Palau Public Utilities Corporation
The Republic of Palau

No.

FINAL REPORT
ON
THE MASTER PLAN STUDY
FOR
THE UPGRADING OF ELECTRIC POWER SUPPLY
IN THE REPUBLIC OF PALAU

JULY 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

THE CHUGOKU ELECTRIC POWER CO., INC.

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PREFACE

In response to a request from the Republic of Palau, the Government of Japan decided to conduct the Master Plan Study for the Upgrading of Electric Power Supply and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Mitsuhisa Nishikawa of Yachiyo Engineering Co., LTD. (yec) and consists of yec and Chugoku Electric Power Co., INC. three times between January and June, 2008.

The team held discussions with the officials concerned of the Government of Palau and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Palau for their close cooperation extended to the study.

July 2008

Seiichi Nagatsuka
Vice President
Japan International Cooperation Agency

Mr. Seiichi Nagatsuka
Vice President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

July 2008

Dear Sir,
It is my great pleasure to submit herewith the Final Report of “The Master Plan Study for the Upgrading of Electric Power Supply in the Republic of Palau”.

The Study Team that consists of Yachiyo Engineering Co., Ltd. and Chugoku Electric Power Co., Inc. conducted field surveys in Palau over the period between January and June, 2008 according to the contract with the Japan International Cooperation Agency (JICA).

The Study Team compiled this report, which consists of the Master Plan Study for the Upgrading of Electric Power Supply, Pre-Feasibility Study on Prioritized Projects, Recommendations to Operational Improvement of Power Supply Equipment, etc. through close consultations with officials concerned of the Government of the Republic of Palau and other authorities concerned.

On behalf of the Study Team, I would like to express my sincere appreciation to officials concerned of the Government of Palau and other authorities concerned for their cooperation, assistance, and heartfelt hospitality extended to the Study Team.

We are also deeply grateful to the Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Economy, Trade and Industry, and the Embassy of Japan in Palau for their valuable suggestions and assistance during the course of the Study.

Yours faithfully,

Mitsuhisa Nishikawa
Team Leader
The Master Plan Study for the Upgrading of Electric Power Supply in the Republic of Palau

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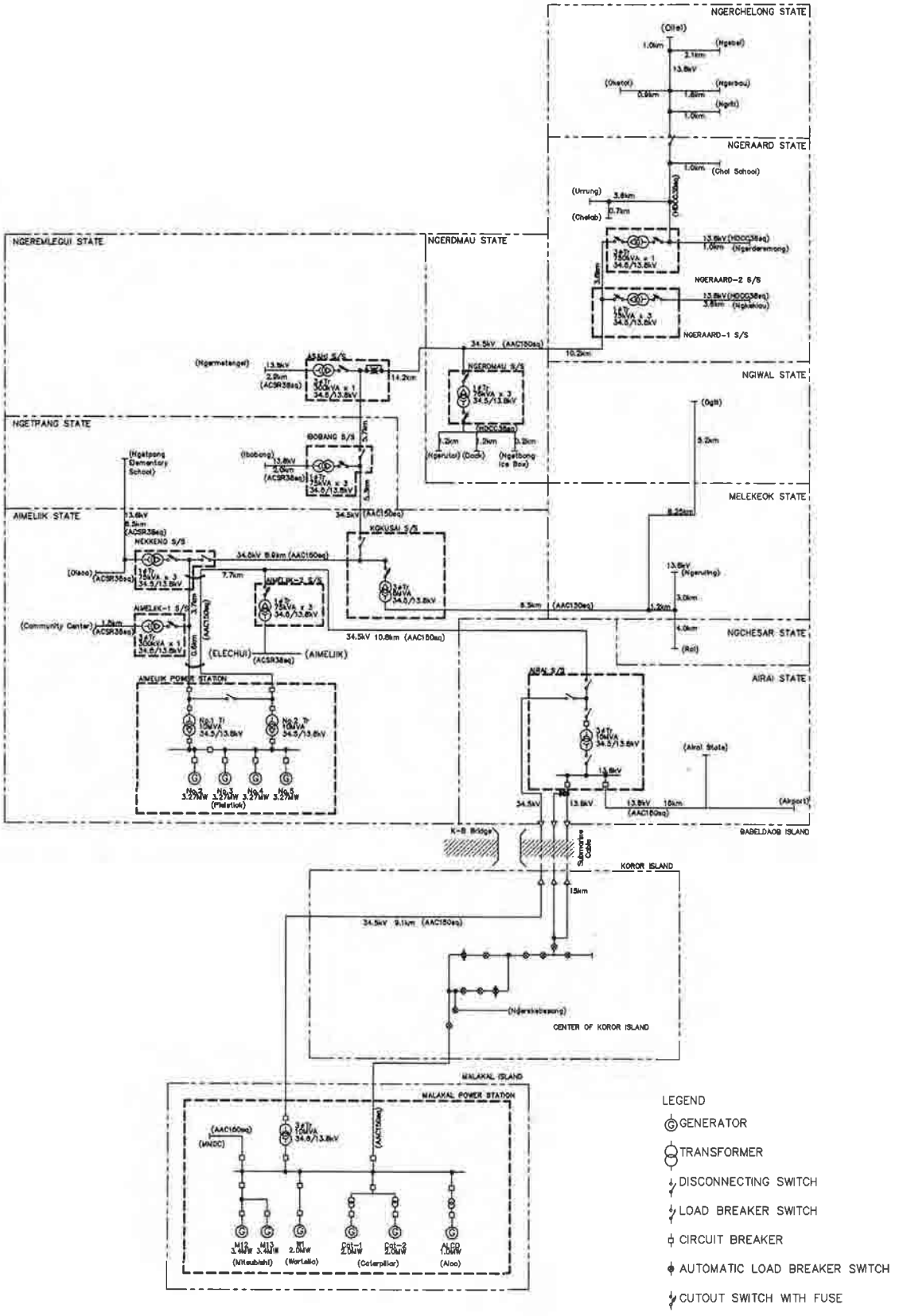
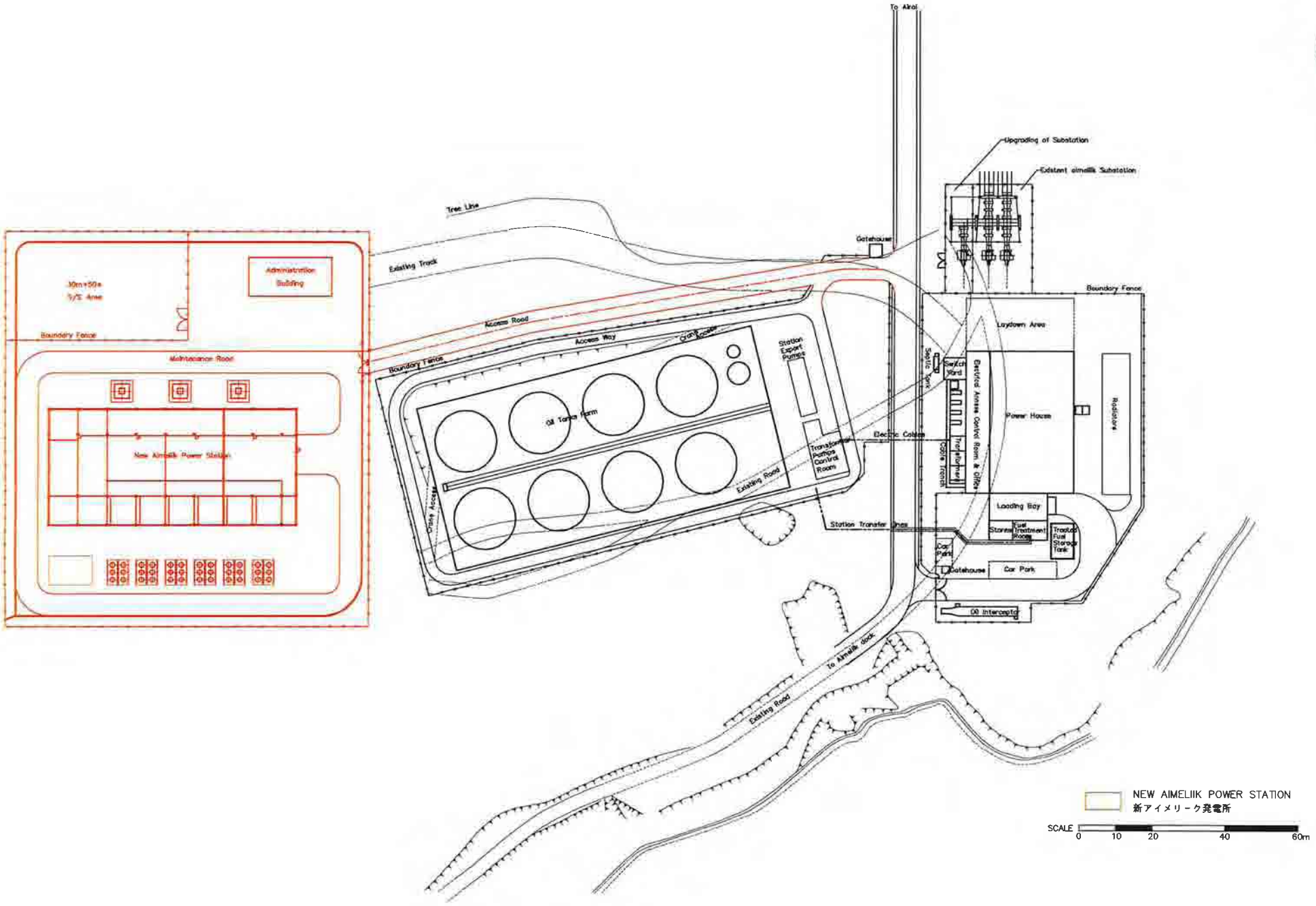


Power System in Koror & Babeldaob

prepared by JICA Study Team on April. 28, 2008



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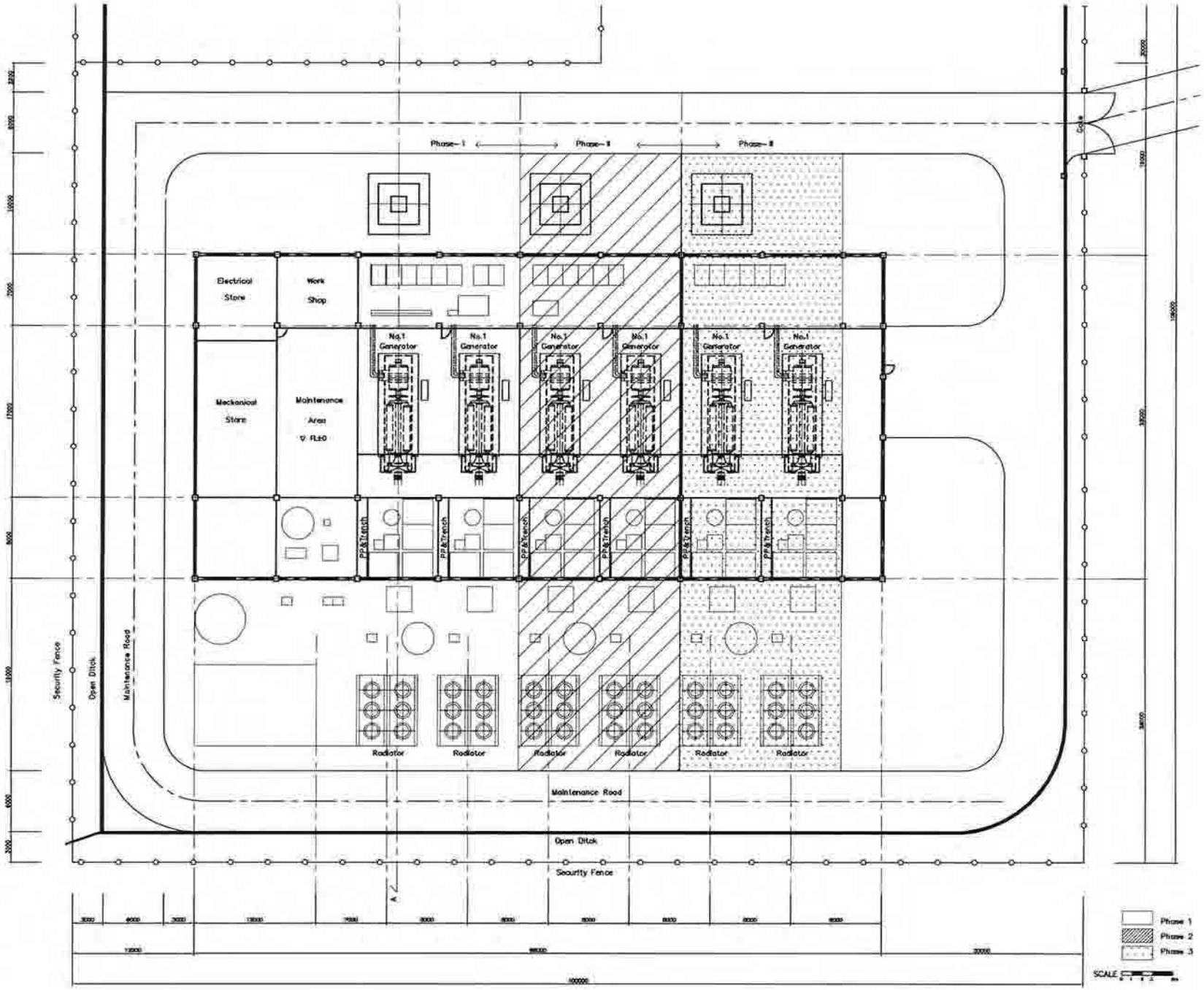

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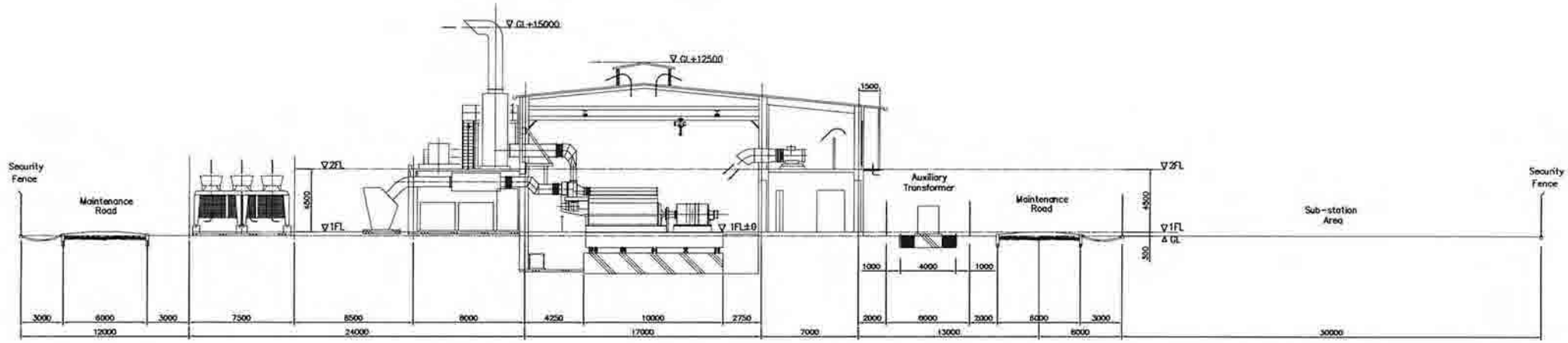

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Abbreviations

AAC	All Aluminum Conductor
AC	Aluminum Conductor
ACFA	Accelerated Co-Financing scheme with ADB
ADB	Asian Development Bank
ADF	Asian Development Fund
AFPAC	Automatic Fuel Price Adjustment Clause
ANSI	American National Standards Institute
AusAID	Australian Agency for International Development
CB	Circuit Breaker
CDM	Clean Development Mechanism
CEO	Chief Executive Officer
CFL	Compact fluorescent lamp
CFO	Chief Financial Officer
CTF	Compact Trust Fund
DS	Disconnecting Switch
DSM	Demand Side Management
EA	Environmental Assessment
EHC	Environmental Health Criteria Monograph No.238
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPC	Engineering, Procurement and Construction
EPDC	Electric Power Development Company
EQPB	Environmental Quality Protection Board
ETR	Electricity Tariff Rate
EU	European Union
FIRR	Financial Internal Rate of Return
FOB	Free On Board
FY	Fiscal year
F/S	Feasibility Study
GCB	Gas Circuit Breaker

