM

Chapter 6 Transmission and Distribution Facilities/Power Supply System

6.1 Power Development Plan and Transmission Line

In order to meet the growing power demand in the Solomon Islands, development of hydro power plant and associated transmission lines up to year 2015 are planned as mentioned below. With regard to the generator capacities shown in Fig. 6-2-1 to Fig. 6-2-6, amounts in parenthesis show installed capacities by June 2000 and the amounts without parenthesis are planned capacities. Diesel generator and hydro generator are denoted with letters "D" and "H", respectively.

(1) Guadalcanal Island

Maotapuku I P/S and Maotapuku II P/S, located near gold ridge, will be the most useful sites for hydropower station. The transmission line from Maotapuku I and II to Lunga P/S will be 33 kV and approximately 39 km long as shown in Fig. 6-1-1.

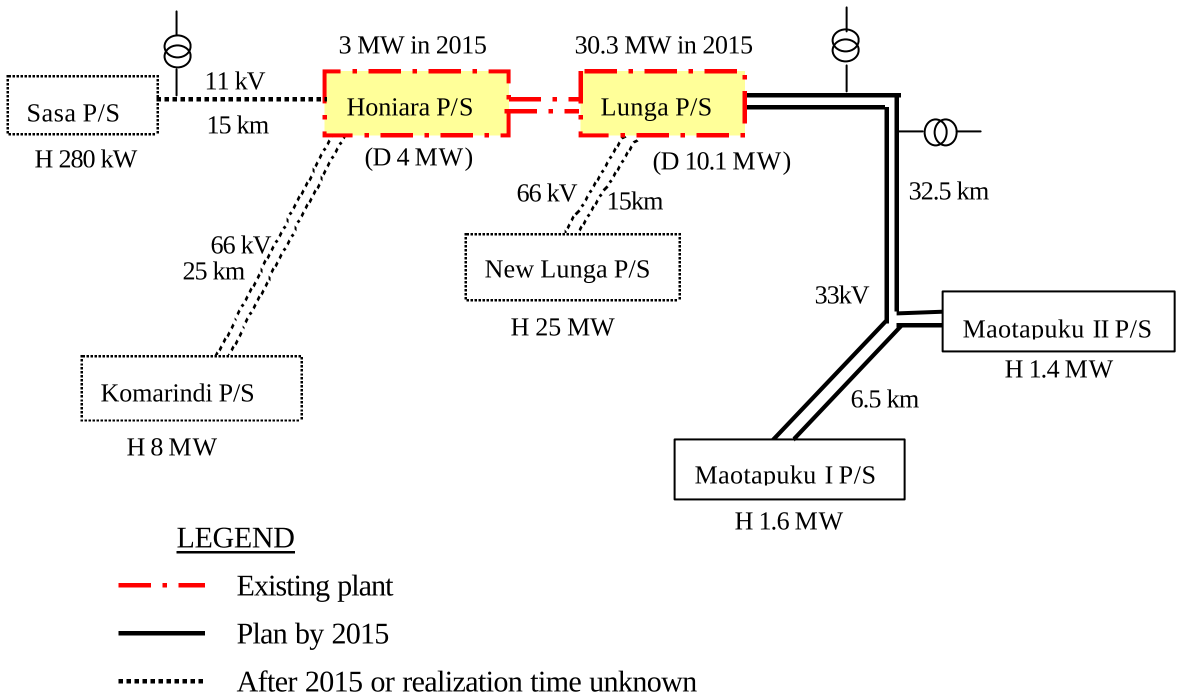


Fig. 6-1-1 Network System of Guadalcanal Island

(2) Malaita Island

Rori P/S shall be developed as soon as possible since it is very easy to construct at a minimum cost. A 33 kV transmission line between Bina and Malu'u will be installed by SIEA. A diesel generating plant shall be installed at Bina for Bina project. The next development will be Ruala'e P/S, Silolo P/S, Fausande switching gantry and 8 km of 33 kV transmission line between Silolo P/S and Fausande S/G. Kware'a P/S and Fiu P/S will be implemented after 2015. Manakwai P/S and Aero P/S also shall be developed.

The transmission line between Fausande S/G and Auki P/S shall be designed taking into account not only the electric power from Rori but also from Manakwai, Aero and Silolo.

(3) San Cristobal Island

Huro P/S shall be developed for reinforcing the power supply system in the Kirakira area. An 11 kV transmission line shall be installed from Kirakira P/S to Nukukaisi where there is a rural health clinic, and along the route power can be distributed to the coconuts crushing mill to be installed at Kaonasugu and to the vocational school at Pamua (see Fig. 6-1-5).

(4) Santa Isabel Island

An 11 kV transmission line shall be installed between Buala P/S and Ghojoruru. It will be useful for the coconut crushing mill in Ghojoruru and the community school in Guguha. Refer to Fig. 6-1-6.

(5) Choiseul Island

Sorave P/S site is located about 200m from the logging road. Transmission lines can be constructed along the logging road, one to a secondary school and the other to a village newly developed. The plan by 2015 is shown in Fig. 6-1-2.

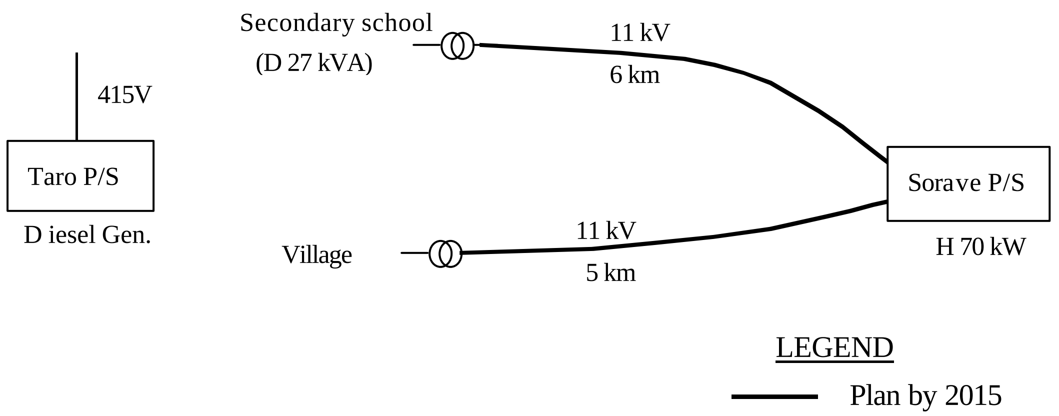


Fig. 6-1-2 Power Supply System of Choiseul Island

(6) Santa Cruz Island

The Luembalele hydro power station will contribute to decrease the load of diesel generators. The transmission line will be a 22 km 11 kV line. Refer to Fig. 6-1-3.