GDP	Gross Domestic Product
GE	General Electric
GEF	Global Environment Facility
GIS	Geographic Information System
GM	General Manager
GNI	Gross National Income
GRT	Gross Receipt Tax
HDCC	Hard Drawn Copper stranded Conductor
HE	Heavy Equipment
HFO	Heavy Fuel Oil
IBRD	the International Bank for Reconstruction and Development
ICNIRP	International Commission on Non-Ionization Radiation Protection
IEE	Initial Environmental Examination
IEEE	Institute of Electrical and Electronic Engineers
IMF	International Monetary Fund
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature and Natural Resources
JAMSTEC	Japan Agency for Marine Earth Science and Technology
JBIC	Japan Bank For International Cooperation
JI	Joint Implementation
JICA	Japan International Cooperation Agency
LAN	Local Area Network
LDC	Least Developed Countries
LFT	Liquid Fuel Tax
LIBOR	London Inter-Bank Offered Rate
LP	Line Post
MCC	Motor Control Center
MCCB	Mold Case Circuit Breaker
MOPS	Mean of Platts Singapore
MRD	Ministry of Resources and Development
NASA	National Aeronautics and Space Administration
NEDO	New Energy and Industrial Technology Development Organization

NESC	National Electrical Safety Code
NOAA	National Oceanographic and Atmospheric Administration
NPV	Net Present Value
OCR	Ordinary Capital Resource
ODA	Official Development Assistance
OTEC	Ocean Thermal Energy Conversion
OGTF	Oil and Gas Task Force
OJT	On the Job Training
O&M	Operation and Maintenance
PICRC	Palau International Coral Reef Center
PNMDP	Palau 2020 National Master Development Plan
PPE	Palau Pacific Energy, inc
PPR	Palau Pacific Resort Hotel
PPUC	Palau Public Utilities Corporation
PSIP	Public Sector Investment Program
PT	Potential Transformer
SARS	Severe Acute Respiratory Syndrome
SCADA	Supervisory Control And Data Acquisition
SEL	Schweitzer Engineering Laboratories, Inc.
SID	Small Island Developing Countries
SVR	Step Voltage Regulator
TA	Technical Assistance
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Program
UNELCO	Union Electrique du Vanuatu
USAID	United States Agency for International Development
USGS	United States Geological Survey
WHO	World Health Organization

INTRODUCTION

Introduction

1. Background and Current Status of the Study

1.1 Background of the Study

The Republic of Palau (hereinafter referred to as "Palau") is located in the Pacific approximately 3,200 km south of Japan and is an island country consisting of some 340 islands with a total area and population of 488 km^2 and 19,907 (2005 National Census) respectively. Political and economic activities in Palau are centred on Babeldaob Island where the capital of Melekeok is located and on Koror Island as some 93% of the total population live on these islands (2005 National Census). The power demand (peak load) on these islands recorded an average annual growth rate of 7.3% in the nine year period from 1997 to 2005 because of the stable population growth of 2% a year, increased power consumption per capita and development of tourism, etc. and it is predicted that the peak demand will exceed the available generating capacity in 2007. Meanwhile, the power supply facilities of the Koror-Babeldaob power system can no longer provide a stable power supply due to their deterioration and insufficient maintenance and planned outages of eight hours a day were introduced for one and a half months in August, 2006.

In the past, Japan has provided grant aid for the expansion of the generating, transmission, distribution and transforming facilities of the Koror-Babeldaob power system on three occasions. However, the planning capability of the Ministry of Resources and Development (MRD) and the operation and maintenance capability of the Palau Public Utilities Corporation (PPUC), which are responsible for power supply in Palau, is still insufficient while there have not been sufficient discussions on the necessary measures to deal with a possible power crisis in the future.

Against this background, the Government of Palau has made a request to the Government of Japan for a development study for the formulation of a power supply improvement plan (hereinafter referred to as "the Study"). The suggested contents of the Study include the power demand forecast for Koror and Babeldaob Islands, formulation of a power facilities expansion plan, Feasibility Study (F/S) on the power facilities required from the medium to long-term viewpoint, examination of possible funding sources, improvement of the business management of the PPUC, development of human resources at the PPUC and recommendations for the improvement of power facility operation.

1.2 Basic Policies of the Study

(1) In view of the urgency of the Study and the need for its quick and efficient implementation, (hereinafter referred to as "the Consortium") the Study team will complete the pre-F/S as soon as

possible based on the reference data, information and discussion results with Palauan side, after the completion of the preliminary design work for the replacement of the Aimeliik Power Station, the construction of transmission line from the Aimeliik Power Station to the Koror Substation and the construction of the Koror Substation.

(2) The regional power supply and demand in Palau is in the midst of a major transitional period because of the relocation of the capital in October, 2006 and replacement work for the Aimeliik Power Station in recent years. It is the intention of the Study to formulate the optimal power development plan, taking such changes of the power supply and demand situation in Palau into consideration.

(3) For strengthening of the local capability to operate and maintain the power supply facilities, concrete and effective recommendations will be made utilising the expert knowledge possessed by the Study team which is built on the previous grant aid cooperation, follow-up study, soft components of similar projects and know-how of electric utilities, etc.

(4) For business management improvement and funding, concrete as well as feasible plans will be proposed to enable the PPUC to implement the priority projects, i.e. target issues of the pre-F/S, at an early date.

2. Relevant Issues and Points to Note for the Formulation of the Plan

2.1 Related Development Plans in the Sector Concerned and Points to Note

(1) Power and Energy Policies

The Palau 2020 National Master Development Plan (PNMDP) formulated in 1997 states the following strategy for the power sector.

In 2003, a five year plan for the PPUC was prepared by Oceanic Companies (Marshalls), Inc., an American consultant, featuring a development plan for the power generation, transmission, distribution and transforming facilities, calculation of the development cost, necessary environmental and social considerations in the face of the planned development, a plan to revise the electricity tariff and other matters. While this plan is considered to express the development strategy of the PPUC, the proposed projects of the plan have not yet materialised because of the lack of funding required to invest in new facilities.

The Study will explore the current power and energy policies in Palau, taking the above-described background into consideration.

2.2 Socioeconomic Conditions

From 1947, Palau formed part of the UN Trust Territory of Pacific Islands under US administration. With the enforcement of the Compact of Free Association with the US in 1994, Palau achieved independence as "a country of free association" and joined the UN in the same year. Public sector finance in Palau is largely dependent on the financial assistance (compact money) of the US. In the private sector, commerce and the construction industry are relatively buoyant because of the knock-on effects of foreign aid. There is no manufacturing industry other than the small-scale food processing industry and most consumer goods, including food, are imported. As the financial assistance of the US based on the Compact of Free Association is due to come to an end in 2009, the Government of Palau consider the achievement of a self-reliant economy by that year to be the highest national priority. Nevertheless, the current reality is that the country relies on foreign aid to sustain its public finance as well as economy and Palau's achievement of a self-reliant economy in two years time appears to be difficult. Continual aid by Japan and other donors is essential for Palau to develop such infrastructure as roads, water supply and sewerage systems and power supply facilities, etc., all of which require huge funding.

2.3 Development Plans

As some time has passed since the formulation of thee plans, the PNMDP of which the review has been in progress since August, 2007 with the technical assistance of the Asian Development Bank is believed to indicate the latest development policies. For this reason, the emphasis of the Study on the development plans in Palau will be placed on clarifying the review situation of the PNMDP.

2.4 Electricity Tariff and Fuel Prices

The electricity tariff of the PPUC consists of the fixed rate and metered rate. There are three types of users for the purpose of charging which are household, commercial and government users.

The electricity tariff of the PPUC is subject to the automatic fuel price adjustment clause (AFPAC) which makes the tariff reflect fluctuations of the fuel price.

The current adjustment rate (adjustment by 1 cent/kWh for the electricity tariff linked to a fuel price fluctuation of 12.7 cents/gallon) is judged to be appropriate in view of the facts that the average fuel efficiency of the Aimeliik and Malakal Power Stations is 13.825 kWh/gallon and that the increase of the unit generation cost linked to a fuel price increase of 12.7 cents/gallon is 0.919 cents/kWh. The Study will examine the historical changes of the PPUC's electric tariff and of the diesel oil price in Palau for the purpose of contributing to the business management of the PPUC.

2.5 Business Management Situation of the PPUC

The PPUC is a public corporation which was established on 6th July, 1994 and which is entirely owned by the government. Its structural inability to avoid a chronic deficit poses a very serious problem. Any attempt to improve the business management of the PPUC must firstly revise the tariff so that the income matches the cost. This should be followed by the examination of each cost with a view to reducing its size. Moreover, the thinking of the management which appears to accept a chronic deficit and that of ordinary employees must be changed as part of the reform of the prevailing business mind. From the viewpoint of the business management technique, improvement of the loss-making income and expenditure structure by means of revising the present tariff is an urgent issue.

2.6 Current State of Power Generating Facilities

The power generating sources for the Koror-Babeldaob power system are the Malakal Power Station on Koror Island and the Aimeliik Power Station on Babeldaob Island. Both power stations run on diesel oil. The Study will analyze the results of the Power Plant Performance Audit conducted by a US consultant prior to the field survey and a fact-finding study on these two power stations will also be conducted for the purpose of contributing to the following work to be conducted under the Study.

- Assumption of the timing for the withdrawal of the existing power generating facilities for the purpose of planning the development of power sources
- Examination of the specifications for new diesel engine generators
- Preparation of an O & M manual
- Proposal of points for improvement in regard to the O & M of power stations

2.7 Current State of Transmission, Distribution and Transforming Facilities

The transmission voltage and distribution voltage in Palau are 34.5 kV and 13.8 kV respectively and all of the transmission lines are single circuit and, therefore, the system reliability is not very high. In the case of distribution lines, two lines are available to the Koror area where the demand is especially concentrated while distribution to other areas uses only a single circuit.

At present, the Aimeliik Power Station, Malakal Power Station and 10 substations are linked on the 34.5 kV grid. Only the Malakal Power Station, Aimeliik Power Station and Asahi Substation are protected from accidents by protective relays, making the introduction of an advanced system to protect the power system and to improve the system reliability an important future task.

While the transformers and other equipment at the Aimeliik Power Station and Airai Substation are due to be overhauled under the follow-up assistance of the JICA scheduled to take place in 2007, other substations are experiencing an increased frequency of breakdowns because of ageing of the equipment. In view of this situation, the Study will be conducted with the possible transfer of technology for the improvement of operation in mind.

2.8 Renewable Energies

The Study intends the comprehensive evaluation of the technical maturity and economy, etc. of renewable energies which can be used for power generation with a view to clarifying the priority technologies and pending tasks for the development of renewable energies as power sources in Palau while taking the efforts of Palau to develop renewable energies into consideration. Renewable energies which are practically used at present for power generation are hydropower, geothermal energy, solar, wind power, waste and biomass. The intended course of action to deal with renewable energies under the Study is explained in the following table.

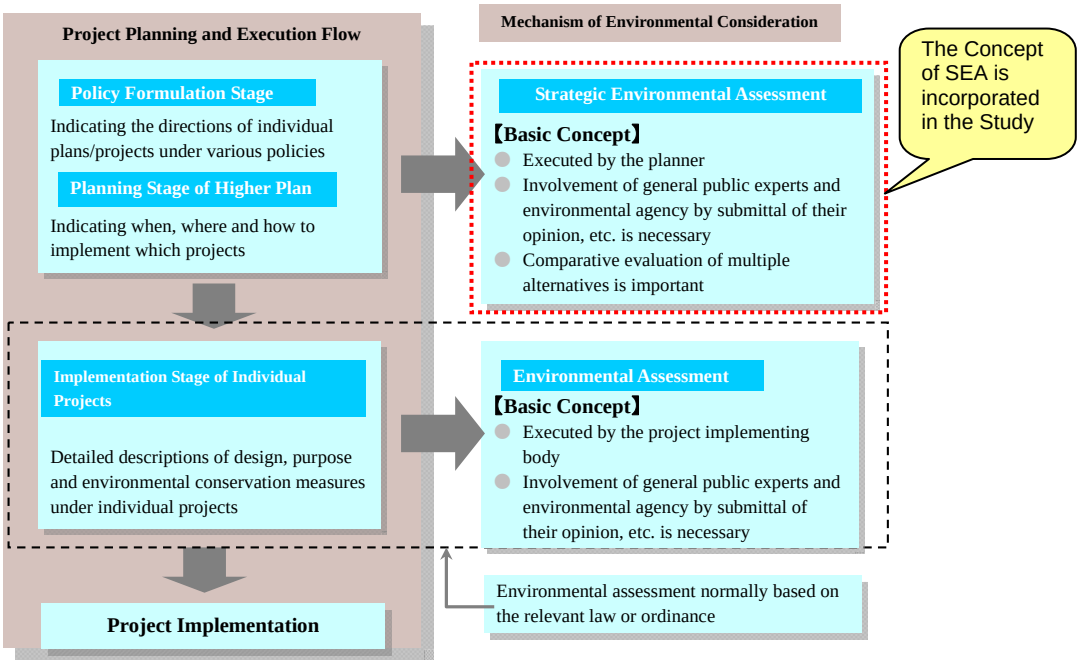
Technological Level of Renewable Energy Development and Intended Course of Action under the Study

Type of Power Generation	Present Technological Level, etc.	Intended Course of Action Under the Study
OTEC	OTEC is still at the research or small-scale demonstration test stage globally. As major problems still exist in regard to the technology and construction cost, the development of a practical power generation system will not be easy. At the present technological level, the in-house power demand consumes some 70% of the electric energy generated, leaving only 30% for outside supply.	The progress situation of the cooperation agreement between Palau and Saga University, a relevant future programme and actual implementation plan in Palau, etc. will be studied to determine the status of OTEC in the power source development plan in Palau.
Photovoltaic Power Generation	Photovoltaic power generation has already reached the stage of practical use. At the end of 2005, some 3.7 million kW was installed worldwide and a rapid increase is anticipated.	A basic study on photovoltaic power generation will be conducted to identify feasible sites and scales. A proposal will be made to conduct a one year detailed solar radiation survey in Palau and a power system survey.
Wind Power Generation	Wind power generation is now fully practical. As of the end of 2005, some 59 million kW is installed worldwide and a continual rapid increase is anticipated. The system is affected by the locational conditions (requiring constant strong wind) and power system conditions, such as the bus bar capacity and stability in the case of a wind power generation system linked to the grid system. Once these conditions are met, its potential as a renewable energy source for power generation is extremely high together with photovoltaic power generation.	A basic study on wind power generation will be conducted to identify feasible sites and scales. A proposal will be made to conduct a one year detailed wind condition survey in Palau and a power system survey.
Waste/Biomass Power Generation	The regular collection of a sufficient quantity of waste or biomass for use as the fuel is necessary in addition to the safe storage of a certain amount. The system is said to be unsuitable for an island country with a small population like Palau.	An outline survey will be conducted on the types of fuel, daily collection amount, collection method and possible sites to analyze the potential of this type of power generation in Palau.

Type of Power Generation	Present Technological Level, etc.	Intended Course of Action Under the Study
Hydropower/Geothermal Power Generation	Although there are no technological problems for these types of power generation, their feasibility is determined by the site and natural conditions, including the availability of energy resources.	Under the Study, data on the locational and natural conditions for these types of power generation will be obtained from the MRD and other government bodies in Palau.

2.9 Environmental and Social Considerations

The environmental and social considerations under the Study are required to comply with the Guidelines for Environmental and Social Considerations of the JICA and to incorporate the philosophy of "strategic environmental assessment" technique. This strategic environmental assessment (SEA) means environmental assessment featuring the plan (higher plan) and policies at the strategic decision-making stage prior to the implementation of individual projects as such a plan and policies provide the framework for the planning and execution of individual projects. SEA aims at avoiding and/or reducing severe environmental impacts by means of identifying possible severe environmental impacts at the stage of examining a project location and scale, etc. and comparing several alternatives from the viewpoint of the environment. As a mechanism to allow wider environmental consideration from an early stage, SEA has already been introduced in the world's major countries, including the US, Canada and 25 out of 27 EU countries. In Asia, the SEA mechanism has been introduced in China, Korea, Vietnam and Hong Kong. The system is being developed in the Philippines and Thailand. The Study will incorporate the philosophy of SEA to conduct the environmental and social considerations.



Project Planning and Execution Flow and Mechanism of Environmental and Social Considerations

3. Planning Concept for the Optimal Plan

3.1 Power Demand Forecast

In principle, the official forecast figures of the Government of Palau will be used as the forecast figures for the population, economic growth rates, the demand side management and the promotion of renewable energy to be used for the power demand forecast.

Following the relocation of the capital from Koror to Melekeok on Babeldaob Island in October, 2006, the demand structure of the Koror-Babeldaob power system, which is the subject of the Study, has shown some changes by area before and after this relocation. Melekeok State experienced a power demand (kWh) increase at an average annual rate of 41.6% from 2000 to 2003 with a total increase of 2.8 times in these four years. This figure was the highest among the states served by the said power system. Meanwhile, the annual demand growth rate in Koror State from 2000 to 2003 was a mere 0.075% which was the lowest among the states served by the said power system.