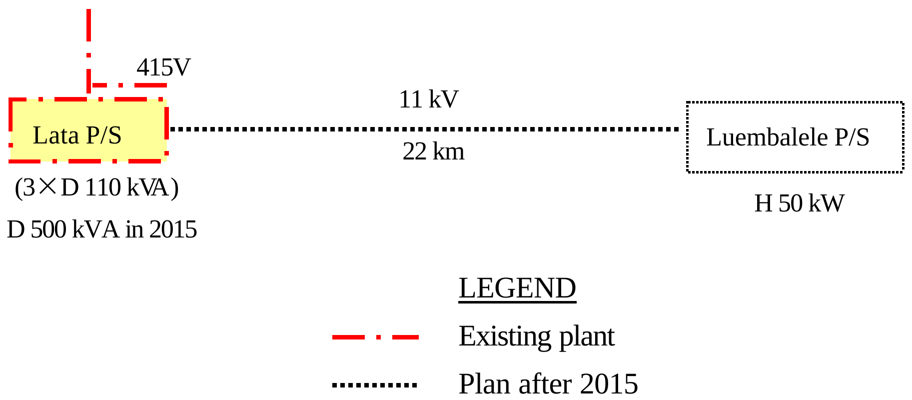


Fig. 6-1-3 Network System of Santa Cruz Island

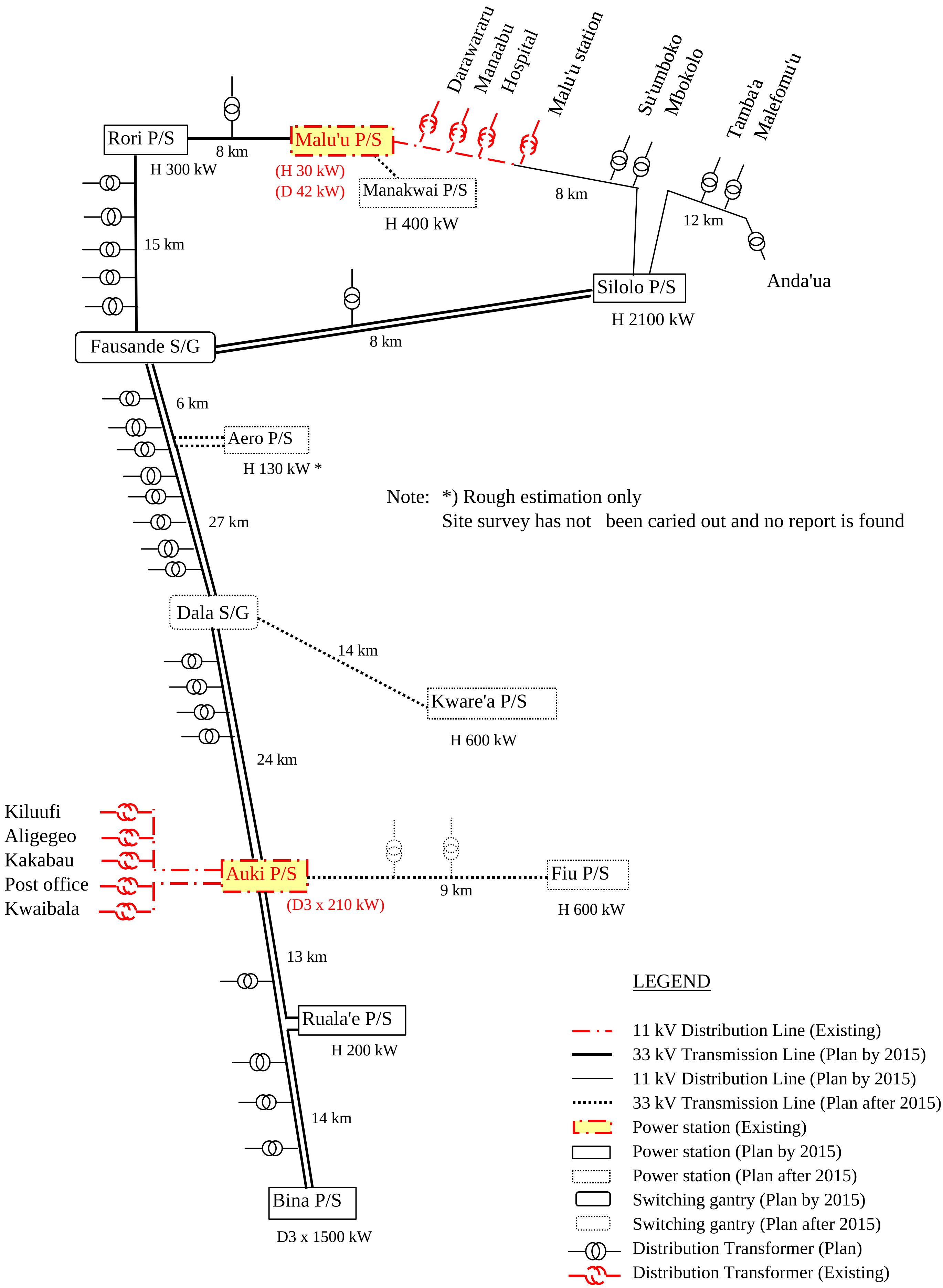


Fig. 6-2-4 Network System of Malaita Island

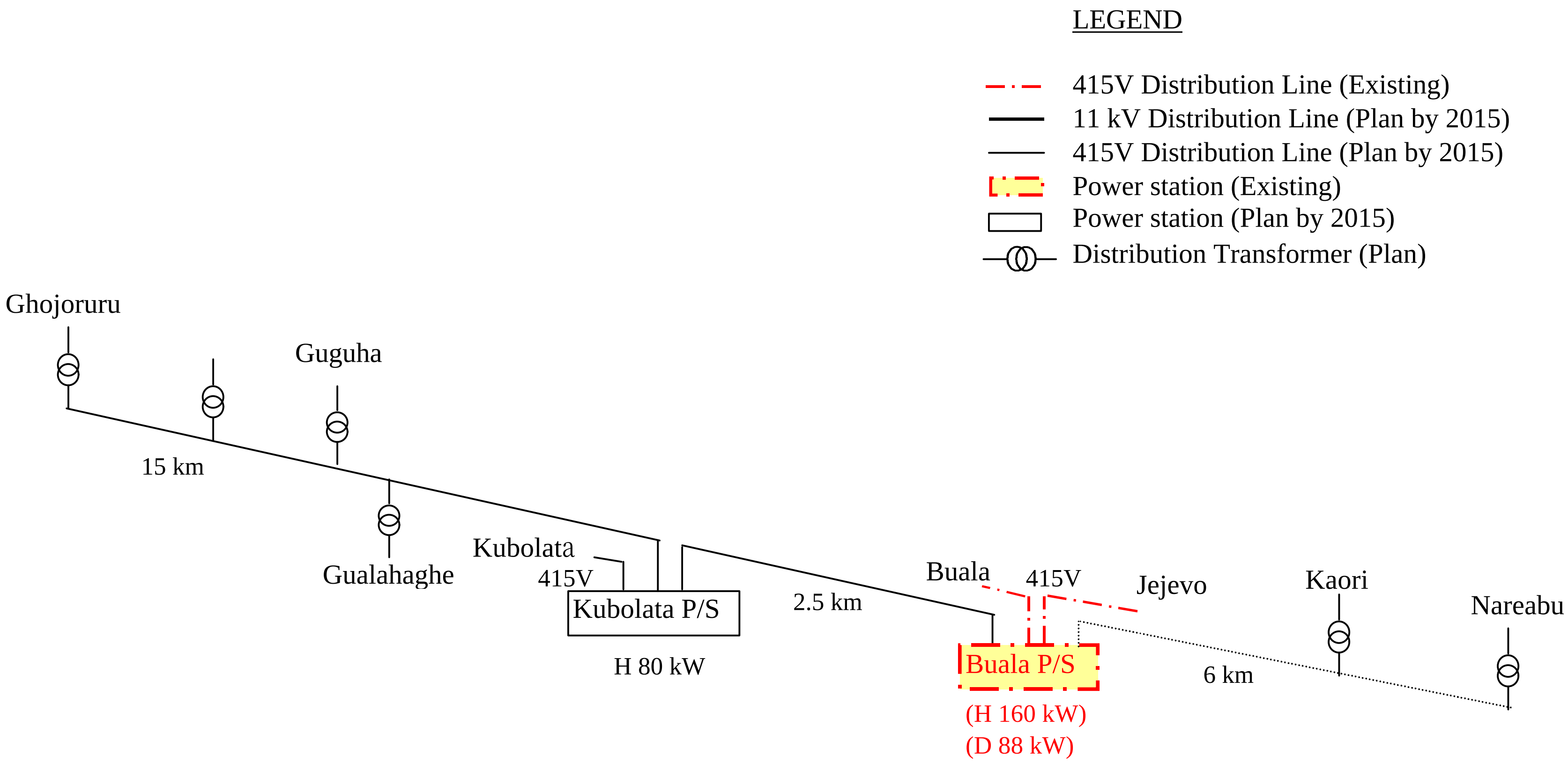


Fig. 6-2-5 Network System of Santa Isabel Island

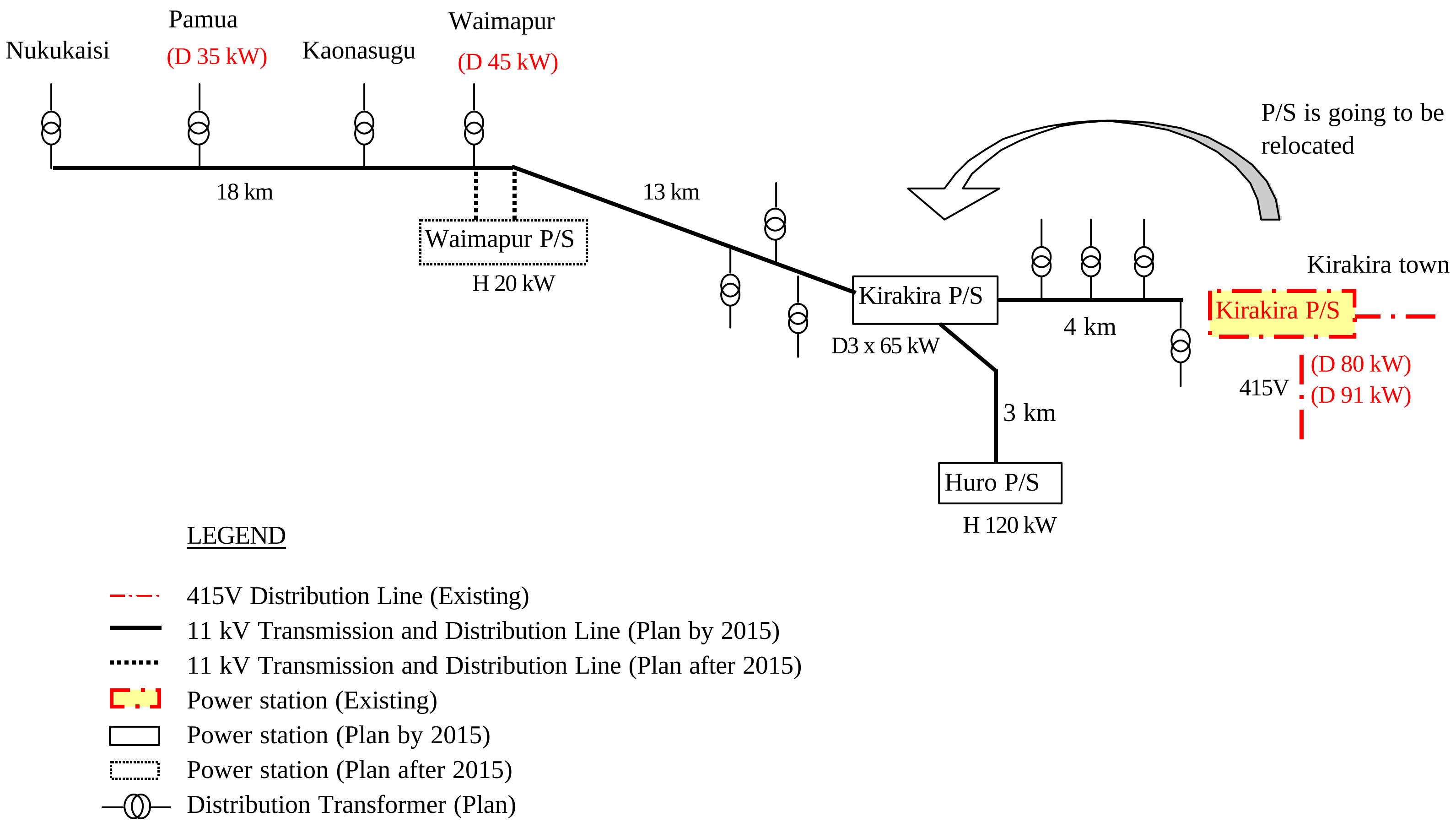


Fig. 6-2-6 Network System of San Cristobal Island

CHAPTER 7

SOLAR POWER GENERATION

Chapter 7 Solar Power Generation

7.1 Solar Power Generation Development Methods

The areas where electrification by grid extension or by mini-hydropower are not economically suitable, will be electrified by Solar Home System (hereinafter SHS). Also, pertaining to the areas where implementation of the grid extension or mini-hydropower development will take a long time, the promotion of the electrification is to be considered in such a way that electrification using SHS is firstly implemented, and then, it is changed to the grid extension or to mini-hydropower, wherever is possible.

7.2 The Field Survey

Ten villages were investigated during the first survey and 12 villages were investigated during the second survey. Technical and economical data were collected, and was used to form a base for the SHS design. The results found are as follows:

(1) Places requiring electrification by SHS

a. Village houses, clinic, and teacher’s houses

Kerosene lamps are used for illumination at these places. After electrification is implemented, villagers want to install lamps, as their first needs. It was found that kerosene lamps are used for 3 to 4 hours per day by villagers and by the teachers. At the Health Aid Post, kerosene lamps, that are brought by the patients when they visit the clinic to get medical attention, are used just for a short time.

b. School

The elementary school gives a supplementary lesson to Standard 5 and 6 groups for the secondary school entrance examination. Kerosene lamps are used for these activities.

Most of the elementary schools finish their supplementary lessons by sunset, but there is one school that gives the supplementary lesson 5 days per week using kerosene lamps at night. Supplementary lessons usually last for 1-2 hours.

c. Meeting Hall and Church

There is a meeting hall in the village and one to three churches. In the church, nightly worships are made for about 2 hours. Kerosene lamps or fluorescent lamps powered by a small diesel generator are used in these buildings.

(2) Villagers payment capacity

a. Income

The villages that are near to big consumption centers sells vegetables and fishes in the markets and get a comparatively high income (SB$100-500 /month). The income of the villages far from markets is less than SB$100 /month.

b. Kerosene expenses

The amount of money that householders pay for the kerosene is SB$5-38/month.

c. Payment for SHS

The amount of money that seems possible to be paid by villagers for the SHS is about SB$20/month. The payment to SHS seems to be possible by villagers contributing to the church and the meeting hall through the Community Fund.

(3) Determination of electrification areas by SHS

The results of village surveys showed that the present economical and geographical situations, such as solar resource, transportation and maintenance issues, differ largely depending on local conditions. Although the Study Team and the counterpart personnel in charge from the Energy Division of the MNR tried to select villages for SHS electrification, it was found to be difficult. Therefore, the Study Team and the counterpart, the Energy Division of the MNR, agreed to determine the electrification villages based on the evaluation of the Pilot Scheme, once this scheme finishes.

7.3 Pyranometer and sunshine recorder installation and operation

A pyranometer and a sunshine recorder were installed during the second field survey at the Vavaya Ridge Upper Air Observatory that is at the top of a mountain at the back of the Diet, in Guadalcanal Island. This equipment was acquired in Japan by JICA Study Team and then shipped to the Solomon Islands. Personnel of the Vavaya Ridge Upper Air Observatory is in charge of data collection; results are sent to the Meteorological Office to be analyzed and recorded.

7.4 Data collection and analysis

(1) Consecutive non-sunshine days

From the sunshine data recorded in the Solomon Islands, the number of five or more non-sunshine consecutive days is 0.1 times the annual mean of all the recording stations. Concerning to the SHS design, it is considered that 5 non-sunshine consecutive days would be enough.

(2) Sunshine duration daily average

Sunshine duration daily average

Place	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Guadalcanal	86-98	6.0	6.0	6.3	6.6	6.7	6.9	6.2	6.7	6.6	7.2	7.6	6.6	6.6
Santa Cruz	88-96	5.6	5.4	5.1	5.8	5.0	5.3	5.4	5.3	5.3	6.0	6.4	5.7	5.5
New Georgia	81-96	5.9	5.0	5.8	5.6	5.5	5.3	4.6	5.4	5.5	5.9	6.5	6.2	5.6
Choiseul	88-97	5.9	5.6	5.7	5.9	5.0	4.9	3.9	4.5	5.3	5.5	6.4	5.9	5.4

(Source: Monthly Mean Sunshine Hours, Solomon Islands Meteorological Service)

(3) Data collection from the new meteorological equipment

Results from the four months measurement from the pyranometer and sunshine recorder installed at the Vavaya Ridge Upper Air Observatory are presented below. Data measured from April 2000 has not been summarized.

Measurement Results (Average)

Year/month	Sunshine duration (h/day)	Irradiation energy (kWh/m²-day)	Conversion coefficient (kW/m²)
1999/12	6.55	4.76	0.73
2000/1	4.64	4.11	0.89
2000/2	6.18	4.56	0.74
2000/3	5.96	4.51	0.76
Average	5.83	4.49	0.78

Source: Vavaya Ridge Upper Air Observatory

The solar irradiation from December 1999 to April 2000 is 4.49 (kWh/m²-day) in average, and sunshine duration for the same period is 5.83 hours in average. The conversion coefficient, which is the solar irradiation divided by the sunshine duration, is 0.78 (kW/m²) in average.

Since measurement of the solar irradiation is not made in the Solomons, the solar irradiation is estimated from the conversion coefficient and the sunshine duration. The conversion coefficient of 0.7 kW/m^2 used in this master plan is considered to have enough slack.

7.5 Design and Specifications

(1) Calculation of the solar irradiation

The solar irradiation on a tilted surface depends on the latitude, the inclination of the PV module, and season (month), even if having the same sunshine duration. The inclined solar irradiation for a surface tilted 12.5 degrees and facing north is shown in Table below.

Inclined solar irradiation (MJ/m^2-day) tilt angle:12.5 degree

Place	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
Honiara	14.10	14.56	15.95	17.48	18.44	19.37	17.26	18.05	17.03	17.77	18.05	15.37	16.95
Munda	13.80	12.08	14.62	14.76	15.06	14.80	12.74	14.48	14.13	14.50	15.37	14.37	14.23
Taro	13.69	13.43	14.26	15.44	13.58	13.56	10.71	11.97	13.52	13.42	15.01	13.56	13.51
Lata	13.23	13.17	12.97	15.44	13.84	14.97	15.12	14.36	13.75	14.88	15.28	13.35	14.20

7.6 Systems and installation

Three systems, with capacity of 36 Wp, 55 Wp, and 75 Wp, are designed for use as SHS. The system to be used is selected taking into account the size of the building and the payment ability.

(1) 36 Wp system

Supplies one fluorescent lamp of 9W-11W and also an electric outlet for the radio cassette recorder. The use of the fluorescent lamp is about 4 hours. A radio cassette recorder of 6W can be used for about 0.2-2 hour. This system will be installed in private houses and teacher's houses.

(2) 55 Wp system

Supplies 3 fluorescent lamps of 7W and also an electric outlet for the radio cassette recorder. The three fluorescent lamps can be used for 3-4 hours. A radio cassette recorder of 6W can be used for 0-2 hours. This system will be installed in the clinic, private houses, and the teacher's houses.

(3) 75 Wp system

Supplies 4 fluorescent lamps of 11W and also an electric outlet for the radio cassette recorder. The four fluorescent lamps can be used for about 2 hours. A radio cassette recorder of 6W can be used for about 0.2-1 hour. This system will be installed in the public facilities. Several systems can be installed depending on the building size.

7.7 Construction costs

The SHS construction cost depends on the number of purchased sets. As for the cost that was used in this investigation, it is supposed that 500 SHS sets will be purchased. Also, it is supposed that SHS will be imported from Brisbane, Australia. Estimated construction costs for two cases, with and without import duties and goods tax, are considered.

(1) Customs duties and goods tax included

Construction cost of SHS with customs duties and goods tax

System	Cost (US$)
36 Wp System	1,195
55 Wp System	1,398
75 Wp System	1,640

(2) Customs duties and goods tax not included

Construction cost of SHS without customs duties and goods tax

System	Cost (US$)
36 Wp System	996
55 Wp System	1,160
75 Wp System	1,301

7.8 Operation and maintenance costs

The SHS rental charge is estimated based on costs such as O&M and construction costs. The SHS rental charges are estimated for two cases, one including import duties and goods tax and the other not including them. Also, comparisons are made when the interest rates are 4% and 0%. The ownership of SHS is not transferred to the user and the owner is responsible for the maintenance during 20 years after installation even if payment of the rental charge has been completed. Battery cost includes disposal expenses (US$4/unit).

(1) Case including customs duties and goods tax

a. When a rental charge is paid during 20 years

Rental charge for 20 years including O & M cost (With customs duties and goods tax)

System	4 % of interest (US$/month)	0 % of interest (US$/month)
36 Wp System	10.8	7.3
55 Wp System	12.4	8.4
75 Wp System	14.5	9.8

(Down payment:US$30)

(2) Case not including customs duties or goods tax

a. When a rental charge is paid during 20 years

Rental charge for 20 years including O & M cost (Without customs duties and goods tax)

System	4 % of interest (US$/month)	0 % of interest (US$/month)
36 Wp System	9.1	6.2
55 Wp System	10.4	7.0
75 Wp System	11.7	8.0

(Down payment:US$30)

7.9 Training

Training is indispensable in order to strengthen the dissemination of SHS. Concerning the training procedure in the Pilot Scheme, engineers from each province who are working at the Provincial Government will be trained at the PV Training Center in Honiara. The PV Training Center will be established in REAC, Rural Electrification Advisory Committee. After engineers completed the course, they would train at the provincial capital technicians from each village communities where pilot systems are be installed, in order to get qualification for SHS operation and maintenance. Regarding the Nationwide Scheme, and similarly to the Pilot Scheme, the engineers who completed the course in Honiara would train at the provincial capital technicians from each village community where SHS will be installed, in order to get qualifications for system operation and maintenance.

7.10 Village maintenance and management organization

This defines the person to be in charge of the SHS installation, maintenance and management, in the village where SHS will be installed. This person in charge of maintenance and management should be a technician who has completed the training. One qualified technician should be in charge of maintenance and management activities of 50 sets of SHS, and according to the number of SHS to be installed, more than one technician might be necessary. The technician should get into an agreement with the SHS owner to maintain and manage the systems, and will receive a monthly salary from the owner according to the number of SHS. The technician in charge of the maintenance management will record the results of the maintenance using a special SHS management ledger.

7.11 Battery disposal

(1) Disposal procedure

The used batteries will be accumulated in Honiara and sent to Brisbane, Australia, in lots of 500 units, and entrusted to deliver them to a battery disposal company. The battery disposal company, located in Brisbane suburbs, refunds 2 AUcent/kg, when batteries are carried in for disposal.

(2) Disposal costs

The battery disposal costs are estimated at 4 US$/piece including transportation, and are considered in the original battery price.

CHAPTER 8

RURAL SOCIETY

Chapter 8 Rural Society

8.1 Present State and Distinction

Clan and language group are essential factors of social identity in the Solomon Islands. In other words, extended family (or kinship) and the wantok system are the core of society. This system has sustained their egalitarian society and functioned as an informal safety-net to disadvantaged people like the young, the sick and the old. It has protected villagers from absolute poverty. These systems are rooted in the subsistence economy – a system of high self-sufficiency. However, villagers are increasing their dependence on the market economy, and are under pressure to earn money. Traditional systems are rapidly changing or eroding.

The penetration of Christianity to rural society is another feature in the Solomon Islands. Statistics show that 96% of Solomon Islanders is estimated to belong to the Christian religion, and actually so many activities in rural area have relationship with Christianity. The church is thought to be the most important public building in the village. Due to such circumstance, the consensus for the project related to the Church will be established easily among the community.

8.2 Village Structure

For rural people, communal rule is superior to that of the nation, and the village still enjoys a highly independent existence in the Solomon Islands.

In this study, the following organizations have been identified as common to the social infrastructure of the people: the village committee, the church committee, the school committee, the health committee, the water committee, the women's club, the men's club and the youth club. The groups that are related to the church and community primary school function well. In this study, several churches were found to be equipped with diesel generators for lighting and other electrical goods. So, in the case of electrification by the Solar Home System (SHS), it would be advantageous to introduce such facilities to churches and community primary schools.

8.3 Village Livelihood

(1) Villagers' cash income

Self-sufficiency is still the basis of rural people's life in the Solomon Islands. However, cash is already indispensable even for rural life. Various kinds of income generating activities are recognized throughout the Solomon Islands.

Copra production, garden products and cocoa growing are thought to be the influential and general sources for cash income in rural areas.

Copra production, which is the most popular income source throughout the Solomon Islands, is a labor intensive activity, and family members are required to assist in these activities during the process. If the area of coconut plantation is more than sufficient, the crucial factor restricting production is available family labor.

Another popular activity is to sell garden products. Garden products are important resource for self-sufficiency, but also for cash income. However, the location of villages is the influential factor. If the village is located in a remote and dispersed area, income from garden products is not promising. In such villages where rural people participate in barter and sale in their local market, cash income from garden products is around SB$10.00 per week. The villages located near the provincial capital possibly get cash income of SB$50.00 to SB$200.00 per excursion to the market, and excursions can occur more than once a week.

Cocoa growing without any processing is also a worthwhile income source for rural people. This is because labor input is smaller, and the price for producers is more attractive than copra production. Actually, in January 1999 the price of wet (unprocessed) cocoa bean was SB$2.00/kg, though copra was about SB$0.75/kg. In the middle of 1999, the price of wet cocoa bean dropped from SB$2.00/kg to SB$0.60/kg, thus the producers who concentrate on cocoa growing have suffered losses. However, the region where people grow cocoa is still assumed to be favorable, because it is possible to manage copra production together with cocoa growing.

Based on existent data and collected information in this field survey, Guadalcanal Province, West Province and Malaita Province are relatively higher cash income provinces than the others. In addition, considering the factors, like cash crop plantation, that are influential for cash income in rural area, the northern part of Guadalcanal Island, especially such areas where the Central Market in Honiara is accessible, coastal areas from the north-west to west in Malaita Island and regions located around and between Gizo and Munda in the West Province are higher cash income areas. As such they are relatively promising for the cost sharing project with beneficiaries.

(2) Villagers' expenditure for energy

The range from SB$10.00 to SB$20.00 per month was the most popular range for the payment of electricity suggested by rural people in this field survey. It seems that most rural people had some experience utilizing electricity from the grid in the capital and/or provincial capitals directly and sensed the convenience of electricity.