Forecasting of the power demand generally uses either the engineering method (build-up of individual demands) or the econometric method.

While the Study will basically employ the econometric forecast method, the build-up method will also be used to produce a forecast which reflects an increase of the power demand by new large users by examining the existing development programmes of the government and commercial sector to ensure an accurate demand forecast.

3.2 Power Station Expansion Plan

(1) Important Points for Plan Formulation

For the formulation of the Aimeliik Power Station Replacement Plan, the optimal timing for the introduction of new power sources and the optimal capacity of a single unit will be examined on the basis of the reserve capacity based on the power demand forecast, decrease of the output at the time of periodic inspection and the planned withdrawal of the existing diesel engine generating facilities, etc.

(2) Power Generating Facilities Expansion Plan (Draft)

A suitable plan will be formulated for the expansion of the generating facilities at the Aimeliik Power Station, taking the conditions of the global market for the diesel engine generators to be procured, scope and shape of the usable land, specifications and operating performance of the existing diesel engine generators, excess supply capacity of the existing utilities (fuel and water) at the Aimeliik Power Station and the required environmental measures into consideration.

3.3 Transmission, Distribution and Transforming Facilities Expansion Plan

For the formulation of this plan, the following points must be taken into consideration.

- Plan contents which reflect the natural environment of Palau (checking of meteorological data)
- Likely demand trend from the long-term viewpoint
- Compatibility between the power generating facilities and transmission, distribution and transforming facilities
- Effective utilisation of the existing facilities (in consideration of their efficiency)
- Timing for the addition of the necessary new facilities while taking the required construction periods into consideration
- Cost reduction by means of the slimming down of the facilities and containment of the construction cost, etc.
- Meeting of the required supply reliability and maintenance of an adequate power quality

• Compatibility with the existing facilities (common maintenance work and the sharing of spare parts)

4. Improvement of the Operation of Power Facilities

4.1 Power Generating Facilities

The Aimeliik Power Station requires urgent replacement in view of the fact that its generating facilities are highly deteriorated due to their operation for more than 20 years. While the diesel engine generators owned by the PPUC have broken down one after another due to burning out of the crank shaft. The lubricating oil analysis results in April, 2006 suggest contamination of the lubricating oil by water, the anti-rusting agent for the cooling water and iron (from abrasion of the cylinders). The occurrence of a serious generator incident despite the existence of such foreboding sign implies the insufficiency of the daily maintenance capability of the maintenance staff of the PPUC.

The Study intends to make concrete proposals for the preparation of a generating facility O & M manual, development of a spare parts control system, introduction of preventive maintenance techniques and improvement of the organizational set-up.

4.2 Transmission, Distribution and Transforming Facilities

Some 30 maintenance staff members are currently responsible for the maintenance of the transmission and distribution facilities and the proposal of an efficient maintenance method under the Study is important. Improvement of the facility operation will be attempted, taking the following points into consideration.

- Proposal of efficient daily operation management (patrol frequency, daily inspection item, contents of periodic inspection and control of spare parts, etc.)
- Introduction of the concept of preventive maintenance
- Establishment of rules for facility operation by means of the provision of an O & M manual

5. Business Management Improvement Measures

The present financial structure of the PPUC, including the structure producing a loss, will be thoroughly analysed using the data obtained from the analysis of financial statements and interviews with personnel of the PPUC's Accounting and Finance Department. This will be followed by work focusing on the key points for improvement of the income and expenditure structure by means of revision of the electricity tariff already for detailed examination of the characteristics of such structure and the degree of impact of a revised tariff on the business income. Based on the results of such

analysis, a profit and loss forecasting model and cash flow forecasting model will be developed for the PPUC. At the same time, the required size of income to meet the funding demand as established by the funding planning work listed below will be estimated based on the inputs of the engineering side (future power development plan and estimated funding required to realise this plan). Simulation incorporating the financial and engineering requirements will then be conducted using the profit and loss forecasting model and cash flow forecasting model mentioned above to examine an appropriate electricity tariff. The key points of this process are further explained below.

① Revision of the Basic Charge (Fixed Rate)

② Bottoming Up of the Basic Charge (Fixed Rate)

③ Review of the Electricity Tariff for Remote Islands

④ Examination of an Adequate Electricity Tariff Increase Rate

⑤ Re-Examination of the Fuel Price Adjustment Mechanism

⑥ Collection of the Electricity Tariff for Street Lighting

6. Funding Plan

The necessary amount of funding will be calculated based on the cost estimates for the power station construction plan and the transmission and distribution facilities expansion plan put forward by the engineering side of the Study Team and a funding plan will be formulated. At the same time, feasible fund raising methods and funding source will be examined. As many options can be assumed for fund raising, careful analysis will be conducted to determine the best option(s) for not only the MRD and PPUC but also for the national economy.

In any case, the selection of the most advantageous as well as realistic option is essential.

- Establishment of the flow of the necessary investment funds
- Examination of the likely operating body (PPUC or IPP)
- Listing of the candidate financial institutions providing soft loans (JBIC, ADB and World Bank, etc.)
- Listing of the financial institutions providing export credit
- Listing of private financial institutions actively operating in the Pacific region
- Examination of the possibility of government funding in Palau
- Appropriate matching in view of the size of the required funding
- Cooperation of the lead time for various types of loans in view of the required timing for funding

7. Technology Transfer

7.1 Effective Use of the Working Group

To achieve the purposes of the Study and the transfer of technologies/skills relating to the formulation of a power supply plan and operation of power facilities to the counterparts, it will be necessary for the PPUC and other organizations related to the Study to fully understand the purposes of the Study and to actively participate in the Study through the active exchange of opinions and information. For this reason, the agenda will be presented in advance for any discussion/consultation meetings of the Working Group and the members will also be given tasks if necessary to prompt the active participation of the members.

7.2 Workshops

The Study Team will prepare reference materials to be used at the two planned workshops to be held in Palau. However, it is planned that the presentations at these workshops will be made by the counterparts where possible from the viewpoint of technology transfer.

7.3 Preparation of an Effective O & M Manual

For the preparation of an O & M manual for the power facilities, such in-house rules of one of the members of the Consortium (The Chugoku Electric Power Co., Inc.) as power facility maintenance regulations and detailed rules will be referred to. Consideration will be given to ensuring that the finalised O & M manual will be highly practical, reflecting the reality of the facilities owned by the PPUC.

7.4 Unification and Compatibility of the Applied Standards

Electric facilities in Palau are installed in accordance with the standards applied in the US. Accordingly, a proper understanding of the US standards is important for effective technology transfer.

The planned technology transfer will be made paying special attention to the National Electrical Safety Code (NESC) and the reality of the power facilities of the PPUC.

7.5 Management of Drawings and Data

As the scale of the power system grows, proper management of the latest power facility operation data will become increasingly difficult. The collection of data for the Study will be conducted by the counterparts as much as possible in view of the proper management of the new facilities by the PPUC itself.

8. Formulation Process of the M/P and Pre-F/S

Fig 1 Work Flow of the Study shows the formulation process of the M/P and Pre-F/s for the Power development plan of Babeldaob and Koror islands which is described in this Summary and in more detail in the main report.

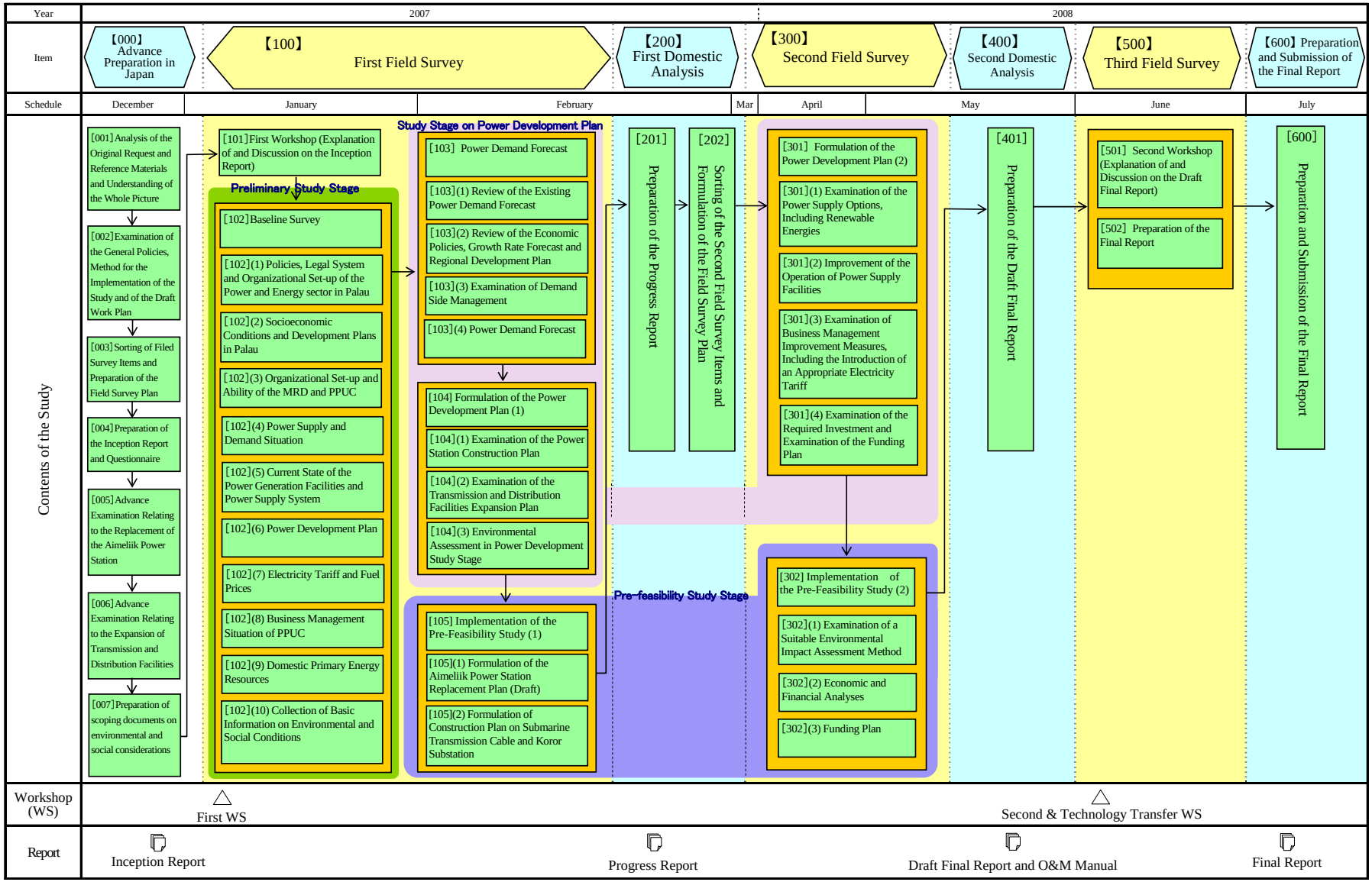


Fig. 1 Work Flow of the Study

1. SOCIOECONOMIC CONDITIONS AND DEVELOPMENT PROGRAMMES IN PALAU

1. Socioeconomic Conditions and Development Programmes in Palau

1.1 Situation of Social Development

1.1.1 Population, History and Geography

The Republic of Palau (hereinafter referred to as "Palau") is located between 6°53'N and 8°12'N and between 134°8'E and 134°44'E with a total land area of 488 km^2 and a population of 19,907 (2005 National Census). Although the capital was relocated from Koror State to Melekeok State in 2006, Koror State where 64% of the total population is concentrated is still the centre of Palau's economic activities. Foreign nationals account for some 31% of the total population. The largest expatriate ethnic group is made up of Filipino settlers and workers, accounting for approximately 17% of the total population.

Since the Second World War, Palau has received financial assistance from the US as part of the UN Trust Territory of the Pacific under US administration. It became an independent country as a country of Free Association with the US on 1st October, 1994 under the Compact of Free Association which guaranteed financial assistance by the US for a period of 15 years until 2009 while entrusting the US with the responsibility for the national defense and security of Palau. Based on this Compact, compact funding totalling US$ 700 million is provided for Palau for the 15 year period and the annual payment of these funds has been an important source of income to support Palau's economy.

1.1.2 Industrial Activities

The public finance of Palau heavily relies on grant aid based on the Compact with the US while the financial aid of Taiwan with which Palau established a diplomatic relationship in 1999 has been increasing in recent years. The main industries are (i) the construction industry which relies on grant aid from the US and Taiwan, (ii) commerce based on the importation of foodstuffs and consumer goods and (iii) tourism. Each industry is highly dependent on foreign labour which is primarily provided by Filipino workers. Tourism, which is one of the main industries in Palau, attracts more than 90,000 tourists a year, primarily from Taiwan, Japan, Korea and the US. While the present administration has aimed at stimulating the economy based on the promotion of inward investment and foreign aid for agriculture, fisheries and tourism along with a policy of reducing the size of and improving the efficiency of the government, the reality is that the country is still heavily dependent on foreign aid to sustain both public finance and the national economy. The achievement of a self-reliant economy by 2009 when the financial assistance under the Compact comes to an end appears to be difficult. The outcome of the ongoing negotiations to extend funding under the Compact will, therefore, have a major impact on the future of Palau's economy.
Palau is classified as a middle income country as its GDP per capita is US$ 7,267 (2005). However, of the government revenue of US$83.7 million in 2006, more than US$ 45 million, i.e. more than 50%, came from foreign aid, including funding under the Compact. Accordingly, the real GDP per capita is inferred to be around US$ 2,000 – 3,000. The public sector has traditionally accounted for the largest share of the GDP. However, the trade sector became the first sector of which the GDP share was larger than that of the public sector in 2006. Meanwhile, the employment share of the public sector declined from 44% in 1991 to 31% in 2005, indicating a gradual change of Palau's economic structure dominated by the public sector.

The manufacturing, agricultural, fisheries and mining industries are not particularly extensive although in the fisheries industry, a foreign fishing company has obtained fishing rights for offshore Palau to export tuna to Japan, Korea and China. The local supply of food is heavily dependent on imports from the US even though taro and cassava are locally produced along with the catch of coastal fishery.

1.1.3 Situation of Public Services and Infrastructure Development

The Government of Palau has formulated the Palau 2020 National Master Development Plan which aims at achieving self-reliant development in a departure from the traditional reliance on US aid and protection of the national culture. Separately from this Master Plan, the Palau Sector Investment Programme (PSIP) was formulated in April, 2003, compiling development projects scheduled for implementation in the five year period from 2003 to 2007, in an attempt to review the development of the public sector. The PSIP identified tourism, agriculture, fisheries, trade and light industry as priority sectors for economic development. The PSIP also classified concrete development projects in such fields as transport (roads, airports and harbours), water supply, sewerage, solid disposal, energy and communication into three categories (A, B and C) based on their priority. While some of these projects are in progress with the assistance of various donors, many remain on the desk because of a lack of funding. The main projects which have been implemented in the last five years are the relocation of the capital, improvement of Compact Road, rehabilitation of the runway at Palau International Airport, improvement of the local water supply system in Koror State and Airai State, improvement of the sewerage system in Koror State and improvement of the fishing port and road widening on Peleliu Island. The Government of Palau is currently in the process of formulating a new PSIP compiling development projects for the next five years (2008 – 2012).

Table 1.1.3-1 shows the development state of public services (as of 2005). The water supply coverage and electrification rate, including rural areas, are as high as 94.6% and 98.9% respectively. Telephones and televisions are used by more than 85% of the total number of households.

Table 1.1.3-1 Development Situation of Public Services

No. of Households	Water Supply		Electricity Supply		Telephone		Television	
	Households	Ratio (%)	Households	Ratio (%)	Households	Ratio (%)	Households	Ratio (%)
4,707	4,452	94.6	4,656	98.9	4,056	86.2	4,076	86.6

Source: 2005 Census, Republic of Palau

In regard to the transport network which is an important infrastructure, the K-B Bridge constructed with Japanese grant aid to connect Koror Island to Babeldaob Island has been playing an important role in stimug the economy on these two islands. Compact Road was constructed with grant aid of the US in 2005 as a circular road for Babeldaob Island, the economic development of which was lagging behind that on Koror State, partly because of the small size of its population. This new road not only provides access to the new capital but also allows islanders to quickly move around the island. The vitalisation of economic activities centering on tourism on the island is anticipated in Melekeok State where the new capital is located. In addition, rehabilitation of the trunk road linking Koror Island where the urban functions are concentrated, Malakal Island with an international port, Ngerekebesang Island where the President's Office and national hospital are located and Airai State where the international airport is located is in progress with Japanese grant aid.