The data collected in this field survey shows that rural household expenditure of Kerosene, mainly for lightening, varies from SB$10.0 to SB$36.4 and the combined amount of Kerosene and dry batteries, mainly for radios with cassette players and torches, from SB$16.4 to SB$59.7. Average monthly payment per rural household for electricity based on the records of the SIEA, Malu'u Branch Office in Malaita, is SB$20.4. Considering the above data, the range from SB$10.00 to SB$20.00 suggested by rural people is a reasonable amount. In addition, the data come from SIEA Malu'u Branch Office supports SB$20.00 as an affordable amount for rural people who have certain cash income sources.

8.4 Sensitive Issue

(1) Land Tenure System and Land Dispute

There are two types of land tenure system in the Solomon Islands. Alienated land covers 13% of nation's land, and customary land covers 87%.

Alienated land is land that was exploited by colonial governments and foreign immigrants before such activities were banned in 1914. At present, most of the alienated land is utilized for the capital, provincial capitals and commercial farms. Boundary and ownership are fixed.

Customary land has been traditionally occupied by clans or land groups, and boundaries are defined by geographical features like rivers, valleys and mountain peaks. Therefore exact boundaries have not been fixed. Also some land has several kinds of owners who keep primary rights, secondary rights and, in some cases, tertiary rights. In case of land dispute the discrimination of rights is crucial.

(2) Land acquisition

As a result of the detailed survey of 11 potential sites for a hydropower station, three categories of land ownership have been identified.

The three groups are:

Type A: Customary land where land ownership has not yet been clarified officially

Type B: Customary land where land ownership has already been clarified officially

Type C: Alienated land where land ownership is already clear

In case of *Type A "Customary land where land ownership has not yet been clarified officially"*, the first and basic issue is how to identify the just owner of the prospective land. Especially in the small areas, where several villages are located, this is expected to take a long time. This is due to the fact that there is no written record generally, and reliable evidence amounts to neighbor's memories and information that has been passed down from ancestors. Fig. 8-1 shows the procedure applied officially to acquire customary land, considering the above mentioned situation.

If concerned people (groups) agree to obey the preliminary decision at Step 4 in Fig.8-1, land disputes will be easily and quickly concluded. If land disputes end up being taken to court (Step5-1 and Step6-1), it will take several years to reach a conclusion.

Actually, if a dispute is focused only on land ownership (and doesn't include implementing the project) the land dispute and the project can be processed separately. In the case of the construction for the Malu'u Hydropower Station in Malaita Province and the Buala Hydropower Station in Santa Isabel Province, the above separation of procedure was applied.

In case of Type B "Customary land where land ownership has already been clarified officially" and Type C "Alienated land where land ownership is already clear", the owners (owning groups) and rented persons (groups, firms) are assumed to be sure, thus the consent for constructing a hydropower station from those owners and rented persons should be obtained or confirmed.

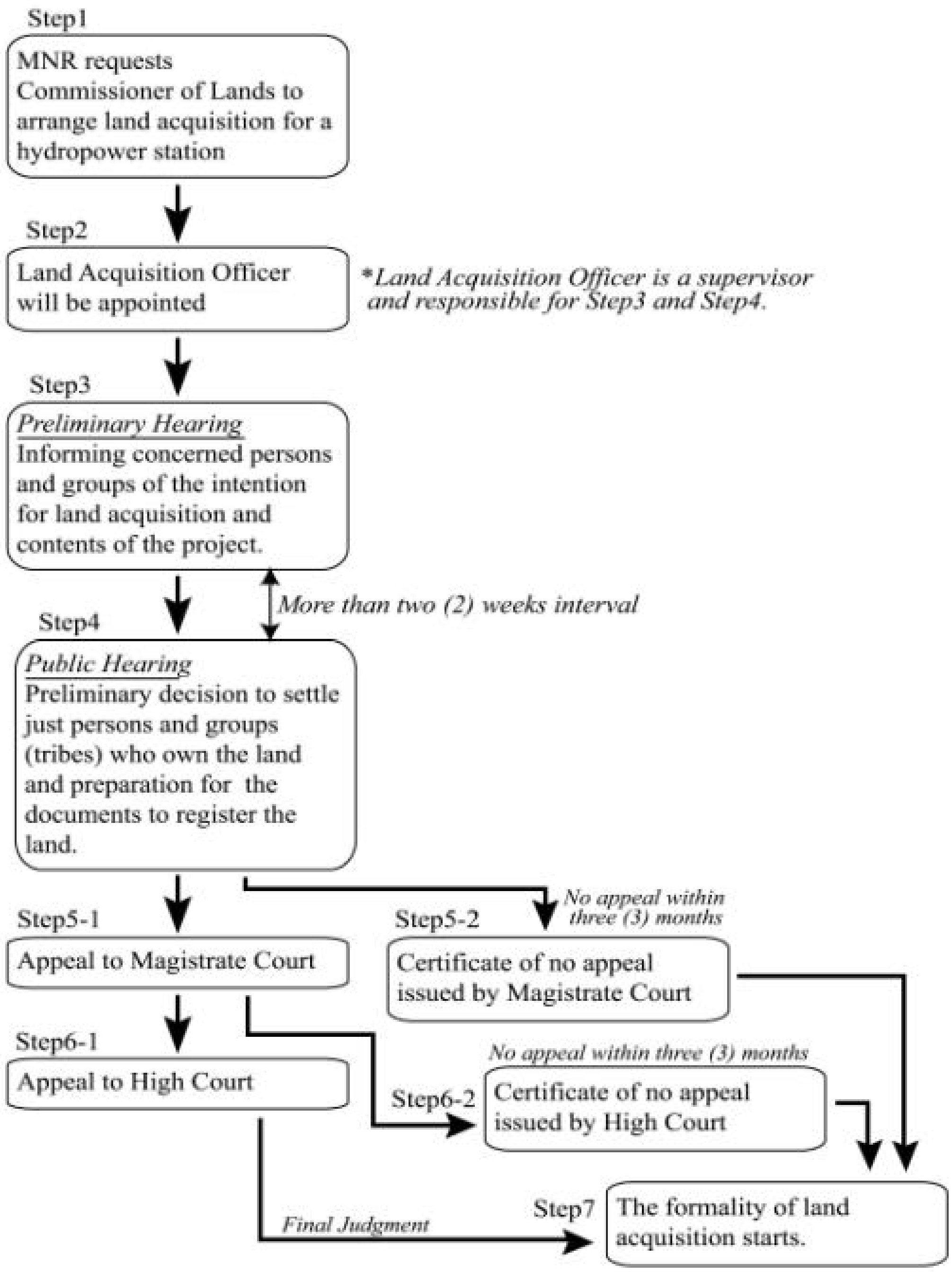


Fig. 8-1

Flow Chart for Land Acquisition

In case of constrcting a hydropower station by Ministry of Natural Resources(MNR)

(3) *Tambu* Site

In the process of this study, *Tambu* sites were understood to be a critical obstacle to implementation of any project in the Solomon Islands. Basically *Tambu* sites have not been admitted in potential 11 hydropower sites.

There is not a general definition of *Tambu* sites, but these sites may be altars where human or animal sacrifices were conducted, burial grounds of ancestors and known chiefs or places where spiritual existence was important in some way before Christianity spread all over the nation. 96% of Solomon Islanders belong to the Christian religion at present, and Christianity has affected village life profoundly. Still *Tambu* sites are taboo for villagers and it is advisable not to ignore such feelings.

(4) Natural environment

From the point of view of natural environment, two potential sites are recognized to be important to pay certain consideration. One site will include constructing dam and another site is recognized to exist unique wildlife in downstream of expected site.

(5) Water Rights

The law for utilizing river water has not yet been established.

A complex issue is how to treat such people who have land ownership in upstream areas, especially the water catchment area. The official stance of the government is that monetary compensation will not be done to the owners or owning groups. However, there is high potentiality to cause dispute. Advance coordinate avoiding such dispute will be required, when owners of facilities' sites and upstream water catchment areas are different.

(6) Others

Even when satisfying the above conditions, there still remains some risk of positive and passive interference from local residents without establishing consensus through involving them enough. Therefore, before starting the project, it is necessary to explain the project sufficiently -- not only to landowners (land owing groups) and residents along the river, but also to neighborhood residents who may not have any direct interests.

CHAPTER 9

ENVIRONMENTAL CONSIDERATION

Chapter 9 Environmental Consideration

9.1 Environmental assessment scheme and guideline

The part Ⅲ of the Environment Act will also give the basis for environmental impact assessment, environmental report and statement, public information and monitoring procedure for environmental aspects of development. The director of SIECD may issue guidelines for the above.

When a feasibility study for a development project selected by this Master Plan study, especially a MHP project with the construction of a small-scale dam and river diversion works, is conducted, the study should refer to and follow '*Solomon Islands Environmental Impact Assessment Guidelines, FOR PLANNERS AND DEVELOPERS, May 1996, SIECD*' and its accompanying documents, '*Environmental Appraisal Summary, Solomon Islands EIA Guidelines*' and '*Checklists of Issues to Consider and Appraisal Form, Solomon Islands EIA Guidelines* (one for forested areas: for construction, infrastructure, agricultural and mining projects in any environment: for coastal zone and marine environment) '.

The implementing agency should be careful not to disturb the following areas, which are also noted in the above guideline.

Environmentally or Ecologically Sensitive Elements

Wildlife habitats (undisturbed forests, mangroves, wetlands and swamps, coral reefs, sand and sea-grasses and so on), volcanic areas, places of great scenic beauty, archaeological sites, tambu sites, catchment of rivers supplying drinking water and areas contributing to groundwater or groundwater lens recharge (mainly limestone areas) and sandy surfaces on low islands.

Archaeological sites

Local people will be generally not aware that sites exist. Typical patterns in site occurrences are; sites behind beaches and headlands, on open areas near creeks, on ridges or saddles in hilly areas, in rock shelters, and at the sites of present, or former villages.

9.2 Environmental Impacts to be considered

The followings are the summary of environmental impacts to be considered in electrification by mini-hydro power generation and solar home system

(1) Conceivable impacts on natural environment by the mini-hydro power generation scheme

- (Construction Stage) Disposal of excavated soil and sand in the construction of dams and water conveyance structures
- (Construction Stage) Conflict between inflowing workers and surrounding communities in construction period
- (Construction & Operation Stages) Adverse impacts on the surroundings and

downstream ecosystem by a project not employing the project design which mimics the natural settings (e.g., access of large scale machinery and roads into upstream areas, change of natural dry spell)

- (Operation Stage) Water shortage downstream of a water intake, especially during dry spell
- (Operation Stage) Water shortage or pollution of the potable water supply source if it is located downstream
- (Operation Stage) Disturbance of migration of fish, which could be a food source to nearby communities
- (Operation Stage) Disturbances of agro-forestry production and landscape
- (Operation Stage) Inflow of logging business into upstream areas through leftover access roads for the construction of electrification facility

The followings are unlikely with the proposed scheme, but still due to the sizes of their impacts it should be noted that they are carefully studied during planning and designing stages.

- Location of the structure in relation to the sites of conservation areas
- Impacts on endemic or rare species of wildlife
- Large scale reshaping of the slopes and rivers which could cause artificial or intensified landslides or floods

See Chapter 8 on social aspects like land acquisition or lease agreement procedure.