1.2 Economy and Fiscal Situation

1.2.1 Economic Growth and Structural Characteristics

(1) GDP

According to World Development Indicators 2007 by the World Bank, the economy appears to have expanded at an average of around 2% per annum over the last 10-12 years on the real term basis. Looking into the detail, the mean growth rate conceals marked swings. After the independence in 1994, the economy expanded quite substantially in the first two years: 1995 and 1996. Thereafter little progress has gained until the 2003. When the tourist sector boosted economic growth in 2004 and 2005, the expansion in real GDP is estimated to be 5% in both fiscal years.
The GDP of Palau is estimated to have reached US$ 170 million in 2007, according to the provisional estimate by the Office of Planning and Statistics. Per capita GDP is estimated to be US$ 7,267.

Table 1.2.1-1 Recent Trend of GDP and Sector Growth in Palau

Unit: US$ 1,000

	1998	1999	2000	2001	2002	2003	2004	2005	2006 Prov	2007 Prov
Agriculture	1,398	1,358	1,372	1,399	1,427	1,470	1,544	1,606	1,927	2,312
Fisheries	2,038	3,148	3,274	3,372	2,529	2,630	2,788	2,928	3,047	3,228
Mining	176	218	229	240	240	243	243	249	249	249
Manufacturing	1,702	1,609	1,690	1,774	1,774	532	540	547	553	558
Electricity, Gas and Water	2,360	3,393	3,563	3,741	3,741	3,928	4,242	4,582	4,811	5,003
Construction	10,389	8,249	12,621	14,261	15,402	16,018	18,421	22,105	25,421	29,234
Foreign Trade	24,837	23,165	23,860	24,337	21,903	22,998	26,218	28,840	33,166	38,141
Hotels and Restaurants	12,370	11,938	12,057	12,419	10,929	11,694	13,565	15,328	17,628	20,272
Transport and Communication	9,191	9,846	10,338	10,855	10,095	10,600	11,660	12,476	13,349	14,284
Finance and Insurance	5,706	4,297	4,511	4,647	4,368	4,499	4,769	4,960	5,108	5,211
Real Properties	6,555	4,611	4,842	5,036	4,985	5,185	5,600	5,935	6,292	6,543
Public Services	28,462	29,374	30,255	30,860	31,169	31,792	32,428	33,077	33,077	33,077
Other Services	9,907	9,691	9,982	10,381	9,550	9,837	10,132	10,588	10,588	10,588
Sub-Total	115,091	110,897	118,593	123,323	118,114	121,428	132,150	143,220	155,216	168,700
Bank Commissions	-2,640	-2,384	-2,540	-2,666	-2,681	-2,600	-2,820	-2,890	2,890	2,890
Import Duties	4,869	4,972	3,810	3,999	4,022	3,900	4,229	4,335	4,335	4,335
Nominal GDP (Calendar Year)	117,320	113,485	119,863	124,656	119,455	122,728	133,560	144,665	157,685	170,144
Nominal Growth Rate		-3.3	5.6	4.0	-4.2	2.7	8.8	8.3	9.0	7.9
Per capita GDP					5.527	6.266	6.146	6.264	6.763	7.267

Source: Office of Planning and Statistics
The figures of 2006 and 2007 are provisional estimates

The initial growth at substantial pace was achieved as the result of abrupt upsurge in government expenditure, since Compact payments were disbursed in the period of 1994-1996.

(2) GNI

Palau has the highest per capita GNI (US$7,630, 2005, the World Bank) and the highest per capita aid recipient (US$1,712 averaging over 1999-2002) of the Pacific Island countries.

Palau receives substantial assistance from the United States through the Compact of Free Association, totaling US$ 500 million over the period of 1994-2009. In recent years, annual disbursements are likely to have averaged around 20% of GDP. Compact Trust Fund has been raised to finance government operations, in order to enable Palau to become self-sustainable.

(3) Structural Characteristics

The Palauan economy has been dominated by the public sector for decades. Public administration is currently estimated to account for 26-27 % of GDP. Government-owned corporations are active in the supply of electricity and communication services, and water and disposal. Public sector demand is critically important to sectors of construction, transport, and trade industries. The ratio of public expenditure to GDP is estimated at 60.4% for FY2006-2007. Taking a look from another aspect, the economic growth of Palau will illustrate the problems of extremely public-sector-oriented growth. Such growth is very volatile. Without the Compact aid, the public sector employment will not continue to sustain. Furthermore, it can be said that such situation would have diminished opportunities of self-sustaining growth by private sector. Currently, Compact aid as well as the other donors' technical and financial assistance is underway to upsurge the GDP level of Palau. These improvements might be just apparent and superficial achievements until 2009. The economic strength of Palau should undergo close scrutiny.

Tourism is another major drive to the economy. The tourism industry has recovered steadily after a series of adversely affecting events: the Asian financial crisis (1997/1998); September 11 (2001); SARS outbreak (2003). Before the Compact, visitor arrivals to Palau were below 35,000, but rose to 66,000 in 1997. The visitor arrivals declined to 54,000 in 2001, and achieved swing recover to 95,000 in 2004, and 86,000 in both years of 2005 and 2006.

The primary industry of agriculture, forestry and fishing occupies a small share of GDP, representing only 3.4% of GDP, on the basis of 2005 GDP data. The secondary sector does not occupy a big share as well, representing only 19.0%, more than half of which derive from construction and the most of remainder from electricity, gas and water. On the other hand, the service sector occupies 77.6% of GDP. There is some food local food processing, bottling of drinking water and furniture. Although Palauan exports can enjoy free access to US market, under the agreement of the Compact, local manufacturing activity has been very low and will not be likely to achieve remarkable growth in future.

One of the striking characteristics of Palau economy is the massive existence of foreign workers. Migrant foreign workers, who number about 6,500, will make up nearly one third of the population and over half of the labor force. As a result, such migrant workers remit much of their income to their mother country. It will surely account for substantial outflows of money from Palau. In addition, many Palauans remit their money to their children studying at US higher education institutes. The remittance from Palauan living overseas to Palau is not thought to be very large. It is very difficult to figure out the remittances to be understood on precise level.

1.2.2 Financial Sector

(1) Currency

Palau uses the US$ as its national currency. Therefore, it does not have a central monetary authority and does not have to operate an independent monetary policy.

(2) Banking institutions

Although Palau is a very small country and the population is only 20,000, the financial sector is composed of a large number of banks and other financial institutions. There are currently seven commercial banks and the government-owned Palau Development Bank, and several small credit unions and insurance companies. Among all, the Bank of Hawaii is the largest commercial bank, and two other US-based banks are operating in Palau. They are subject to US bank regulations, and occupy around 80% of deposit and more than 60% of loans. Three other commercial banks are foreign-owned and the remaining banks are locally incorporated and are operating under a conditional license. There is a large spread between deposit and lending rates. For instance, the Bank of Hawaii offers annual deposit rate of 0.3-2.0%, in contrast to the consumer lending rate: 16-18%, and commercial lending rate: 10%. Although a large number of financial institutions are operating, formal lending is very minor. They are mainly focused on salary-secured small consumer loans. Around half of local deposits are invested in US and other financial markets. Informal lenders extend fund for small business development, but National Development Bank has reduced commercial lending because of the bad performance in the past. Therefore, individual consumer lending now accounts for most of its portfolio.

Table 1.2.2-1 Banking Institutions in Palau

Category & Name of Bank	Nationality or Ownership
1. Commercial Banks	
1.1 Foreign-owned majority	
Bank of Hawaii	U.S.
Bank of Guam	Guam
Guam Savings Bank	Guam
First Commercial Bank	Taiwan
Palau Construction Bank	China
1.2 Domestic-owned majority	
Pacific Savings Bank	Palau
Bank of Palau	Palau
Melekeok Government Bank	Melekeok State Gov.-owned
2. Development Banks	
National Development Bank of Palau	National Government-owned

(3) Price

Palau commenced statistics study of consumer price index only 8 years ago in 2000. There was almost no inflation from 2001 to 2003, but it jumped up 5% in 2004, following the rise in oil prices and increased taxes on cigarettes and alcohol. Inflation remained relatively high in the current years (3.9% 2005, 4.5% 2006 and 2.9% 2007).

Table 1.2.2-2 Consumer Price Index – Annual change

Year	CPI (Dec 2004 = 100)	Annual % Change
2000	96.8	
2001	95.1	-1.8%
2002	93.9	-1.3%
2003	94.7	0.9%
2004	99.4	5.0%
2005	103.3	3.9%
2006	107.9	4.5%
2007	111.1	2.9%

Source: Office of Planning and Statistics

Base: CPI (Dec 2004)= 100

1.2.3 Fiscal situation

(1) Budgetary Deficit

Payments under Compact dominate the fiscal situation of Palau. In the first year of the Compact, the Palau Government finance recorded a big surplus which was equivalent of more than 100% of GDP. While many grants due under the agreement were paid, the funds were not disbursed. The large surplus of that year ensured large fiscal deficits in the following years.
In 2002, the overall budgetary deficit accounted for US$ 34.2 million, which was equivalent to around 30% of GDP. Thereafter, the deficit has been reduced to less than 10%: -2.4% in 2003, -6.8% in 2004, -3.9% in 2005 and -0.4% in 2006 as compared with GDP.

Table 1.2.3-1 Fiscal Deficit of Palau, 2002-2006

			Unit:%
	Unit: million US$		Overall budgetary deficit
Year	Overall budegtary deficit	GDP	% to GDP
2002	−34.2	115	−29.7
2003	−2.9	122.7	−2.4
2004	−9.1	133.6	−6.8
2005	−5.6	144.7	−3.9
2006	−0.7	157.7	−0.4

Source: Key Indicators 2007, Asian Development Bank

The expenditure of the Government surprisingly corresponds to more than half of GDP. In 2002, the expenditure occupied around 70% of GDP. Thereafter, the ratio gradually decreased to 53% in 2005, but increased to 60% again in 2006. In contrast to expenditure, revenue has not been so big. Palau regularly records a sizable fiscal deficit. The constant shortfall between the revenue and expenditure has been compensated by lots of grant money from the Compact as well as the other grants. This means that the renegotiation of the Compact will be a key factor for Palauan economy. The ratio of grants to GDP has accounted for more than a quarter of GDP. In 2006, it rose to 33.8% from 25.5% of 2005.
In recent years, IMF urges the Palauan authorities to reduce the deficit as well as the expenditure substantially.

Table 1.2.3-2 The amount of Revenue, Expenditure and Grants, % to GDP

					Unit:%		
	Unit: million US$				Revenue	Expenditure	Grants
Year	Revenue	Expenditure	Grants	GDP	% to GDP	% to GDP	% to GDP
2002	28.8	80.1	22.4	115	25.0	69.7	19.5
2003	31.7	76.3	34.2	122.7	25.8	62.2	27.9
2004	35.0	80.8	36.1	133.6	26.2	60.5	27.0
2005	39.1	76.9	36.9	144.7	27.0	53.1	25.5
2006	41.3	95.3	53.3	157.7	26.2	60.4	33.8

Source: Key Indicators 2007, Asian Development Bank

The largest expenditure item in the Government budget is wages and salaries, which accounts for a quarter of GDP, or around 40% of public expenditure. In general, public sector overwhelms private sector in terms of wages and salaries. As a result, many capable and trained people are employed by public sector. It seems to be difficult for private sector to attract capable workers.

(2) Balance of Payments

Balance on Goods (Import/Export)
Since Palau is a very small country, it is reasonable that almost all of goods are imported from overseas. Self-sufficiency should not be pursued in terms of foreign trade, although it was debated as a policy option in the past. From the viewpoint of economy of scale, it is unlikely to be feasible to develop export manufacturing industries. Domestic business development strategy should be focused on tourism and related commercial development.
Therefore, Palau has to accept the fact of a large trade deficit. To the contrary, the service sector should earn such a large surplus as to match the large trade deficit.

(3) Public Debt and Assets

When the Compact of Free Association commenced, the external debt outstanding was US$ 20 million. It was scheduled for full repayment in FY 1999-2000. As of 2006, the external debt outstanding amount was estimated to account for US$ 17.5 million, which has been gradually decreasing in recent years from US$ 20.0 million as of 2002.
A new external loan of $ 20 million was obtained from Taipei, China to help fund the new capital. In addition, the Government negotiated a concessional loan of $ 15 million from Taipei, China for resurfacing the runaway of Koror International Airport, upgrading the new terminal and providing a new instrument landing system to improve air safety. However, the Government recently received a commitment from the US Federal Aviation Administration for a 25 million grant. The US$ 15 million loan became unnecessary.
In addition to these debts, the civil service pension plan is estimated to have an unfunded liability of US$ 30 million. Eventually it should be funded by the budget or the reduction of payouts. The social security administration scheme has an unfunded liability of at least US$ 10 million. In terms of lending from the government bank, the Government is the guarantor of the commercial loans issued from PNDB (the Palau National Development Bank) for local small and medium firms. PNDB is negotiating another concessional loan of US$ 5 million with Taipei, China. This loan will need the guarantee from the Government.
With the reference to the public assets of Palau, Palau is net plus. From an initial investment of US$ 70 million, the values of the CTF rose and peaked at US$ 161 million in FY 1999-2000. The amount gradually decreased to 136 million as of September 30, 2003, and rose back to US$ 157 million as of September 30, 2006.

1.2.4 Compact Revision and Economic Reform

(1) Negotiation of the Compact, scheduled in 2009

In the near-term, Palauan economic growth will be sustained, but medium term prospects will face fiscal uncertainty, particularly with the scheduled sharp reduction in grant assistance from the United States after 2009. It will definitely affect government expenditure, domestic consumption, and all the economic activity. Under the agreement, Palau has benefited from substantial amount of US assistance since 1994. The direct payments from 1994 to 2009 aim at developing economic-self-reliance by financing current expenditure, developing infrastructure and the balance of the Compact Trust Fund (CTF) whose objective is to provide a sustainable income stream from 2010 to 2043. In recent years, budgetary grants from the United States have averaged around 18% of GDP, of which one third comes from federal grants outside of the Compact. As aforementioned in the last section, the CTF balance stood at US$ 157 million as of September 30, 2006. As stated in the Compact, the purpose of CTF

is to provide a steady source of income that would replace the annual grants after the termination in 2009. However, another 35 years from 2009 might be too long for the economy of Palau to sustain with only CTF without annual grant assistance and in-kind aid. In 2004, IMF made an assessment study on the current CTF withdrawal schedule in three scenarios. According to the assessment, CTF will be exhausted in 2019, 2023 or 2031 prior to 2043, respectively, in the three cases: pessimistic, middle and optimistic.
In this context, it will be critically important whether the renegotiation of US grant assistance beyond the first 15 years will be successful or not. In 2004, the Federated States of Micronesia and the Republic of Marshall Islands renegotiated the Compact, and both of them renewed. They could successfully negotiate a continuation of substantial US grants. The Government of Palau has already showed its hope to the United States that Palau would like to seek grant assistance beyond 2009. At present, it is unclear whether Palau will be successful in the US grant continuation negotiation or not, because the former agreement of those countries, however, contained the provision of automatic renegotiation, but there was not in that of Palau. Unlike Palau, those two countries were not given such fund as CTF. It is desirable if Palau can self-sustainably manage and develop its economy without direct grant aid, but immediately it will be a very difficult task for Palau, in consideration of the current situation of substantial dependence on sizable grants.

(2) Structural Reform of Palauan Economy and Development Policy

In view of future self-sustainable growth, it is deemed as essential for private sector to foster development and change its heavily dependent structure on public expenditure and foreign aid. Among all, tourism seems to be the most priority to be developed. Since Palau is a very small country, the economic strengthening strategy should be selective.
As IMF, ADB points out, the following matters are critical aspects to affect future growth of Palauan economy.

- Articulating and implementing a high-end tourism development policy
- A complete overhaul of foreign investment regulations
- Realigning and streamlining the role of the Government in the economy
- Undertaking tax reform
- Undertaking land reform
- Reforming the financial market
- Review and reform of the legal system for commercial activities

1.3 Development Plans

Palau has several development plans, including the Palau 2020 National Master Development Plan (PNMDP), the Regional Development Promotion Plan for Palau (October, 2000, JICA) and the Public Sector Investment Program 2003 – 2007 (PSIP). As some time has passed since the formulation of these plans, the PNMDP of which the review has been in progress with the technical assistance of the Asian Development Bank is believed to indicate the latest development policies. This review began in August, 2007 by a team of Australian and New Zealand consultants and the draft report is compiled as of May, 2008.
In the draft report, development priority is ranked by sector and project. The expansion of PPUC's power generating facilities is ranked as the second highest.