(2) Environmental Impacts by the SHS scheme

- Reduction in the use of dry batteries and the amount of their disorderly disposal (*positive impact*)
- Disposal of used batteries at the end of a lifecycle of SHS facility (*adverse impacts*)
- Disturbance of the surrounding landscape with transmission lines and SHS facilities (*adverse impacts*)
- Safety issues of transmission lines and the likes in the cyclone and strong winds (*adverse impacts*)

(3) Environmental impacts on global environment

- The comparison of CO_2 gas emissions between mini-hydropower (MHP) generation and diesel-based generation
- The comparison of the proposed mini-hydro power generation with that of energy required to produce the materials, such as cement, steel, etc., for the hydro and to build the scheme, such as transport, power tools, etc.
- CO_2 gas emissions to generate all the required energy to implement the project

9.3 Measures of environmental consideration to be taken

The following measures should be taken to mitigate environmental impacts listed in 9.2, assuming the proposed scheme, mini-hydro power and solar power generation, and the proposed approach that be without resettlement of people and trans-boundary diversion of water.

(1) As for social consideration, refer to Chapter 8 primarily.

- Land acquisition (see 8.5 in Chapter 8)
- Tabu (Tambu) sites (see 8.5 in Chapter 8)
- Water rights (see 8.5 in Chapter 8 and 9.1.1- (3) and (4) in Chapter 9)

(2) As for natural environment, the following measures are recommended.

- (Second Phase of M/P Study, Planning, and Designing Stage） Plants and wildlife
- As for site selection, it should be confirmed at SIECD, provincial government, and acting local NGOs if a proposed site is in accord with any prospective conservation area (declared catchment areas, conservation areas for endemic or rare species, forest reserves, etc.).
- (Note: The follow-up survey was conducted in Rural Society Study during the second field survey of M/P study. See Table 8-5-1 for its result)
- The occurrence of fish migration into a river should be screened on the planning phase of respective projects, namely F/S study. Then necessary mitigation measures should be taken in the basic design if migration of important fish species is identified.
- (Planning Stage) Global Environment
- When alternative methods are compared between mini-hydropower (MHP) generation and diesel-based generation, the comparison should be made for CO_2 gas emissions in construction and operation stages, energy required to implement the project, and energy to be generated by the planned facility.
- (Planning and Basic Design Stages) Securing and protection of intake of potable (drinking) water for the surrounding communities
- In case a proposed site might be inevitably selected upstream of drinking water source, the necessary measure should be taken to secure the amount of water intake and to protect the water quality on the basic design stage.
- (Planning and Basic Design Stages) Battery disposal
- No proper disposal system for batteries seems to be actually working in the country. It is necessary that the collection system for used out batteries and facilities should be included in the design concept of SHS. It is recommendable that the economic feasibility be roughly evaluated in the M/P Study for their prospective collection system. The collection system should be included in the basic design.

- (Planning and Basic Design Stages) Disposal of excavated soil and sand
- In planning a project to dispose a good amount of excavated soil and sand in the construction of dams and water conveyance structures, it is necessary in planning and basic design stages that the plans should be made for the disposal of excavated soil and sand and be agreed by the concerned communities. The plans should include those for the quality test of disposed soil, the location permit and method of soil disposal by the concerned communities.
- (Planning and Designing Stages) Influence on floods, landslides and soil erosion
- In the proposed scheme the serious impacts are unlikely on this aspect. However, this is a matter of technical design of the structural scheme, this aspect should be noted technically in the site selection and designing stages.
- (Basic Design Stage) Mimicry of the natural settings
- The method should be employed in the basic design of respective projects. In the mini-hydro power generation project, the basic design should mitigate water shortage downstream of a water intake during dry spell and disturbances of agro-forestry production and landscape by the planned facilities.
- (Basic and Detailed Design Stages) Harmony with the surrounding landscape and safety measures of power line and other facilities
- The proper consideration should be taken for the aspects on the design phase since the scheme does not contain a large size of facilities technically.
- (Construction Stage) Inflowing workers and surrounding communities
- The construction workers should be employed from the groups in friendly relations with the surrounding communities and the periodical onsite monitoring for their relations are necessary in construction period. (The conflict between different groups is surfaced in the Solomon Islands.)
- (Operation Stage) Post management of leftover access roads
- The plan for the post management of leftover access roads should be made and agreed with SIEA and the concerned communities before the end of construction period so that people of logging business and others should not enter into upstream areas illegally through leftover access roads.

CHAPTER 10

POWER SUPPLY PLANNING

Chapter 10 Power Supply Planning

10.1 Basic policy for power supply planning

The following basic policy for power supply planning is consistent with the "SOLOMON ISLANDS NATIONAL ENERGY POLICY AND GUIDELINES" formulated by the Solomon Government

(1) Hydropower shall be developed as much as possible for supplying power to the area served by the existing grid power.

(2)-1 Hydropower shall be also developed as much as possible for supplying power to the provincial capital and large towns (station towns).

(2)-2 Hydropower or PV shall be developed for supplying power to large towns (station towns).

(3) PV shall be developed for rural electrification to the town/village where there is no hydropower potential, and no hydropower or other power source development plan.

(4) Existing diesel power shall be extended or up-graded for supplying power to the area served by the existing diesel power system where there are no hydro potential sites or where to develop hydro power potential would take too long.

10.2 Existing power supply facilities

The existing power supply facilities owned by SIEA account for 30,730 kW of total capacity (de-rated capacity is 22,692 kW) as of June 2000.

Non-SIEA facilities had 280 kVA of total capacity by the end of 1989. However, since churches and some people have their own diesel generators, the real situation is not clear.

10.3 The power supply plan and rural electrification plan

When a power supply plan for an area is made in accordance with the "National energy policy and guidelines", the area served by power source is classified as follows:

A. A area served by grid power,

B. A area served by independent isolated power source (hydropower source or diesel power source),

C. A area served by PV (Photovoltaic: Solar energy generation)

D. Area served by existing diesel power

The power supply plans for each province are shown below. The preparation of each power supply plan is based upon the power demand forecast for each province (demand center), as shown in Chapter 4.

10.3.1 Areas served by grid power

- Guadalcanal Province

This province has 49 hydro potential sites, which can be developed. JICA Team investigated three sites. Several power supply plans were prepared and evaluated taking into account these hydro potential sites, as well as other hydro potential sites and other diesel plants.

The power will be supplied by the selected optimum power supply Plan-3 to Araveu, Ruaniu, Ndoma, Aruliho and Kohimarama villages and to the Technical College in the northwestern area, and to St. Martins village and Tenaru Mission College in the eastern area. The future area to be electrified is shown in Appendix 10-3-1.

10.3.2 Areas served by independent power source

(1) Malaita Province

This province has 23 hydro potential sites, which can be developed. JICA Team investigated three sites, and several power supply plans were prepared and evaluated taking into account these hydro potential sites, as well as other hydro potential sites and other diesel plants. The power will be supplied by the selected optimum power supply Plan-3 to villages in the area from Bina to Malu'u. The future area to be electrified is shown in Appendix 10-3- 2.

(2) Isabel Province

This province has 6 hydro potential sites, which can be developed. JICA Team investigated two sites and from a technical point of view judged that the Poporo potential site is very difficult to develop, and several power supply plans were prepared and evaluated taking into account these hydro potential sites, as well as other hydro potential sites and other diesel plants. The power will be supplied by the selected optimum power supply Plan-1 to Buala and Jejevo villages, to the Ghojoruru coconut crushing mill and to the Guguha school. The future area to be electrified is shown in Appendix 10-3- 3.

(3) Makira Province

This province has 12 hydro potential sites, which can be developed. JICA Team investigated one site, and several power supply plans were prepared and evaluated taking into account this and other hydro potential sites and diesel plants. The power will be supplied by the selected optimum power supply Plan-2 to Kirakira Township, Nukukaisi and other villages and to the Waimapuru and Pamua schools and the Kaunasugu coconut crushing mill. The future area to be electrified is shown in Appendix 10-3- 4.

(4) Temotu Province

This province has 2 hydro potential sites, which can be developed. JICA Team investigated one site, and several power supply plans were prepared and evaluated taking into account this and other hydro potential sites and diesel plants. The power will be supplied by the selected optimum power supply Plan-2 to Lata Township and some villages and to the Temotu coconut crushing mill and the fish center. The future area to be electrified is shown in Appendix 10-3- 5.

(5) Choiseul Province

This area has no power supply from SIEA at present. This province has 15 hydro potential sites, which can be developed. JICA Team investigated one site, and several power supply plans were prepared and evaluated taking into account this and other hydro potential sites and diesel plants. The power will be supplied by the selected optimum power supply Plan-1 to the villages of the newly developed commercial and industrial area on the main island.

On the other hand, a new diesel power plant should be developed in Taro Island, because the interconnection line between main island and Taro Island will be very difficult and not be economical due to the proximity of Choiseul Bay.

10.3.3 Areas served by existing diesel power source

(1) Gizo area, Gizo Island, Western Province

This province has 23 hydro potential sites, which can be developed. However, there is no hydro potential in Gizo area. JICA Team prepared and evaluated several power supply plans. The power will be supplied by the optimum power supply Plan-2 to the township and surrounding villages. The future area to be electrified is shown in Appendix 10-3- 6.

(2) Noro-Munda area, New Georgia Island, Western Province

There are 23 hydro potential sites in this province and 8 sites in New Georgia Island, which can be developed. However, there is no suitable hydro potential site on New Georgia Island. JICA Team prepared and evaluated two power supply plans. The power will be supplied by the selected Plan-2 to the township and surrounding areas. The future area to be electrified is shown in Appendix 10-3- 6.

(3) Tulagi area, Central Province

JICA Team prepared the power supply plan based upon diesel power source, because maps for the hydro potential study could not be obtained. The power will be supplied by the selected Plan-2 to the township and surrounding areas.

10.3.4 Area electrified by Solar Energy Generation

It has been confirmed through rural society surveys and solar energy generation (PV) potential surveys that the needs for electrification in every village are very high. However, it is found out that there is a difference of income revenue among villages and high-income villages tend to be located near to large towns or capitals. These high-income villages have capability to pay for PV systems.

The following scenario, which is the electrification plan for those areas which would not be electrified by grid extension or by power sources to be newly developed, is recommended as the rural electrification program until the year 2015.

Scenario for rural electrification:

The scenario shall be classified into three stages in order to implement the rural electrification plan, which consists of the power supply to public facilities such as schools, churches and clinics and to individual houses in non-electrified villages.

(1) First stage: Preparation stage

The following steps shall be carried out for solar power generation.

- ➢ Establishment of REAC and definition of its role
  - Awareness by villagers of information on PV
  - Establishment of a technical training center
  - Establishment of a revolving fund for SHS
  - Preparation of a management and technical training manual
  - Legislation of technical standards and codes
- ➢ Establishment of a guideline to apply for PV systems
- ➢ Establishment of a workshop

(2) Second stage: Pilot scheme

- ➢ In regard to the selection of a village for SHS installation, the average annual income of households should be investigated.
- ➢ Based upon the result of the average annual income survey, villages in Solomon Islands shall be classified into the next three categories: high income, middle income and low income. It is aimed to identify any difference that may rise from provinces and villages subject to this scheme.
- ➢ One to two villages would be selected from each province, but excluding Rennell and Bellona Province (36Wp, 55Wp, 75Wp system, 8 to 13 villages)

The pilot SHS plant would be installed at each selected village so that the monitoring of sustainability of the management organization could be made for three years.

The pilot scheme is described below.

Pilot Scheme (assumed starting year 2001) Unit: US$

No.	Provincial name	capital	Individual house			Public facility			Construction cost (US$)	Remarks
			Nos. of vil.		Nos. of set	Nos. of vil.		Nos. of set		
1	Guadalcanal	Honiara	1	36Wp	50	1	75Wp	3	64,950	
2	Malaita	Auki	1	36Wp	20	2	75Wp	3	33,900	
3	Isabel	Buala	1	36Wp	20	2	75Wp	3	33,900	
4	Makira	Kirakira	1	36Wp	20	2	75Wp	3	33,900	
5	Choiseul	Taro	1	36Wp	20	2	75Wp	3	33,900	
6	Western	Gizo	1	36Wp	50	1	75Wp	3	64,950	
7	Central	Tulagi	1	55Wp	50	1	75Wp	3	74,950	Vunuha vil.
8	Temotu	Lata	1	36Wp	20	2	75Wp	3	33,900	
9	Rennell & Bellona	Tinnggoa		-			-		0	
Total			8		250	13		39	374,350	

Note: Individual house	36Wp	US$	1,200	install at individual house
	55Wp	US$	1,400	install at individual house
Public facility	75Wp	US$	1,650	install at school and/or church

The construction of PV SHS systems would be finished in the first year, and the monitoring should be carried out for three years to find whether or not a sustainable operation and maintenance organization is achieved, and to identify any deficiency. Results of this pilot scheme, together with results of the UNDP funded scheme to be implemented in Rennell and Bellona, should form a basis for the nationwide scheme so that it could be reviewed and re-planned.

(3) Third stage: Nationwide scheme

The draft of the nationwide scheme would start at the second year after the pilot scheme finishes. A total of 270 sets of SHS for individual houses and 27 sets for public facilities in each village of 9 provinces would be installed every year. The nationwide scheme is described below.

Nationwide Scheme (assumed starting year: 2005) Unit: US$

No.	Provincial name	capital	Individual house			Public facility			Construction cost (US$)	Remarks
			Nos. of vil.		Nos. of set	Nos. of vil.		Nos. of set		
1	Guadalcanal	Honiara					75Wp			
2	Malaita	Auki					75Wp			
3	Isabel	Buala					75Wp			
4	Makira	Kirakira					75Wp			
5	Choiseul	Taro	9	36Wp	30	9	75Wp	3	368,550	
6	Western	Gizo					75Wp			
7	Central	Tulagi					75Wp			Vunuha vil.
8	Temotu	Lata					75Wp			
9	Rennell & Bellona	Tinnggoa					75Wp			
Total			9		270	9		27	368,550	

Note: Individual house 36Wp US$ 1,200 install at individual house
Public facility 75Wp US$ 1,650 install at school and/or church

The rural electrification plan including the pilot and the nationwide schemes are shown in Table 10-3-12.

Disposal of batteries used in SHS

According to the rural electrification plan based on the use of SHS, the lifetime of batteries would be seven (7) years. After batteries reach their life time and when some amount is stocked (approximately 500 batteries), they should be transported to Brisbane in Australia in order to dispose them for recycling, taking care that disposal should not affect the environment.

Reference: Solar power electrification plan in Rennell Island by UNDP

UNDP is going to implement a plan of rural electrification by solar power in Rennell Island under the co-financing between EU and Germany, as of May 2000. The results of this project could be expected to be a reference for our SHS rural electrification plan.

The JICA Team prepared a rural electrification draft plan by using solar and wind power as shown below. However, since the Team has not surveyed Rennell and Bellone Islands, this plan is only for reference.

Year	Rennell and Bellona province, Renne1l area Plan 1
1998	-
1999	-
2000	-
2001	-
2002	Solar PV (30kW*2) develop
2003	-
2004	-
2005	Wind power (20kW*1) develop
2006	-
2007	-
2008	Solar PV (30kW*1) extend
2009	-
2010	-
2011	Wind power (20kW*1) extend
2012	-
2013	-
2014	Solar PV (30kW*1) extend
2015	-
2016	-
2017	-
2018	-

10.4 Evaluation of power supply planning

The evaluation of power supply plans for each demand center has been carried out based on requirement conditions, which should be satisfied for each demand center. The plan that satisfies these conditions for each demand center is taken as the optimum power supply plan.

The power supply plans are also evaluated from the following aspects without any particular tendency, being this only a reference evaluation.

(1) Cost

- Unit cost per kW, unit cost per kWh, total construction cost

(2) Accessibility

- Survey, construction, operation and maintenance

(3) Receptivity

- Village community, compensation

(4) Economic and financial analysis

- EIRR, FIRR, LRMC (LRAIC), electricity tariff

(5) Environment

(6) Land ownership

(7) Others (Coordination with the National Energy Policy and Guidelines)

10.5 Optimum power supply plan

From the above evaluation results, the optimum power supply plan for each demand center in each province and the rural electrification plan by SHS are included in Table 10-5-1.

Table 10-5-1 Optimum power supply development scheme in Solomon Islands

Province / Island / Demand center / Plan No. / Fiscal Year	Guadalcanal	Malaita	Isabel	Makira	Temotu	Choiseul	Western		Central	Rural electrification by SHS
Island	Guadalcanal	Malaita	Santa Isabel	San Cristbal	Santa Cruz	Choiseul	Gizo	New georgia	Tulagi	Solomon Islands 9 provinces
Demand center	Honiara-Lungga	Auki-Malu'u	Buala	Kirakira	Lata	Taro & Choiseul	Gizo	Noro-Munda	Tualgi	Solomon Islands 9 provinces
Plan No.	3	T	1	2	2	1	2	2	2	-
1998	-	-	-	-	-	-	-	-	-	-
1999	Lungga diesel No.9 (3900kW) installed	-	-	-	-	-	-	-	-	-
2000	Lungga diesel No.10 (4200kW) install, Lungga diesel No.4 & No. 5 (1000kW*2) and Honiara diesel No.	Auki diesel 2 units (200kW*2) replace, Malu'u diesel 1 unit (83kW) install			-	New diesel No.1 & 2 (20kW*2) develop in Taro Is.	Gizo diesel 2 units (200kW*2) replace	-	-	-
2001	-	Bina diesel No.1 unit (1500kW) develop, existing diesel 1 unit (208kW) retire	-	New diesel No.4 (200kW) install	-	-	-	Noro new diesel No.4 & No.5 (2000kW*2) extend	-	Pilot scheme First year 36Wp SHS 200 sets, 55Wp SHS 50 sets, 75Wp SHS 39sets
2002	-	Bina diesel No.2 unit (1500kW) install	-	-	-	-	New diesel No.4 & No.5 (300kW*2) install	-	-	Pilot scheme Second year Monitoring
2003	Lungga diesel No.11 (5000kW) develop	Bina diesel No.3 unit (1500kW) install, Rori hydro (300kW) develop	-	-	-	Sorave hydro (70kW) develop in Main island	Existing old diesel No.3 (170kW) retire	-	-	Pilot scheme Third year Monitoring
2004	Lungga diesel No.12 (5000kW) develop, Lungga diesel No.7 (2300kW) retire	-	-	New diesel No.5 (170kW) install	-	-	-	-	-	-
2005	-	-	New diesel No.2 (160kW) install	-	New diesel No.4 (200kW) install	-	-	New diesel No.6 & No.7 (2000kW*2) extend	New diesel No.3 (60kW*1) extend	Nationwide scheme first year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2006	-	-	-	-	-	-	New diesel No.6 (300kW*1) install	Exsiting old diesel No.1 (900kW) retire	-	Nationwide scheme second year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2007	Lungga diesel No.13 (5000kW) install	-	-	-	-	-	-	Exsiting old diesel No.2 (900kW) retire	-	Nationwide scheme third year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2008	Lungga diesel No.8 (3600kW) retire	-	-	-	-	-	-	Exsiting old diesel No.3 (900kW) retire	-	Nationwide scheme 4th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2009	-	Ruala'e hydro (200kW) develop	Kubolata hydro (80kW) develop	-	-	-	-	-	-	Nationwide scheme 5th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2010	Maotapuku 1 & 2 (1600kW, 1400kW) develop	-	-	-	-	-	-	New diesel No.8 & No.9 (2000kW*2) extend	-	Nationwide scheme 6th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2011	-	-	-	New diesel No.6 (170kW) install	-	-	-	-	-	Nationwide scheme 7th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2012	Lungga diesel No.14 (5000kW) install	-	New diesel No.3 (160kW) install	Existing old diesel No.1 (60kW) retire	New diesel No.5 (200kW) install	-	-	-	-	Nationwide scheme 8th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2013	-	Silolo hydro (2100kW) develop	Existing old diesel (62kW) retire	Existing old diesel No.2 (50kW) retire	Existing old diesel No.1 (60kW) retire	-	-	-	-	Nationwide scheme 9th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2014	-	-	-	-	Existing old diesel No.2 (40kW) retire	-	-	-	-	Nationwide scheme 10th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2015	-	-	-	-	Existing old diesel No.3 (60kW) retire	-	New diesel No.7 (300kW*1) install	-	-	Nationwide scheme 11th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2016	Lungga diesel No.15 (2000kW) install	-	-	-	-	-	-	New diesel No.10 (2000kW*1) extend	-	Nationwide scheme 12th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2017	-	-	-	-	-	-	-	-	-	Nationwide scheme 13th year 36Wp SHS 270 sets, 75Wp SHS 27 sets
2018	-	-	-	-	-	-	-	-	-	Nationwide scheme 14th year 36Wp SHS 270 sets, 75Wp SHS 27 sets

CHAPTER 11

INSTITUTIONAL BUILDING
IN ELECTRICITY SECTOR

Chapter 11 Institutional Building in the Electricity Sector

Institutional building is a key factor for planning, implementation, and management of any type of projects. This chapter provides the data, information, and analysis for planning desirable institutional framework to promote rural electrification and presents the framework based on the analysis.

11.1 Overview of Stakeholders in Electricity Sector

Figure 11-1 identifies the stakeholders in the sector and the relationship among them. To opt for the desirable institutional framework in the sector, it is important to closely look at the characteristics of the existing and potential stakeholders, as well as the related policy and legal framework.