2. CONDITIONS OF ELECTRICITY AND ENERGY SUPPLY IN PALAU

2. Conditions of Electricity and Energy Supply in Palau

2.1 Policies, System and Organization Relating to Electricity and Energy Supply

2.1.1 Electricity and Energy Policies

There is currently no master policy governing the entire electricity and energy sector. One exception is the Palau 2020 National Master Development Plan (PNMDP) formulated in 1997 as the PNMDP states the following strategy for the electricity sector.

> *Provide electrical power to all communities in Palau to an adequate standard and at efficient prices which will entail allocation of additional revenues to overhaul existing units and expand capacity at Aimeliik Station; upgrade Malakal Station; upgrade the Koror power grid; extend distribution to additional states on Babeldoab; upgrade plants and systems on other islands; encourage energy conservation and improve the management arrangements for PUC to enhance its economic efficiency.*

Based on the above policy, the PNMDP incorporates an improvement and expansion plan for power supply facilities and efforts to develop the power sector are in progress based on this plan. At present, work is in progress to revise the PNMDP with the technical assistance (TA) of the Asian Development Bank (ADB) and it is unclear how the policies for the electricity and energy sector are treated in this revision process.

As an individual policy regarding the electricity and energy sector, Executive Orders of the President No. 234 and No. 245 regarding a reduction of the energy consumption have been enforced. These orders clearly specify the obligation and targets for government organizations to reduce their energy consumption. In November, 2007, the Energy Efficiency Action Plan was formulated with EC assistance, indicating energy consumption reduction measures (wide use of small fluorescent lamp and a subsidy for the installation of solar water heaters, etc.) for both the public and private sectors.

2.1.2 Legal Framework for Electricity Business

RPPL No. 4-13 (PUC-Act) enforced on 16th February, 1994 provides the only legal framework for the electricity business in Palau. In accordance with the PUC-Act, the Palau Public Utilities Corporation (PPUC) was established. The PUC-Act stipulates the authority and obligations of the PPUC, the transfer of assets from the government to the PPUC and the procedure for revision of the electricity tariff, etc.

2.1.3 Organizations Relating to Electricity and Energy Policies

Energy policies in Palau fall under the jurisdiction of the Ministry of Resources and Development (MRD). The MRD has four bureaus, i.e. Bureau of Agriculture, Bureau of Marine Resources, Bureau of Public Works and Bureau of Land and Surveys. The Office of Energy is within the Bureau of Public Works. This Office of Energy is mainly responsible for the promotion of the introduction of renewable energies as well as energy saving and there is no central organization in charge of electricity and energy policies. Fig. 2.1.3-1 shows the organizational set-up of the MRD.

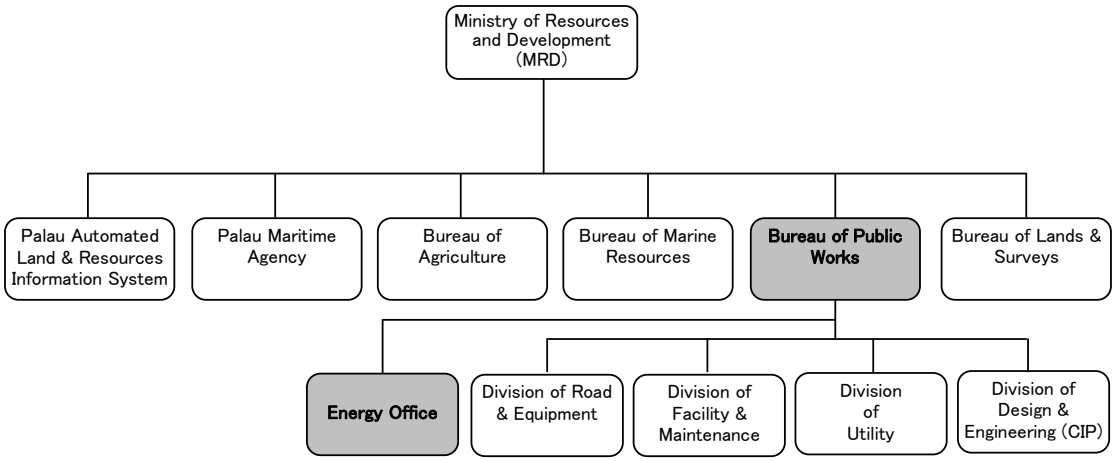


Fig. 2.1.3-1 Organizational Set-Up of the MRD

2.2 Organizations Relating to Electricity Business

The electricity business in Palau is run by the PPUC. The management of the PPUC is under the direct supervision of the Board of Directors appointed by the President and is not under the supervision of the MRD.

The PPUC has six departments, i.e. Business Office, Accounting and Finance, Auxiliary Services, System Control, Power Distribution and Power Generation, as shown in Fig. 2.2-1, and employs some 130 people.

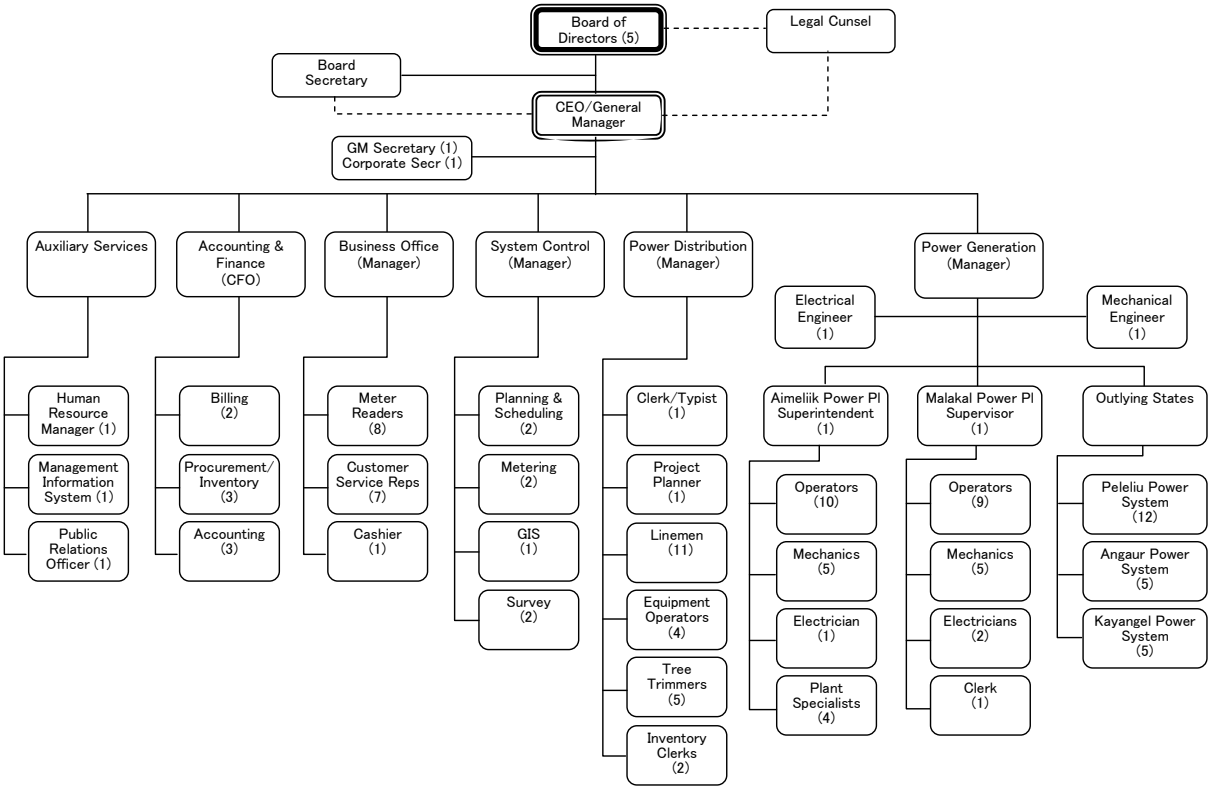


Fig. 2.2-1 Organizational Set-Up of the PPUC

The PPUC has office regulations which clearly specify the contents, obligations and required abilities, etc. for each type of job in the PPUC. While the technical staff of the Power Generation Department and Power Distribution Department have sufficient technical expertise to conduct the routine operation and maintenance of the power supply facilities, both the manpower and capacity of the PPUC are insufficient to formulate medium to long-term facility improvement and maintenance plans. At the end of 2007, the PPUC newly recruited one mechanical engineer and one electrical engineer in its efforts to improve the technical level relating to power generation, transmission and distribution. However, these engineers were recruited from a neighbouring country and it is essential for the PPUC to train and upgrade its own engineers.

2.3 Power Supply and Demand Situation

2.3.1 Power Demand

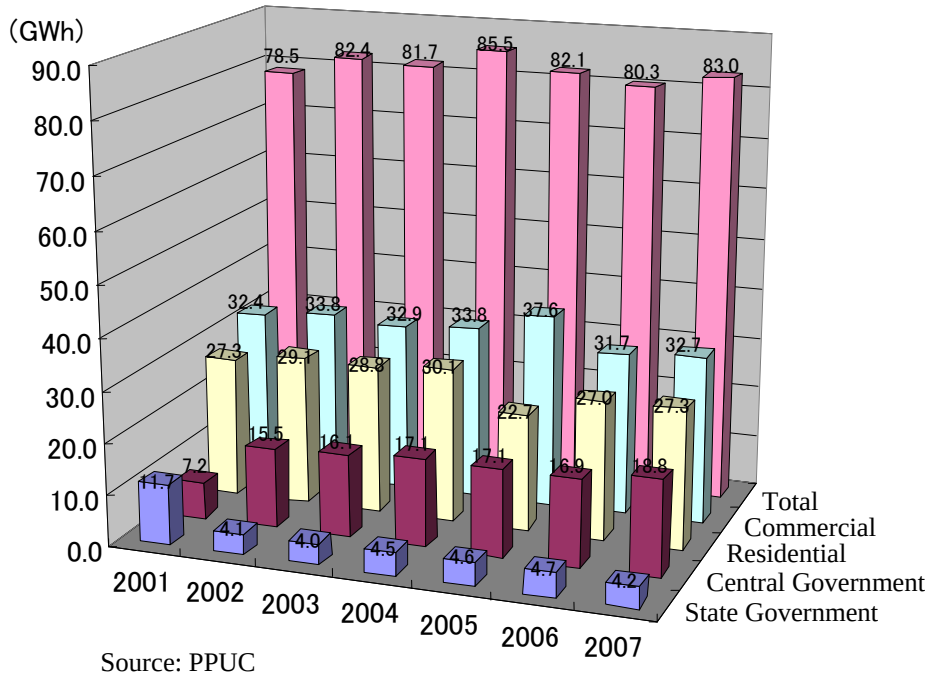
(1) Nationwide Power Demand

The annual changes of the power demand in Palau in the last seven years are shown in Fig. 2.3.1-1. By type of user, the commercial demand accounts for 30 – 40%, the residential demand accounts for around 30% and the public sector demand of the central and state governments accounts for the remainder.

The total power demand has been just over 80 GWh since 2004, giving the impression that the growth of the power demand is stagnant. However, as Palau's total power demand is not especially large, it can be easily affected by the opening of a large-scale commercial facility or hotel, the holding of a major event and/or outages caused by problems of the power facilities. Therefore, the annual figures in Fig. 2.3.1-1 do not necessarily represent the real power demand.

For example, the largest power demand recorded in July, 2004 was influenced by the Festival of Pacific Arts in the same month for which more than 2,000 tourists from abroad visited Palau. In 2005, the work to relocate transmission and distribution lines necessitated by the improvement work for Compact Road made power supply cuts necessary and large users with a private electricity generator were requested to use their own generators, resulting in a drop of the power demand recorded for the year. Another drop of the power demand in 2006 was due to rotating outages which lasted for one month because of the breaking down of the generating units at the Malakal Power Plant.

The power demand increased in 2007, suggesting the potential for a power demand increase due to an increase of the GDP and population, etc.



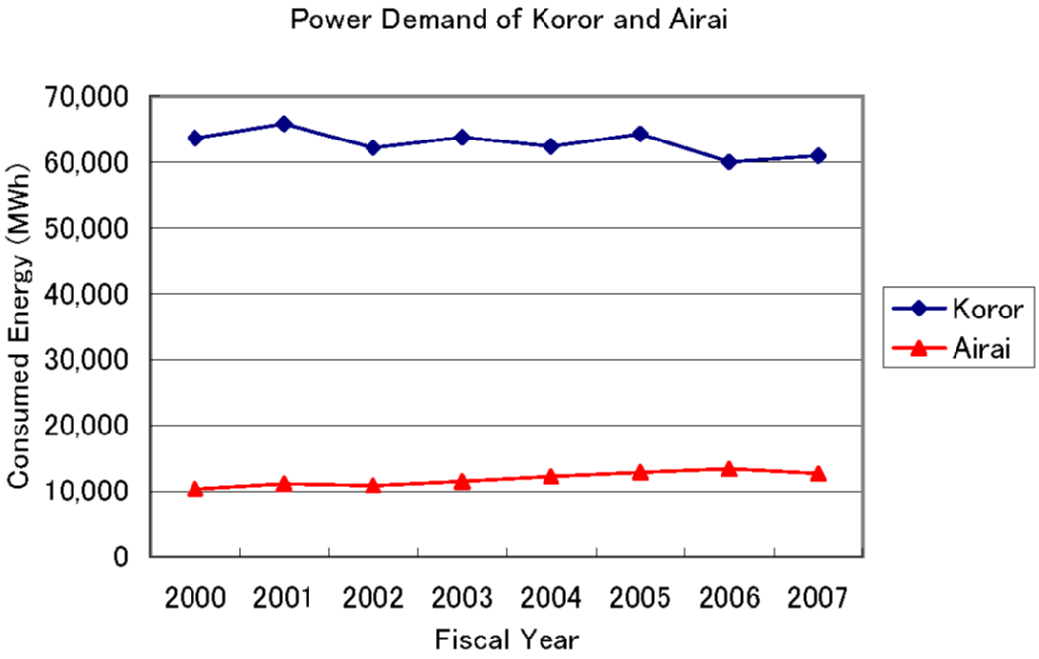
Source: PPUC

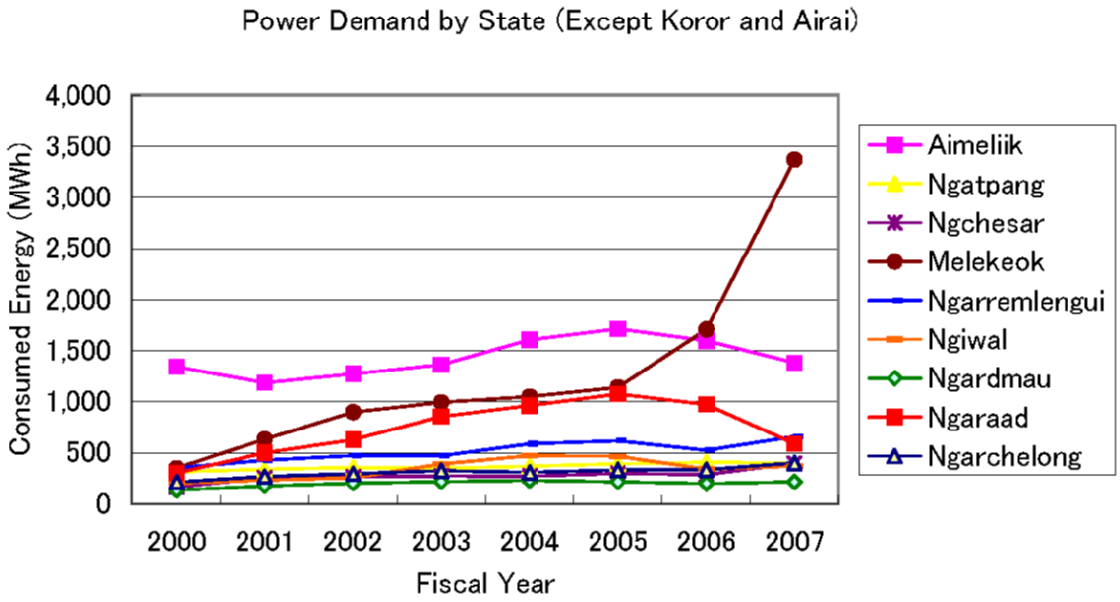
Fig. 2.3.1-1 Changes of the Power Demand by Type of User in the Last Seven Years

(2) Power Demand by State

The local power demand structure of the Koror-Babeldaob power system, i.e. the target power system of the Project, underwent a transformation around October, 2006 when the capital was relocated from Koror State to Melekeok State on Babeldaob Island. As shown in Fig. 2.3.1-2, the power demand in Melekeok State doubled from 2006 to 2007, recording the highest growth rate among all states served by this power system.

Meanwhile, the power demand in Koror State which accounts for 64% of Palau's population has levelled off although it still accounts for some 75% of the total power demand of this power system as shown in Table 2.3.1-1, illustrating the status of Koror State as a major power consumption area.





Source: PPUC

Fig. 2.3.1-2 Power Demand by State Served by the Koror-Babeldaob Power System

Table 2.3.1-1 Share of the Power Demand by State in the Nationwide Demand

State	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007
Koror	82.2%	81.2%	80.0%	79.2%	77.5%	77.0%	75.2%	74.8%
Aimeliik	1.7%	1.5%	1.6%	1.7%	2.0%	2.1%	2.0%	1.7%
Ngatpang	0.4%	0.4%	0.5%	0.4%	0.5%	0.5%	0.5%	0.5%
Airai	13.4%	13.8%	14.0%	14.3%	15.3%	15.5%	16.9%	15.6%
Ngchesar	0.2%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%	0.5%
Melekeok	0.5%	0.8%	1.2%	1.2%	1.3%	1.4%	2.1%	4.1%
Ngaremlengui	0.5%	0.5%	0.6%	0.6%	0.7%	0.7%	0.7%	0.8%
Ngiwal	0.3%	0.3%	0.3%	0.5%	0.6%	0.6%	0.4%	0.5%
Ngardmau	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Ngaraad	0.4%	0.6%	0.8%	1.1%	1.2%	1.3%	1.2%	0.7%
Ngarchelong	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%

Source: PPUC

Fig. 2.3.1-3 shows the breakdown of power users in each state. In Koror State which is the commercial/economic centre of Palau, the commercial demand accounts for some 50% of the local power demand. In contrast, the government demand accounts for 76% in Melekeok State following the relocation of the capital to this state. The share of the residential demand tends to be high in the northern states with a small population size.

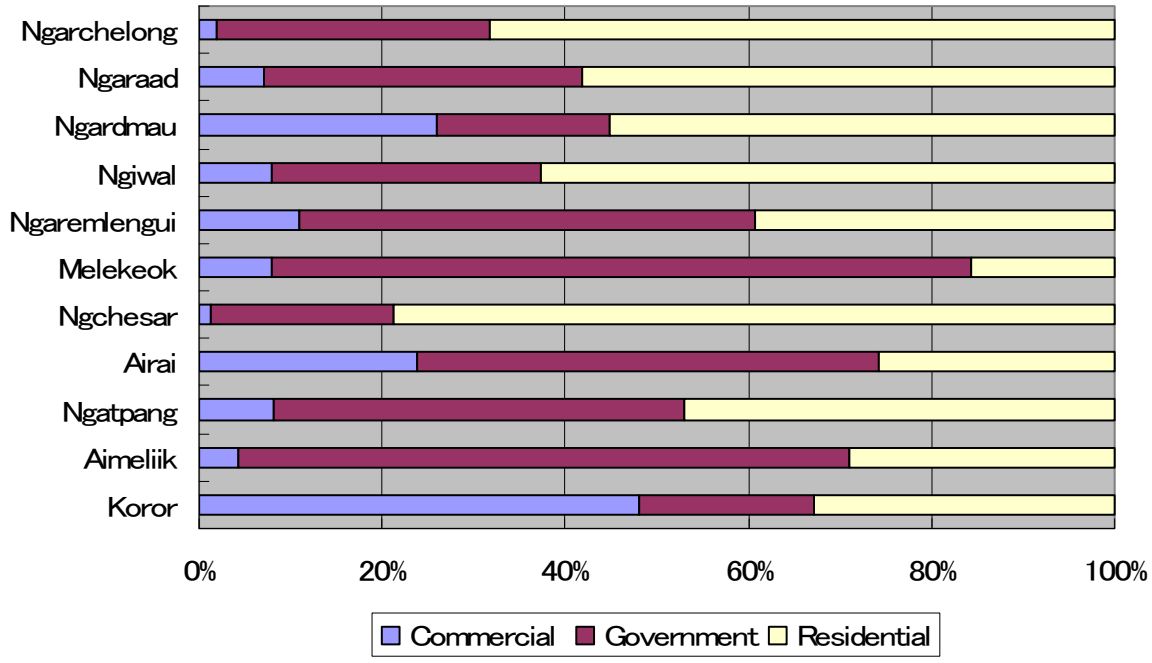


Fig. 2.3.1-3 Share of the Power Demand by Type of User in Each State (FY 2007)

2.3.2 Power Supply Capacity

In Palau, the successive breaking down of four generating units, i.e. Wartsila-2, Wartsila-3, Mitsubishi-12 and Mitsubishi-13, at the Malakal Power Station in 2006 made it necessary to introduce planned outages for eight hours a day in August, 2006. This situation lasted until mid-September when leased emergency power generators (four units with a total generating capacity of 3.68 MW) arrived in Palau, gravely affecting the society and economy of Palau. In

November of the same year, two emergency power generators with a combined generating capacity of some 2 MW commenced operation while the operation of the Mitsubishi-1 and Mitsubishi-2 units recommenced in November, 2006 and January, 2007 after the completion of their repair. As a result, the supply capacity at the end of FY 2007, including that provided by the Aimeliik Power Station, stands at 19.6 MW.

Table 2.3.2-1 shows the maximum monthly power output of the Malakal and Aimeliik Power Stations from FY 1998 to FY 2007. According to this table, the highest monthly output in the last year was 15.6 MW, 63% of which came from the Malakal Power Station. The highest ever output of 16.88 MW was recorded in November, 2004 (FY 2005), indicating a reserve supply capacity of 13.8% at present. However, as there is concern that many of the generating units will break down because of their state of deterioration, the swift repair of the Wartsila-2 and Wartsila-3 units, the operation of which is currently suspended, and the installation of new generating units are urgently required. There is a prospect of the recommissioning of the Wartsila-3 unit with an output of around 1.7 MW in the near future as it is presently awaiting the delivery of spare parts. In the case of the Wartsila-2 unit, there is no clear prospect of its recommissioning as its repairability must firstly be evaluated.

The PPUC has a plan to purchase one 5 MW class diesel engine generator which will be used to meet the base load. This EPC (Engineering, Procurement and Construction) contract negotiation is in its final stage and the Aimeliik Power Station is expected to have additional power generating capacity in 2010 provided that the installation work smoothly progresses. With this new unit, the total available capacity will increase to some 26 MW in 2009. Meanwhile, the present reality is that many of the generating units are liable to breakdown at any time and it is impossible to develop reserve power to allow the stoppage of some generating units for periodic inspection. In short, all of the existing generating units face harsh operating conditions.

When a generating unit does break down, the following large users with a private power generator are requested to switch to their own power generator as an emergency load reduction measure (even though this emergency load reduction is a request to users and is not based on the agreed power supply contract).

Table 2.3.2-2 Subject Users for Emergency Load Reduction Request

User	No. and Rated Output of Power Generator in Possession
Hotel A	1,830 kW x 1
Hotel B	200 kW x 2
Hotel C	750 kW x 2
Large Store A	500 kW x 1
Large Store B	125 kW x 2
Fish Processing Plant A	500 kW x 2
Fish Processing Plant B	500 kW x 1
Total	5,855 kW (10 units)

Source: PPUC

Table 2.3.2-1 Maximum Monthly Power Output of the Malakal and Aimeliik Power Stations from FY 1998 to FY 2007

Month	1998			1999			2000			2001			2002		
	Malakal	Aimeliik	Total	Malakal	Aimeliik	Total	Malakal	Aimeliik	Total	Malakal	Aimeliik	Total	Malakal	Aimeliik	Total
Oct	4,435	8,753	13,188	7,520	6,600	14,120	6,800	7,730	14,530	9,600	6,000	15,600	8,640	6,410	15,050
Nov	4,696	8,904	13,600	6,180	7,970	14,150	8,800	5,950	14,750	9,200	6,375	15,575	8,300	7,500	**15,800**
Dec	5,991	7,001	12,992	7,550	6,720	14,270	9,300	5,810	15,110	8,300	7,350	15,650	9,550	5,850	15,400
Jan	6,040	6,840	12,880	6,800	6,900	13,700	8,320	6,330	14,650	7,620	8,150	**15,770**	8,400	6,800	15,200
Feb	6,260	7,940	**14,200**	9,500	4,130	13,630	8,200	6,770	14,970	7,700	7,260	14,960	8,900	6,500	15,400
Mar	10,450	2,260	12,710	6,460	7,490	13,950	8,100	6,970	15,070	8,200	7,470	15,670	8,400	6,810	15,210
Apr	6,550	5,950	12,500	7,460	6,590	14,050	9,400	5,400	14,800	9,800	5,890	15,690	8,650	6,400	15,050
May	6,420	6,420	12,840	6,220	7,720	13,940	8,000	6,875	14,875	8,800	6,900	15,700	7,800	7,600	15,400
Jun	8,850	4,150	13,000	8,100	5,675	13,775	7,800	7,000	14,800	8,300	6,800	15,100	7,460	7,040	14,500
Jul	6,858	6,502	13,360	9,400	4,010	13,410	7,800	6,750	14,550	9,300	5,486	14,786	9,600	5,300	14,900
Aug	8,730	4,670	13,400	8,435	5,765	14,200	7,786	7,014	14,800	8,050	7,050	15,100	9,800	4,995	14,795
Sep	7,140	6,960	14,100	8,300	6,320	**14,620**	9,120	6,420	**15,540**	8,300	6,725	15,025	9,800	5,250	15,050

Month	2003			2004			2005			2006			2007		
	Malakal	Aimeliik	Total	Malakal	Aimeliik	Total	Malakal	Aimeliik	Total	Malakal	Aimeliik	Total	Malakal	Aimeliik	Total
Oct	8,700	6,475	15,175	9,760	6,040	15,800	10,260	5,825	16,085	10,460	5,300	**15,760**	8,327	5,923	14,250
Nov	8,460	7,085	**15,545**	8,800	6,600	15,400	7,860	9,020	**16,880**	10,660	4,825	15,485	8,264	6,238	14,502
Dec	9,260	6,280	15,540	9,800	5,725	15,525	9,860	6,800	16,660	9,060	6,700	**15,760**	7,947	7,678	15,625
Jan	8,860	6,200	15,060	10,260	5,150	15,410	8,860	7,050	15,910	8,720	6,400	15,120	9,914	4,626	14,540
Feb	9,460	5,240	14,700	10,660	4,675	15,335	9,340	6,520	15,860	8,520	6,720	15,240	9,547	5,286	14,833
Mar	9,460	5,975	15,435	10,960	4,750	15,710	9,720	6,280	16,000	8,520	6,200	14,720	8,802	5,625	14,427
Apr	9,360	6,085	15,445	10,520	5,200	15,720	9,120	6,875	15,995	6,400	8,340	14,740	9,842	5,739	**15,581**
May	10,060	5,240	15,300	10,800	5,100	**15,900**	10,620	4,860	15,480	7,210	7,850	15,060	9,260	5,355	14,615
Jun	9,800	4,900	14,700	9,600	5,500	15,100	9,140	6,800	15,940	5,970	8,315	14,285	9,405	5,210	14,615
Jul	8,800	6,075	14,875	8,200	7,025	15,225	9,120	6,840	15,960	6,610	8,000	14,610	9,753	5,072	14,825
Aug	9,900	5,475	15,375	9,200	5,875	15,075	9,860	6,660	16,520	6,380	7,380	13,760	9,335	5,664	14,999
Sep	10,800	4,275	15,075	9,800	5,935	15,735	10,060	5,800	15,860	1,863	11,987	13,850	9,522	5,270	14,792

Source: Power Generation Division, PPUC (Jan. 19, 2008)

Remarks: ▭ means the highest peak demand in each year.

2.3.3 Load Characteristics of the Koror-Babeldaob Power System

Using demand data, power generation data and the maximum generating-end output, Table 2.3.3-1 shows the calculation results for the power loss and load factor. The total power loss, including the power station service load, transmission and distribution losses, streetlight load and non-technical loss, is approximately 20%. As the corresponding figure was some 25% 10 years ago, a trend of improvement can be observed. The PPUC has been replacing the existing wire of distribution lines with larger sized one. It is assumed that the replacement has contributed to the loss reduction.

The load factor is approximately 73 – 74%. As shown in Table 2.3.3-2, the load factor in industrialised countries is less than 70% except in Germany and the load factor in Southeast Asian countries is commonly around 70%. Compared to these countries, the calculated load factor for Palau cannot be described as low, suggesting a relatively high level of facility utilisation. Fig. 2.3.3-1 shows recent daily load curves (changes of the generating-end output) for weekdays, Saturdays and Sundays. The peak load is observed in the evening, indicating that the type of power load in Palau is a typical civilian-led power load where the lighting load plays the central role. The load curve by day shows the beginning of a load increase at around 9 o'clock in the morning on weekdays and Saturdays, suggesting an increase of the load at offices and commercial premises, etc. On Sunday, the overall demand is some 10% lower than on other day of the week and the daytime load is relatively flat.

As there is no major factory load in Palau, other load sources are inferred to be air-conditioning unit and refrigerators, etc. at homes, offices and commercial premises. More detailed examination results of the load configuration are described later in 4.1.3.3.

Table 2.3.3-2 Load Factor by Country

(Unit: %)

Japan	Germany	France	UK	US
60.7 (summer peak)	77.2 (winter peak)	66.4 (winter peak)	67.0 (winter peak)	59.7 (summer peak)

Source: Agency for Natural Resources and Energy, FY 2006 Annual Energy Report

Table 2.3.3-1 Recent Power Demand, Power Loss and Load Factor

Fiscal Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Demand Energy (kWh)												
Commercial	26,422,246	33,017,210	26,769,270	29,483,478	30,392,903	30,688,750	33,723,849	32,796,070	33,748,781	37,449,226	30,653,677	32,639,230
Percentage of Total Load (%)	44.69	51.03	41.51	41.81	41.57	42.01	41.47	40.75	40.35	46.30	39.55	40.58
Annual Growth (%)		24.96	-18.92	10.14	3.08	0.97	9.89	-2.75	2.90	10.96	-18.15	6.48
Government	12,615,242	10,499,839	15,697,239	16,839,652	17,693,798	9,765,138	3,984,742	3,867,868	4,315,360	4,388,606	4,446,414	3,963,094
Percentage of Total Load (%)	21.34	16.23	24.34	23.88	24.20	13.37	4.90	4.81	5.16	5.43	5.74	4.93
Annual Growth (%)		-16.77	49.50	7.28	5.07	-44.81	-59.19	-2.93	11.57	1.70	1.32	-10.87
Republic of Palau	-	-	-	-	-	7,716,445	15,339,571	15,916,254	16,435,941	16,951,698	16,975,577	18,187,367
Percentage of Total Load (%)	-	-	-	-	-	10.56	18.86	19.78	19.65	20.96	21.90	22.61
Annual Growth (%)							98.79	3.76	3.27	3.14	0.14	7.14
Residential	20,089,675	21,188,610	22,024,319	24,187,684	25,021,904	24,886,334	28,266,801	27,897,780	29,136,605	22,097,084	25,427,909	25,639,272
Percentage of Total Load (%)	33.98	32.75	34.15	34.30	34.23	34.06	34.76	34.67	34.84	27.32	32.81	31.88
Annual Growth (%)		5.47	3.94	9.82	3.45	-0.54	13.58	-1.31	4.44	-24.16	15.07	0.83
Total	59,127,163	64,705,659	64,490,828	70,510,814	73,108,605	73,056,667	81,314,963	80,477,972	83,636,687	80,886,614	77,503,577	80,428,963
Annual Growth (%)		9.43	-0.33	9.33	3.68	-0.07	11.30	-1.03	3.92	-3.29	-4.18	3.77
Generated Energy (kWh)												
Malakal	15,644,085	20,905,210	33,921,033	38,180,031	41,824,933	54,396,353	55,572,481	57,701,414	59,572,796	59,004,032	47,745,176	52,215,115
Aimeliik	63,557,350	61,449,151	53,370,760	55,856,498	58,598,880	47,816,400	45,812,820	44,432,510	46,314,980	50,920,130	51,766,840	40,489,590
Total	79,201,435	82,354,361	87,291,793	94,036,529	100,423,813	102,212,753	101,385,301	102,133,924	105,887,776	109,924,162	99,512,016	92,704,705
Loss (kWh)	20,074,272	17,648,702	22,800,965	23,525,715	27,315,208	29,156,086	20,070,338	21,655,952	22,251,089	29,037,548	22,008,439	12,275,742
Percentage of Generated Energy	25.35	21.43	26.12	25.02	27.20	28.52	19.80	21.20	21.01	26.42	22.12	13.24
Peak Generated Power (kW)	N/A	N/A	N/A	N/A	15,540	15,770	15,800	15,545	15,900	16,880	15,760	15,581
Annual Growth (%)						1.48	0.19	-1.61	2.28	6.16	-6.64	-1.14
Load Factor (%)	-	-	-	-	73.77	73.99	73.25	75.00	76.02	74.34	72.08	67.92
Peak Demand (kW)	-	-	-	-	11,313	11,272	12,672	12,249	12,559	12,421	12,274	13,518
Annual Growth (%)						-0.37	12.43	-3.34	2.53	-1.10	-1.18	10.13
Firm Capacity (kW)					19,500	19,500	19,500	19,500	19,500	19,500	9,700	19,600
Malakal					11,500	11,500	11,500	11,500	11,500	11,500	1,700	11,600
Aimeliik					8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Reserve Margin (kW)					8,187	8,228	6,828	7,251	6,941	7,079	-2,574	6,082
Percentage of Firm Capacity (%)					42%	42%	35%	37%	36%	36%	-27%	31%