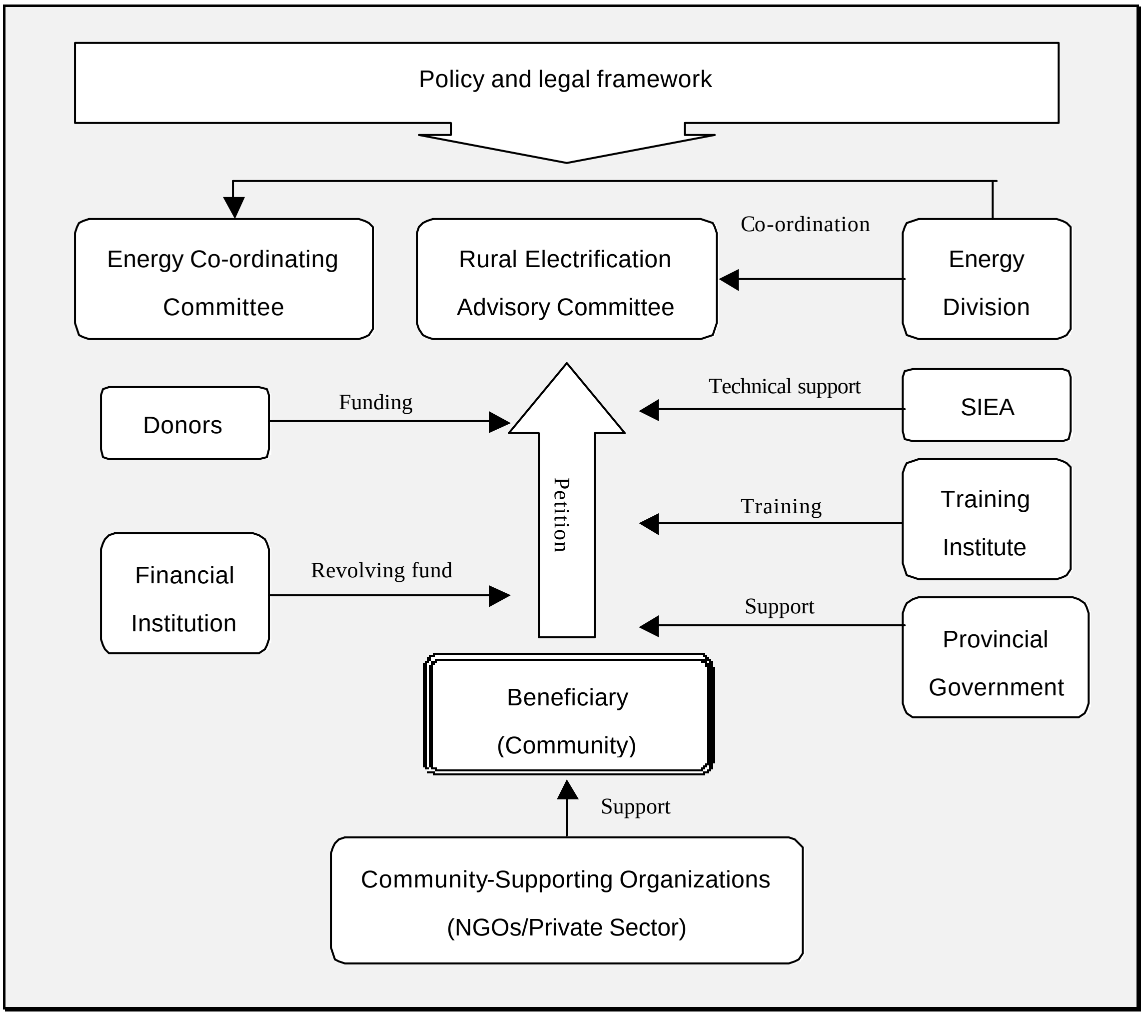


Fig. 11-1 Institutional framework of rural electrification

11.2 Analysis of Planning Issues

Based on the findings, planning issues are presented and analyzed here for formulating an action plan for desirable institutional building. The analysis focuses on rural electrification of SHS and micro hydropower generation targeting rural community. Fig. 11-2 shows planning issues analyzed.

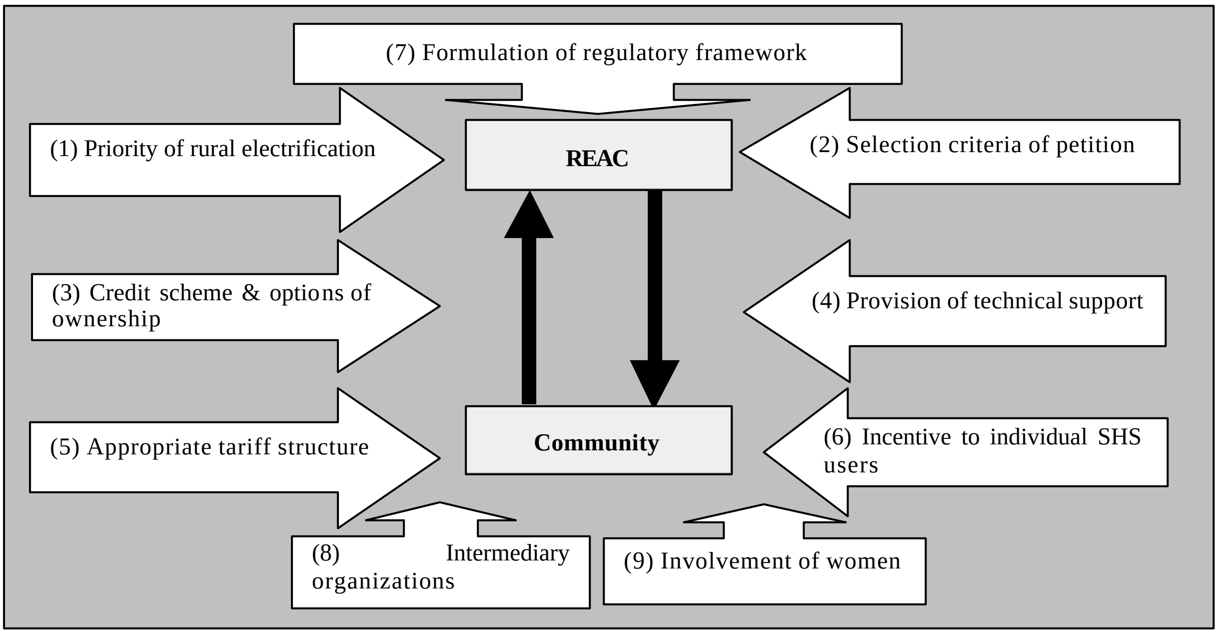


Fig. 11-2 Planning issues for rural electrification

(1) Priority of rural electrification

The issue of targeting is critically important because limited resources are likely to deter the organizations concerned from promoting nationwide rural electrification projects. Possible target areas are shown and compared in Table 11-2.

Table 11-2 Comparison of priority targets for rural electrification

Target	Positive impact	Cost recovery	Remarks
Schools	AAA	AAA	Consensus of parents is required.
Clinics	AAA	A	Willingness to pay of users is unknown.
Churches	AA	AAA	Use of church building is generally limited to religious purpose.
Targeting based on geographical location	?	?	Positive impact and cost recovery depend on project area selection. Selection of particular islands/areas is politically difficult.
Social strata group (poor)	AAA	A	Cost recovery period is long.

Note: AAA; possibility is high, AA; medium, A; low

(2) Selection criteria of petition

Whichever areas and groups are targeted, the criteria for selecting petitions are critically important and should be strictly applied to the selection process, since it is likely that REAC receives more petitions than it can fund. The Guidelines define five criteria for this purpose. These criteria are discussed in the Main Report, based on the findings of the survey.

(3) Credit scheme and options of ownership

The majority of the villagers interviewed did not have any experience in borrowing money from a formal financial institution. The coverage of bank branches is limited to the capital and provincial centers. Although this chapter originally regarded the financial institutions as potential credit providers, the facts lead to the conclusion that the payment should be made as an electricity tariff, rather than repayment of the loan.

Options of ownership are another important issue, especially in the case of SHS. The case of Sukiki implies that REAC should provide the electricity service to users for the lifetime of SHS to avoid inoperational status of SHS due to failure to pay for replacement of used batteries, while REAC retains the ownership of the equipment. It further leads to the conclusion that the tariff should be calculated including not only capital and operational cost but also the cost for batteries and users have to pay tariff for twenty years which are assumed as the lifetime of SHS.

(4) Provision of technical support

Those involved in the rural electrification project need appropriate training. A lack of training in operation and maintenance can easily lead to fatal technical failure, as observed in the case of the Taro Health Center. However, the Energy Division and SIEA have limited technical capability in SHS and micro hydropower. To reach the target groups without placing a heavy burden on REAC and to reinforce the capability of the Division and SIEA, it may be necessary to organize and train licensed electricians and provincial government engineers to assist in operation and maintenance as advanced technical experts.

(5) Appropriate tariff structure

A tariff schedule should be chosen cooperatively by communities, based on seasonal fluctuations in their income levels, if any exist. However, the total sum of the tariffs collected must at least meet the cost-recovery payment level determined by REAC. The communities need to be informed of their potential costs for maintaining the system before they decide on a tariff level.

REAC also needs to allow users to pay the tariff in a shorter period than 20 years when they earn causal income. The advantage is that it contributes to improving cash flow position of REAC's revolving fund. Even if users have finished payment in less than twenty years, they have the right to receive the service for twenty years, including the cost for batteries replacement. Added to that, the times of batteries replacement under the responsibility of REAC should be limited to two during the lifetime of SHS to contain its cost borne by REAC and give incentive to users to use the system properly.

(6) Incentive to individual SHS users

Considering the limited financial resources available to implementing organizations, much effort is needed to promote the installation of SHS by individual users through private dealers. However, the high import duty still remains a disincentive for private users. It will become necessary to reduce the import duty to make the cost of SHS more affordable to individual users.

(7) Formulation of a regulatory framework to assure the quality of electricity service

Regulation and specification of both SHS and micro hydropower equipment is essential, though the current Electricity Act does not specifically refer to these areas. If this is not clearly defined and enforced, low quality equipment may be installed resulting in extra costs for repair and replacement of equipment and ultimately, disappointed users. Even if the Act does not need to be revised, a regulation should be formulated to refer to these aspects. REAC should be responsible for inspecting and checking installed equipment.

(8) Intermediary organizations

The Guidelines assume that NGOs and/or the private sector work as supporting organizations to the communities requesting SHS/micro hydropower projects. Unfortunately, NGOs and the private sector are not prevalent in the Solomon Islands, especially in rural areas, though there are exceptions. They may not have enough capacity to assist all the communities.

Provincial governments may function as alternative intermediary organizations, linking beneficiary communities with REAC in Honiara. In areas where SIEA outstations are located, staff should play that role even though it increases their workload considerably. Furthermore, churches act as supporting organizations, facilitating the process of planning, implementation and operation of the project. The JICA village survey found that several villages had mothers' unions that had been initiated and supported by the churches. Some of NGOs may take this responsibility.

If these options do not work well, REAC may dispatch technicians regularly (e.g. once or twice a year) to check and repair the equipment of the project as an alternative measure.

(9) Involvement of women in the project

The involvement of women in the process is essential. Women are not necessarily well represented in community organizations, as the majority of the committee members are men. Indeed, only one of the villages surveyed by JICA Team has a female member on the village committee. To reflect women's needs relating to electricity, an effort should be made to involve women in the process.

11.3 Institutional Framework for Rural Electrification

This section is intended to present a preliminary institutional framework for rural electrification that is adapted to the context of the Solomon Islands, based on the principles described below and the survey results. This framework consists of (1) implementation schedule of the project, (2) functions of REAC, (3) process of petitions, and (4) contents of workshop.

<u>Principles of institutional framework for rural electrification</u>

(1) Need-based approach

Rural electrification project will be implemented based on processing and selection of petitions submitted by potential users, instead of selecting candidates by REAC. This is because the project requires large capital investment and REAC is unable to meet every request in a relatively short term, due to limited financial and technical capability. In addition, rural communities have a variety of needs and should apply for the project after the due process is taken for identifying electricity as a priority need.

(2) Achievement of financial and operational sustainability

While the project targets those users who want to use electricity service and meets their demand, it also aims to achieve sound financial condition and efficient and effective operational system, which makes possible the expansion of the project in the future.

(3) Provision of satisfactory electricity service for users

Those applying for rural electrification project do not want to own SHS nor micro hydropower equipment, but to receive good qualify of electricity service and benefit from it. Much effort should be made to maximize satisfaction of users, which in turn guarantees tariff payment on time and further increases the number of communities applying for the project.

(4) Correction of imbalance of infrastructure in rural areas

By making the tariff affordable to the poor, the scheme attempts to correct the infrastructure gap between rural and urban areas.

(1) Time framework for the rural electrification project

1. Preparation stage (1 year)

REAC will be established under the Ministry of Natural Resources after the Cabinet is informed of its establishment and approves of it. It will become the major coordinating body for the implementation of the rural electrification project with the Energy Division assigned as secretariat. Members include the ministries of Education, Health, Finance, SIEA, NGOs, and donors in addition to the Energy Division.