Source:
*1 Power Demand from FY1996 to 1999: Republic of Palau 2000 Statistical Year Book
*2 Power Demand from FY2000 to 2007: PPUC
*3 Generated Energy from FY1996 to 1999: Republic of Palau 2000 Statistical Year Book
*4 Generated Energy from FY2000 to 2007: PPUC
*5 Peak Generated Power: PPUC

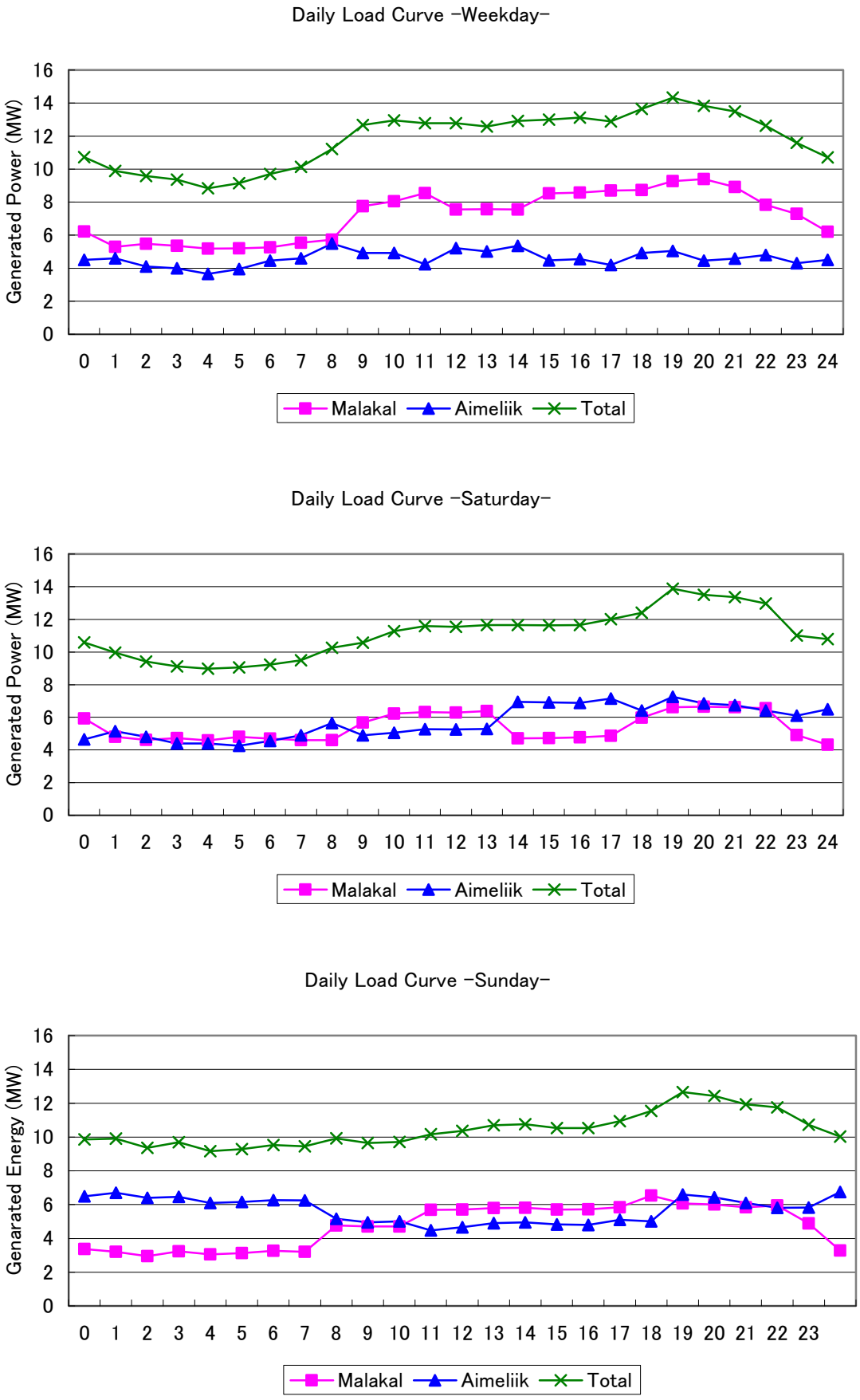


Fig. 2.3.3-1 Daily Load Curves on weekday, Saturday and Sunday

2.4 Present Conditions of Power Generating Facilities and the Power Supply System

2.4.1 Conditions of Power Generating Facilities

The Koror-Babeldaob power system is served by two power stations, i.e. Malakal Power Station on Koror Island and Aimeliik Power Station on Babeldaob Island. Both power stations employ a diesel power generating system using diesel oil as the fuel. Table 2.4.1-1 outlines these two power stations. With deterioration due to age, the available power generating capacity of each station has been declining. As of April, 2008, the total available output of the two power stations is 19.6 MW which is approximately 64% of the total rated output. Table 2.4.1-2 shows the present conditions of the generating facilities at these two power stations.

Table 2.4.1-1 Generating Facilities of the PPUC
(for the Koror-Babeldaob Power System)

Power Station	Unit	Manufacturer	Rated Output (MW)	Available Output (MW)	No. of Cylinders	Engine Speed	Year of Installation
Aimeliik	Pielstick-2	Crossely Pielstick	3.27	2.0	10	450 rpm	1986
	Pielstick-3		3.27	2.0	10	450 rpm	1986
	Pielstick-4		3.27	2.0	10	450 rpm	1986
	Pielstick-5		3.27	2.0	10	450 rpm	1986
Sub-Total			13.08	8.0			
Malakal	Wartsila-1	Wartsila	2.00	1.7	12	1,200 rpm	1998
	Wartsila-2		2.00	(1.7)	12	1,200 rpm	1998
	Wartsila-3		2.00	(1.7)	12	1,200 rpm	1998
	Mitsubishi-12	Mitsubishi	3.40	3.2	12	720 rpm	1998
	Mitsubishi-13		3.40	3.0	12	720 rpm	1998
	Caterpillar-1	Caterpillar	1.825	1.6	16	1,800 rpm	2006
	Caterpillar-2		1,825	1.6	16	1,800 rpm	2006
	Alco-9	Alco	1.25	0.5	n/a	n/a	n/a
Sub-Total			17.70	11.6			
Total			30.78	19.6			

Source: PPUC

Table 2.4.1-2 Present Conditions of the PPUC's Generating Units
(for the Koror-Babeldaob Power System)

Power Station	Unit	Accumulated Operating Hours*	Operability	Present Conditions
Aimeliik	Pielstick-2	128,860	Operable	• Noticeable decline of the output and efficiency due to severe deterioration • Scheduled for rehabilitation in FY 2008
	Pielstick-3	122,359	Operable	• Noticeable decline of the output and efficiency due to severe deterioration • Under rehabilitation since February, 2008
	Pielstick-4	134,584	Operable	• Noticeable decline of the output and efficiency due to severe deterioration • Scheduled for rehabilitation in 2009 or later
	Pielstick-5	132,149	Operable	• As above
Malakal	Wartsila-1	59,587	Operable	
	Wartsila-2	n/a	Inoperable	• Operation suspended due to burning of the crank shaft • Scheduled for repair of the crank shaft after FY 2009
	Wartsila-3	n/a	Inoperable	• Scheduled for repair of the crank shaft in June, 2008
	Mitsubishi-12	69,177	Operable	• Light burning of the crank shaft in August, 2006 and repair work to grind the crank shaft completed
	Mitsubishi-13	63,386	Operable	• Heavy burning of the crank shaft in March, 2006 and repair work to grind the crank shaft completed
	Caterpillar-1	4,358	Operable	
	Caterpillar-2	4,379	Operable	
	Alco-9	35,207	Operable (stand-by)	• Noticeable decline of the output and efficiency due to severe deterioration

* As of the end of January, 2008
Source: PPUC

Table 2.4.1-3 shows the operation results for the Aimeliik and Malakal Power Stations for FY 2007 (from October, 2006 to September, 2007). Six generating units, i.e. Pielstick-2 through Pielstick-5 at the Aimeliik Power Station and Mitsubishi-12 and Mitsubishi-13 at the Malakal Power Station, are operated to cater for the base load and their utilisation factor of 43 – 82% is high. Meanwhile, Wartsila-1, Caterpillar-1 and Caterpillar-2 at the Malakal Power Station are operated to cater for the peak load while Alco-9 at the Malakal Power Station is used as a stand-by generating unit. The fuel efficiency (electric energy generated per gallon of fuel) at the Aimeliik Power Station (average of 13.29 kWh/gallon) is lower than that at the Malakal Power Station (average of 14.61 kWh/gallon). Compared to the most efficient generating unit, i.e. Mitsubishi-12, an extra some 11% of fuel is used at the Aimeliik Power Station to produce the same quantity of electric energy.

Table 2.4.1-3 Operating State of the PPUC's Generating Units
(October, 2006 – September, 2007)

Power Station	Unit	Available Capacity*1 (kW)	Generated Power*2 (kWh)	Fuel Cosumed*3 (gallon)	Utilization Factor*4 (%)	Fuel Efficiency*5 (kWh/gal)
Aimeillk	Pielstic-2	2,000	10,367,600	781,381	59.18%	13.27
	Pielstic-3	2,000	7,456,720	559,270	42.56%	13.33
	Pielstic-4	2,000	12,100,990	912,113	69.07%	13.27
	Pielstic-5	2,000	13,941,350	1,048,153	79.57%	13.30
	Total	**8,000**	**43,866,660**	**3,300,917**	**62.60%**	**13.29**
Malakal	Wartsila-1	1,700	1,783,079	129,358	11.97%	13.78
	Wartsila-2	(1,700)	n/a	n/a		
	Wartsila-3	(1,700)	n/a	n/a		
	Mitsubishi-12	3,200	23,078,214	1,541,572	82.33%	14.97
	Mitsubishi-13	3,000	16,772,954	1,210,313	63.82%	13.86
	Caterpillar-1	1,600	3,614,050	224,213	25.79%	16.12
	Caterpillar-2	1,600	3,500,038	228,989	24.97%	15.28
	Alco-9	500	82,411	8,722	1.88%	9.45
	Total	**11,600**	**48,830,746**	**3,343,167**	**48.05%**	**14.61**
Aimeillk and Malakal		**19,600**	**92,697,406**	**6,644,084**	**53.99%**	**13.95**

[Remarks] *5=*2/*3 *4=*2/(*1x8,760)
[Source] PPUC

Table 2.4.1-4 shows the history of the main inspections and repairs at the Aimeliik and Malakal Power Stations. In the case of the Aimeliik Power Station, a major overhaul has been conducted only three times for each generating unit in their operating period of 22 years. Although the equipment manufacturers recommend periodic inspection every 1,000 hours, 3,000 hours, 6,000 hours and 12,000 hours of operation between major overhauls, these inspections are seldom conducted.

In the case of Malakal Power Station, after the commissioning of the Mitsubishi-12 and Mitsubishi-13 generating units, periodic inspection was initially conducted very 2,500 – 5,000 operating hours but failed to be conducted after the major overhaul in April, 2003 of the No. 12 unit and the 7,500 hours overhaul in November, 2004 of the No. 13 unit, resulting in burning of the crank shaft of both units in 2006.

The lack of proper periodic inspection as recommended by the manufacturers has resulted in the stoppage of various generating units of the PPUC due to sudden breakdowns. To improve the situation, the PPUC is formulating a periodic inspection programme based on the forecast operating hours and is implementing a policy of ordering the required parts for inspection in advance. When these measures are properly implemented, there should be a substantial decline of the number of sudden equipment breakdowns.

Table 2.4.1-4 History of Major Inspections and Repairs of the PPUC's Generating Units

Power Station	Generating Unit	Year of Installation	Major Inspection/Repair
Aimeliik	Pielstick-2	1986	October, 1993: first major overhaul was conducted March, 1998: second major overhaul was conducted January, 2004: third major overhaul was conducted
	Pielstick-3	1986	August, 1996: first major overhaul was conducted August, 2002: second major overhaul was conducted July, 2007: third major overhaul was conducted
	Pielstick-4	1986	August, 1995: first major overhaul was conducted December, 2000: second major overhaul was conducted October, 2005: third major overhaul was conducted
	Pielstick-5	1986	August, 1995: first major overhaul was conducted July, 1999: second major overhaul was conducted August, 2005: third major overhaul was conducted
Malakal	Wartsila-1	1998	• The lubricating oil, fuel and turbo charger filters have been replaced every 1,000 hours of operation.
	Wartsila-2	1998	• The lubricating oil, fuel and turbo charger filters were replaced every 1,000 hours of operation. • Operation was suspended in May, 2006 due to burning of the crank shaft.
	Wartsila-3	1998	• The lubricating oil, fuel and turbo charger filter were replaced every 1,000 hours of operation. • Operation was suspended in August, 2006 due to burning of the crank shaft.
	Mitsubishi-12	1998	September, 1998: 2,500 hours overhaul was conducted October, 1999: 7,500 hours overhaul was conducted May, 2000: 10,000 hours overhaul was conducted January, 2001: 12,500 hours overhaul was conducted August, 2001: 12,500 hours overhaul was conducted February, 2002: 17,500 hours overhaul was conducted April, 2003: major overhaul was conducted August, 2006: operation was suspended due to burning of the crank shaft October, 2006: repair of the crank shaft was completed and operation recommenced May, 2007: major overhaul was conducted September, 2007: 7,500 hours overhaul was conducted
	Mitsubishi-13	1998	September, 1998: 2,500 hours overhaul was conducted June, 2000: 10,000 hours overhaul was conducted July, 2001: 15,000 hours overhaul was conducted December, 2003: 30,000 hours overhaul was conducted November, 2004: 7,500 hours overhaul was conducted March, 2006: operation was suspended due to burning of the crank shaft January, 2007: repair of the crank shaft was completed and operation recommenced January, 2008: major overhaul was conducted
	Caterpillar-1	2006	No maintenance manual (not yet received)
	Caterpillar-2	2006	No maintenance manual (not yet received)
	Alco-9	n/a	-

Source: PPUC

2.4.2 Conditions of Transmission and Distribution Facilities

2.4.2.1 Transmission and Distribution Lines

(1) Outline of Transmission and Distribution Lines

The transmission and distribution lines in Palau use 34.5 kV and 13.8 kV respectively with a three phase, four wire system, a frequency of 60 Hz and a multiple neutral grounding system. Table 2.4.2-1 outlines the transmission lines. The total distribution length is 195.1 km.

Table 2.4.2-1 List of Transmission Lines

Transmission Line	Voltage (kV)	No. of Lines	Length (km)
Aimeliik Power Plant – Nekken Substation	34.5	1	4.3
Nekken Substation – Kokusai Substation	34.5	1	8.8
Kokusai Substation – Ngaraard 2 Substation	34.5	1	38.8
Nekken Substation – Airai Substation	34.5	1	14.3
Malakal Power Plant – Airai Substation	34.5	1	9.2

Source: PPUC

(2) Supports

Concrete poles are the main supports used by both the 34.5 kV transmission lines and 13.8 kV distribution lines. In the case of the 34.5 kV transmission lines, steel pipe poles are used in view of workability at sites where access was difficult at the time of installation due to poor road conditions. In comparison, many wooden poles are used for the 13.8 kV distribution lines. In addition, there is little influence by the typhoon, so the accidents such as the support collapse have not occurred until now.

Regarding to supports used for transmission lines, concrete poles should be used considering environment (it is near the sea.), cost and PPUC's skill and experience. To reduce the cost, it is also considered that the PPUC purchases concrete poles from other suppliers. However some kinds of poles might not match with present accessories, such as cross-arms, due to the difference of specifications. In this case, total cost can be higher, so its specifications should be considered carefully.