2. Pilot project stage (3 years)

Prior to the project implementation, REAC should secure funding from donors as well as the government grant. At this stage, assistance of donors for strengthening technical and organizational ability of REAC and relevant organizations is critically important for them to be able to sustain and expand the project in the future.

Pilot projects will be implemented in the selected sites. The predetermined institutional framework and procedure specified in the following section will be tested and modified based on the outcome of the operation. REAC at this stage should focus on (1) guaranteeing satisfactory performance of the project for users rather than expanding the geographical coverage of the project and (2) strengthening institutional and organizational ability for sustainable operation. The former draws attention to the project from potential users, while the latter increases donors' interest in funding the project.

3. Expansion stage

Project will be expanded by securing donors' new funding and utilizing the fund collected from ongoing projects. If REAC have succeeded in operating the project efficiently and effectively, it will have more chance to receive a fund from donors.

(2) Functions of REAC

REAC shall be established as the primary organization responsible for the rural electrification program. Their main tasks are clarified as follows.

1. Dissemination of information
2. Establishment of a technical center
3. Establishment of Rural Electrification Fund
4. Production of training manuals
5. Legislation of a regulatory framework
6. Selection of petitions
7. Procurement and Installation
8. Provision of after care service
9. Monitoring and evaluation

(3) Process of petitions

The procedure for processing petitions should be transparent and based on clear rules to avoid the interference of outsiders. In reality, pressure from communities or politicians seems unavoidable, as was observed in the RWSS project. Indeed, it is impossible to implement projects for all the competing villages in a relatively short time and satisfy them all. However, transparent and rule-based procedures for processing petitions could alleviate frustration among villages. This section summarizes the information to be included in the petition and the content of the workshops to be held in the villages.

<u>Information required for applications</u>

1. Name of village/ward/province
2. Purpose/target of electrification
3. Number of households
4. Expenditure for kerosene and dry batteries
5. Agreement of resource owners
6. Income sources and level
7. Responsible organization/person
8. Agreement of users of public facilities

Content of workshop

The workshop should be held at an appropriate time during the planning and implementation stage of the project, which includes the following:

1. Information dissemination
2. Socio-economic profiling
3. Needs assessment
4. Environmental impact assessment
5. Survey of water source
6. Technical transfer of operation and maintenance knowledge
7. Agreement of contribution for project implementation
8. Agreement of resource owners
9. Contract signing
10. Tariff collection

CHAPTER 12

ECONOMIC AND FINANCIAL ANALYSIS

Chapter 12 Economic and Financial Analysis

12.1 Calculation of LRMC and examination of the tariff

(1) Calculation of LRMC

The LRMC expresses the average cost with respect to a single unit increase in power demand (increase per 1 kWh) in the long run power expansion program, and power tariff is examined based on this. Two kinds of LRMC are used depending on the method of calculation. The LRAIC shall be adopted for the basic value of the power tariff.

Long Run Average Incremental Cost (LRAIC)

Features : Marginal cost based on increases in facilities capacity

Long Run Marginal Cost (LRMC)

Features : Marginal cost based on increases in power demand

LRMC and LRAIC were calculated for each power supply district and then it was calculated for the whole country. The calculation result was as follows.

LRAIC US$0.1791/kWh (SB$0.8956/kWh)

LRMC US$0.1922/kWh (SB$0.9609/kWh)

(2) Examination of the tariff

The tariff for the optimum power supply plan is recommended to LRAIC + 5.0% in consideration of adding certain operating margin on the power generation cost. In this section, the tariff rate for each power supply district, and after this, the national unified tariff rate for the overall optimum power supply plan was calculated.

The tariff rate in the optimum power supply plan adopted national unified rate LRAIC + 5.0% US$0.1881/kWh (SB$0.9403/kWh) which is around 19% higher than the current tariff rate SB$0.7918/kWh. And the same tariff rate was used in the all financial analysis in this chapter.

12.2 Economic and financial analysis of the optimum power supply plan

In this section, economic and financial analysis of the optimum power supply plan is carried out. Concerning the analysis technique, the overall project in the plan is regarded as a single project, the costs and benefits of all power plants included in this are totaled.

(1) Financial analysis

Financial cost: total cost of the construction and O&M cost for all small hydropower and diesel power plants included in the optimum power supply plan (2000 to 2018)

Financial benefit: sold energy (kWh) x recommended tariff (US$0.1881/kWh)

Period of analysis: 64 years (2000 to 2063)

FIRR: FIRR = 8.38%

Financial feasibility: The optimum power supply plan is deemed to be financially feasible, since FIRR exceeds the actual interest rate of 3.8% between 1992-1998 in the Solomon Islands.

(2) Economic analysis

Economic cost: calculated from financial cost converted by the “conversion factor (CF)”

Economic benefit: sold energy (kWh) x willingness to pay (US$0.1958/kWh)

Project life: 64 years (2000 to 2063)

EIRR: EIRR = 9.63%

Economic feasibility: The optimum power supply plan is deemed to be economically feasible, since EIRR exceeds the social discount rate 8.0% in the Solomon Islands.

(3) Economic and financial analysis of small hydropower in potential sites

The economic and financial analysis for 10 potential sites for small hydropower was carried out.

Financial benefit: tariff rate recommended above

Economic benefit: saved cost of alternative diesel power plants

FIRR and EIRR is as follows:

Table 12-2-1 FIRR and EIRR for the small hydropower potential site

	Maotapuku 1	Maotapuku 2	Sasa	Silolo	Rori
FIRR	5.244%	3.400%	5.880%	6.432%	6.429%
EIRR	3.280%	1.416%	2.726%	10.365%	6.794%

	Kware'a	Kubolata	Waimapuru	Sorave	Luembalele
FIRR	0.313%	4.379%	-1.143%	3.836%	-3.568%
EIRR	1.227%	8.224%	-2.252%	6.694%	-4.610%

12.3 Economic and financial analysis for rural electrification plan

The rural electrification plan will be implemented by SHS. In the case of uniform standards in SHS, regardless of the position of candidate sites, the plant cost, works cost and O&M cost will be viewed as the same. Moreover, regardless of the number of SHS units, financial and economic profitability will be assumed to be the same.

(1) Financial analysis

Financial cost: the market price (with and without tax) of SHS (36Wp, 55Wp, 75Wp) , and the replacement cost of butteries and charge controllers and O&M

Financial benefit: SB$150 for down payment, monthly cost SB$10 - SB$100

Durable periods: 20 years (7 years for butteries, 10 years for charge controllers)

FIRR: Calculation result was as follows.

Table 12-3-1 FIRR calculation of SHS in each tariff system

Without tax (SB$)

	10	20	30	40	50	60	70	80	90	100
36Wp	-25.76%	-10.03%	-3.05%	1.81%	5.79%	9.29%	12.51%	15.55%	18.46%	21.29%
55Wp	-27.83%	-11.93%	-5.02%	-0.34%	3.40%	6.64%	9.58%	12.32%	14.93%	17.44%
75Wp	-30.77%	-14.32%	-7.12%	-2.40%	1.29%	4.43%	7.24%	9.83%	12.27%	14.61%

(2) Willingness to Pay and tariff for SHS

The Willingness to Pay for SHS is estimated around SB$10-20 /month for low-income resident. To achieve the electrification for the rural area of Solomon Islands, it is necessary to set the tariff closer to the lower level.

Down Payment US$20 (SB$100)、monthly US$2.00 〜3.00 (SB$10.00〜15.00)

In this case, FIRR shows a substantial negative figure, it is utterly unfeasible financially. It is suggested that the negative portion of it should be covered by the Rural Electrification Fund which is charged additionally on the original tariff of the optimum power supply plan.

(3) Economic analysis

Economic cost: without tax price of the financial cost

Economic benefit: (1) saved cost of a alternative small diesel power plant
(2) utility based on the saved costs of the kerosene and dry batteries

EIRR: (1) EIRR = 1.41%
(2) EIRR = 11.38%

12.4 Funding and repayment plan

In this section, the funding and repayment plan for the construction cost of the optimum power supply plan and rural electrification plan was studied by the cash flow simulation.

(1) Funding and repayment situation in the past

Grant Aid : England , Taiwan, Japan, Germany, New Zealand

Funding by loan : National Provident fund (NPF)
Asian Development Bank (ADB) (1987 and 1993), totally US$8.98mil

Repayment : Since 1997, all loans has been defaulted.

(2) Funding and repayment plan for the optimum power supply plan

Total construction cost: US$172mil (2000-2018)

Funding plan : The recommended funding plan is as follows.
Loan US$100mil, Grant US$29mil, Own fund US$43mil

Loan condition : Foreign (70%) : interest 1.0%, grace 10 years, repayment 30 years
Local （30%） : interest 6.5%, grace 3 years, repayment 15 years
The loan is funded for the large sized projects over US$20mil

Grant aid : for the small sized project less than US$10mil

(3) Funding and repayment plan for rural electrification plan

Total construction cost: Pilot scheme (2001〜2003） total US$0.37mil
Nationwide scheme （2005〜2018） US$5.2mil （US$0.37mil p.a.）

Funding plan : Pilot scheme is funded by grant aid.
. Nationwide scheme is funded by loan in the initial year, and the fund will be managed by REAC as a Revolving Fund.

Introduction of Rural Electrification Fund

It is suggested that a Rural Electrification Fund be charged on the tariff of optimum power supply plan to cover the negative portion of the SHS tariff. This fund will be collected by SIEA for the first, and transferred to the account of REAC.

Tariff of the optimum power supply plan	US$0.1881	(SB$0.9403)
Additional charge for Rural Electrification	US$0.0036	(SB$0.0182)
Tariff after additional charge	US$0.1917	(SB$0.9585)

Grant will be recommended for the further expansion of the SHS.

12.5 Analysis of Financial Conditions in SIEA

SIEA has been facing a difficult financial situation by cost pressure of fuel oil and equipment parts, interest payment, exchange loss and accumulating number of tariff arrears, etc.

Electricity sales : Sales revenue in 1997 was SB$35.5mil (US$7.1mil).
Sales volume (around 60GWh) the breakdown is as follows.
Residents (24%), Commercial & industrial (62.2%),
Government institutions (11.3%), others (2.4%)

Tariff : unchanged for 5 years since 1993, 23% increase (10% in October 1998, 12% - 13% in August 1999) was executed.

Sales cost : the fuel and lubricant oil (45%), depreciation, manpower and maintenance costs (15%) The unit price is increasing every year.

Operating margin : decreasing since the peak in 1994, falling to 0.21% in 1997

Non-operating profit /loss: substantial loss by interest payment and exchange loss

Net profit & retained profit : substantial loss in both net profit and retained profit since 1966

Liabilities : increasing receivables by number of electricity debtors, shortage in both cash and deposit, shortage in inventory. Around 80% of long term liabilities are funded by ADB.

Financial criteria requested by ADB :

1) Audited financial statements to be completed within 6 months after the end of financial year.
2) Return on asset (ROA) of more than 8.0%
3) Debt Service Ratio (operating profit / total principal and interest payment) more than 1.5.
4) Debt/equity ratio not more than 60%.

Since SIEA has not satisfied above criteria, the new funding is rather difficult. It is necessary for SIEA to adopt some improvement measures such as further tariff increase and strict collection of tariff from electricity debtors.