There are different types of pole arrangement to serve 34.5 kV double circuit lines (between the Aimeliik Power Plant and the Nekken Substation: one towards the Airai Substation and the other towards the Kokusai Substation), 34.5 kV or 13.8 kV single circuit lines and 34.5 kV and 13.8 kV double circuit lines. Table 2.4.2-2 shows the composition of supports.

Table 2.4.2-2 Composition of Supports

Type of Support	Ratio (%)	
	34.5 kV	13.8 kV
Concrete Pole	70%	74%
Steel Pipe Pole	27%	7%
Wooden Pole	3%	19%

Source: PPUC

(3) Conductors

AAC 150 mm^2 conductors are used for the 34.5 kV transmission lines. Connection between Babeldaob Island and Koror Island is provided by submarine cable but the absence of any

design documents or installation records, etc. means that the type of this submarine cable is unclear.

For the 13.8 kV distribution lines, two types of conductor, i.e. AC 38 mm^2 and HDCC 38 mm^2, are used. AAC 150 mm^2 is also used at some sections, including Koror City and the section between the Kokusai Substation and Melekeok State. Between Babeldaob Island and Koror Island, submarine cable (two lines) is used as in the case of the transmission line but the type of cable is unclear. Table 2.4.2-3 lists the conductors used in Palau.

Table 2.4.2-3 Types of Conductors Used

Category	Cable Type	Size
34.5 kV Transmission Line	AAC Submarine cable	150 mm^2 Unclear
13.8 kV Distribution Line	AC HDCC AAC Submarine cable	38 mm^2 38 mm^2 150 mm^2 Unclear
Neutral Line (34.5 kV; 13.8 kV)	AC HDCC	38 mm^2 38 mm^2

(4) Insulators

The types of insulators used are line post insulators for straight pull poles and a combination of line post insulator and suspension insulators for angle poles. Table 2.4.2-4 lists the different types of insulators and their recommended use.

Table 2.4.2-4 List of Insulators

Category	Type of Pole for Use	Type of Insulator		
		LP 30	LP 10	250 mm Suspension Insulator
34.5 kV Transmission Line	Straight Pull	1	-	-
	Angle	1 or 2	-	4
13.8 kV Distribution Line	Straight Pull	-	1	-
	Angle	-	1 or 2	2

(5) Standard Span, Ground Clearance and Phase-to-Phase Distance

The transmission and distribution lines in Palau have been constructed with a standard span of 50 – 70 m. The minimum ground clearance and phase-to-phase distance are based on the relevant specifications under the National Electrical Safety Code of the US and adds a margin in consideration of an approach with the tree. Table 2.4.2-5 lists the requirements for the minimum ground clearance and phase-to-phase distance.

Table 2.4.2-5 Required Minimum Ground Clearance and Phase-to-Phase Distance

Category	Minimum Ground Clearance	Phase-to-Phase Distance
34.5 kV	6.4 m	1,190 mm
13.8 kV	6.1 m	825 m

(6) Maintenance, Management and Work

1) Maintenance

The early facilities were installed or constructed around 1985 and are now some 23

years old. Because of the lack of periodic facility inspection, some insulators appear to be covered with dust (Photo 3). The PPUC prepared a checklist for facilities in December, 2007 and has been implementing inspection based on this list since January, 2008. Although the supports do not show signs of deterioration, their serial numbers have been eradicated by rainwater, etc., creating an undesirable situation from the viewpoint of facility management (Photo 4).

The 34.5 kV submarine cable rises above ground near the KB Bridge using a concrete pole but there is also a cable of which the purpose of use is unclear near the live part (Koror side; Photo 5). The removal of this cable after a proper survey is advisable as it could cause an accident due to a flying object or contact with an animal or bird. Of the two available 13.8 kV submarine cable lines for distribution, only one line is currently used while the other is designated as a reserve line. While this reserve line is not connected to the overhead line on the Airai side, it is connected to the overhead line on the Koror side. Consequently, the reserve line is also charged and careful attention must be paid during inspection work or any other work involving the reserve line to avoid electric shock (Photo 6). According to PPUC's data, as for recent causes of accidents involving transmission or distribution lines, contact with trees occupies more than 20% of all accidents. Once an accident occurs, PPUC staff members visit the site in response to a report by a local resident to deal with the situation (two members are designated to conduct emergency response).

2) Management

Facility data is managed using the GIS (Geographic Information System). As the PPUC only possesses drawings, etc. prepared at the time of construction or installation, it is difficult to check the actual site condition based on the drawings which do not reflect the construction situation of Compact Road and the relocation of obstacles for the road.

3) Work

In principle, all transmission work and distribution work is directly conducted by the PPUC. For this reason, the PPUC owns four trucks mounted with an aerial work platform, two augers required for pole installation work and one crane, etc.

(7) Other

The PPUC has its own training facilities (Photo 7).
In Koror Island, newly construction of the transmission or distribution lines appears to be difficult as the existing lines traverse roads. It is, therefore, advisable to introduce conduit lines for the installation of underground cables when road work is necessary (Photo 8).
Photos (Transmission and Distribution Facilities)

Photo 1 34.5 kV transmission line between the Aimeliik Power Plant and the Nekken Substation

Photo 2 13.8 kV distribution line between the Kokusai Substation and Melekeok State

Photo 3 Insulator covered by dust

Photo 4 Deterioration of a support pole number plate

Photo 5 Rising section of submarine cable

Photo 6 Submarine cable (a 13.8 kV section)

Photo 7 Training facilities at the Malakal Power Plant

Photo 8 Transmission and distribution lines in Koror Island

2.4.2.2 Transforming Facilities

(1) Outline of Transforming Facilities

As shown in a separate paper entitled “Power System in Koror & Babeldaob”, there are 12 substations (including those on power plant premises). Only the Aimeliik Substation and the Malakal Power Plant have a circuit breaker for the transmission line (the Asahi Substation also has one, but that has been out of service because of failure. The PPUC is hoping to replace that with a Recloser because of cost considerations).

Fig. 2.4.2-1 Malakal Power Plant

Fig. 2.4.2-2 Asahi Substation
(circuit breaker for the transmission line)

Most of substations draw out only a single distribution line and only the Airai Substation and the Malakal Power Plant have a circuit breaker for the distribution line. Other substations used to have cut-out switches, but they are being replaced to reclosers recently.

Fig. 2.4.2-3 VCB
(with built-in switchgear)

Fig. 2.4.2-4 Cut-Out

Fig. 2.4.2-5 Recloser

The introduction of planned outages is difficult because of problems with the system configuration and it appears that periodic equipment inspection as recommended by the manufacturers has not been conducted (although the details are unclear because of the lack of inspection records). It is planned to overhaul (replacement of the insulating oil and some parts) the transformers at the Airai Substation and Aimeliik Substation in April, 2008 or thereafter. The 34.5 kV circuit breaker at the Malakal Power Plant is a gas circuit breaker manufactured by Mitsubishi Electric while those at the Aimeliik Substation and Airai Substation are oil circuit breakers manufactured by Inoue Seisakusho (the business of which has subsequently terminated). In Japan, the after-service business has been taken over by AREVA T & D They can accept an order from Palau.

(2) Substation Configuration

The Aimeliik Substation which is one of the main power supply facilities is situated next to the Aimeliik Power Plant. This substation is the only substation with a configuration of two transmission lines and two transformer banks. An oil circuit breaker is installed on the primary side of both the transmission line and transformer. A switchgear on the secondary side of the transformer is installed on the generator bus. No distribution line is drawn out. The substation is surrounded by perimeter fencing and the door is locked.

Fig. 2.4.2-6 Aimeliik Power Substation

The Malakal Power Station which is another power source consists of a transmission line and a transformer. For this reason, the circuit breaker for the transmission line also acts as the circuit breaker for the primary side of the transformer. There is perimeter fencing and the door is locked. Each of the two drawn out distribution lines has a circuit breaker.

Fig. 2.4.2-7 Malakal Power Plant (transforming facilities)

In the case of the Airai Substation from which the distribution line extends to Koror Island, an oil circuit breaker is installed on the primary side of the transformer but the transmission line (linking the Aimeliik Substation to the Malakal Power Plant) passing through the substation premises only has disconnecting switches. These switches cannot interrupt fault current. From this point this substation does not have the ability to divide the transmission line. The low

perimeter fencing requires improvement for public safety. A 13.8kV switchgear is installed in a building on the site and each of the two distribution lines is provided with a circuit breaker.

Fig. 2.4.2-8 Airai Substation (panoramic view)

Fig. 2.4.2-9 Airai Substation (building)

At the other existing substations, the standard configuration is the connection of the transmission and distribution lines via a cut-out to a pole-mounted transformer (except at the Kokusai Substation and the Aimeliik-1 Substation where the transformer is placed on the ground with perimeter fencing with a lock). Even where the distribution line branches out in two directions, there is only one cut-out on the secondary side of the transformer. While the manual operating device of the transmission line disconnecting switch is lowered to ground level, it is not protected by a lock. At those places where a recloser is installed for the distribution line, its state of opening and closing can be monitored by power plant operators (or controlled from the Malakal Power Plant). The pole-mounted transformer acts as the source of house power supply and each equipment (disconnecting switch, recloser and communication device) has a built-in battery and charger.

Fig. 2.4.2-10 Nekken Substation (panoramic view)

Fig. 2.4.2-11 Kokusai Substation (Recloser Control box)

(3) Switching Devices (Air Insulation)

34.5 kV oil circuit breakers manufactured by Inoue Seisakusho are used but their conditions are far from ideal as many traces of oil leakage are observed. Apart from the common practice of using a switchgear or Gas Insulated Switchgear instead of an oil circuit breaker, the fact that Inoue Seisakusho has stopped trading means that it is difficult to procure not only parts for periodic inspection but also repair parts. At the Airai Substation, the height of the frame is dangerously low as evidenced by a serious accident involving the house-service transformer (protective fencing for the equipment is already installed).

Fig. 2.4.2-12 Airai Substation (Oil Circuit Breaker)

Fig. 2.4.2-13 Airai Substation (House-Service Transformer)

It is inferred that the existing disconnecting switches do not often experience (or at least appear to have not visibly produced) common problems relating to the control system as they are manually operated with few occasions for outages for maintenance work. With the load-break switches (only the load current is switchable) used for the transmission line linked to the pole-mounted transformer substations, the operating devices on the ground have no indications (name of the switch or caution to the public). As they are not locked up, there is a risk of unauthorised operation.

Fig. 2.4.2-14 LBS Control Box (no indications)

Fig. 2.4.2-15 LBS (not locked up)

(4) Switchgear

The 13.8 kV switchgear at the Malakal Power Plant has a simple roof but the top side of the switchgear is rusted. Even though the leakage of rainwater through the roof cannot be ascertained as being responsible for this rust, two circuit breakers for the distribution lines have already been replaced because of breakdown. At present, work is in progress to enclose the switchgear.

Fig. 2.4.2-16 Out-door Switchgear (outside)

Fig. 2.4.2-17 Out-door Switchgear (inside)

The switchgear at the Airai Substation is installed indoor and its condition is relatively good. However, it is installed so as to block the equipment delivery door, making any future use of this door impossible.

Fig. 2.4.2-18 In-door Switchgear

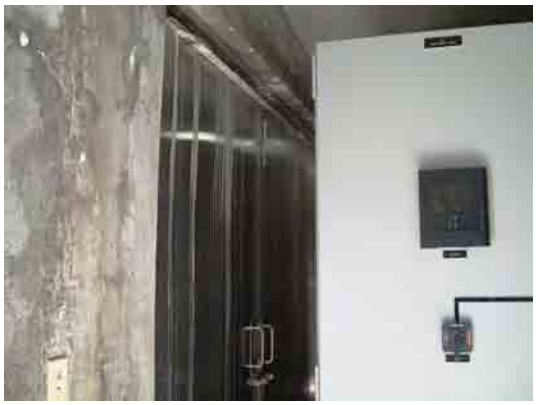


Fig. 2.4.2-19 Equipment Delivery Door

(5) Transformer Winding

The standard connection types for the transformer winding are a Y-connection (direct neutral grounding) for the 34.5 kV lines at power stations, Δ-connection for the primary side of the distribution transformers and Y-connection (direct neutral grounding) for the secondary side of the distribution transformers. However, the Malakal Power Station and the Airai Substation are exceptions. Fig. 2.4.2-20 shows a schematic diagram of the distribution system. Of the two distribution lines drawn out of the Airai Substation, that heading towards Koror Island

can be linked to the same Y-connection distribution line for the Malakal Power Plant. The other heading towards the airport cannot be linked live to the distribution lines from other substations on Babeldaob Island because of the different phase angle. However, as switching after an outage is possible, the only real problem is that uninterrupted switching to the normal system cannot be conducted when repair work at the site of an accident forcing reversed power supply from a neighbouring substation has been completed. Therefore, careful consideration of the type of transformer connection to be used at the planned Koror Substation is required.

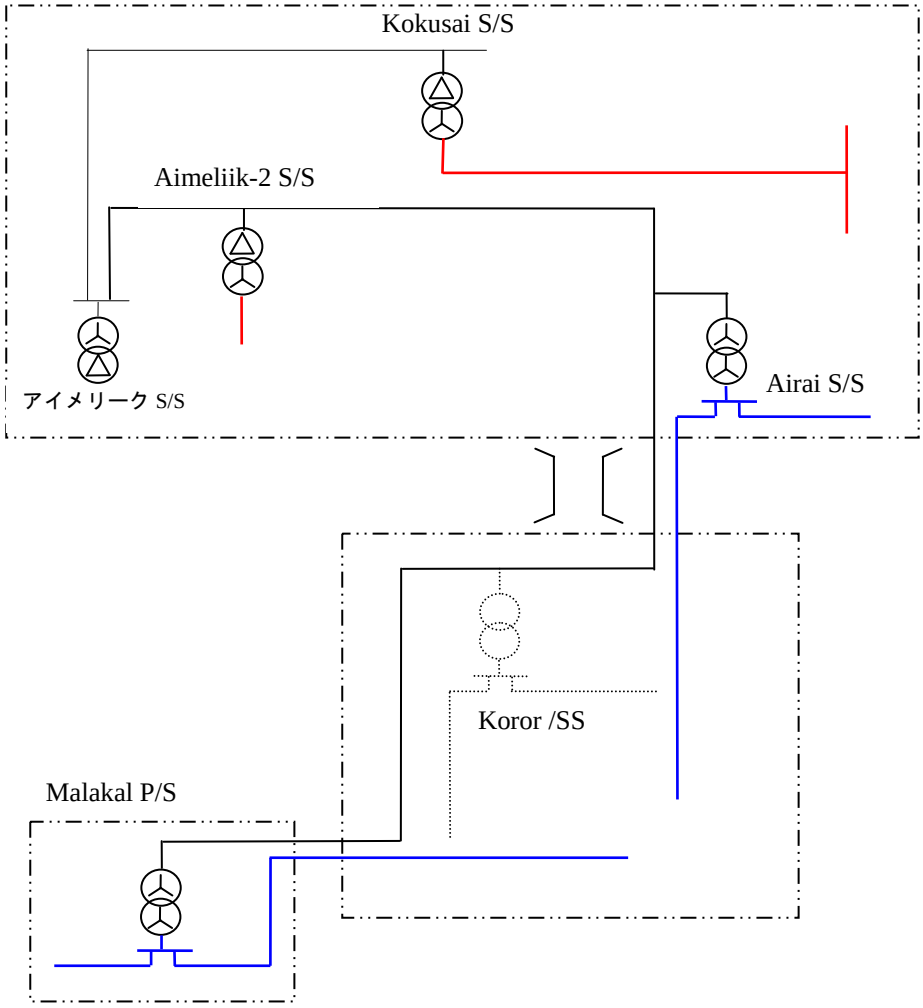


Fig. 2.4.2-20 Schematic Diagram of the Distribution System

2.4.2.3 SCADA

(1) General

The Supervisory Control And Data Acquisition (SCADA) currently used by the PPUC was introduced in 2003 and is primarily used to monitor the power generation and transforming facilities, presumably because of the unfamiliarity of the system to its operators who have not received sufficient training. Electric Power Systems (EPS) which supplied this SCADA system is refusing to supply a terminal (portable PC) and password required to settle and change the relay setting. Consequently, it is necessary for the PPUC to place an order to EPS

when ever a change of the protective relay setting is required and this situation makes the use of the system awkward.

(2) Hardware Configuration

The hardware configuration of the PPUC's SCADA system is shown in Fig. 2.4.2-21 (Communication Page of the SCADA System).

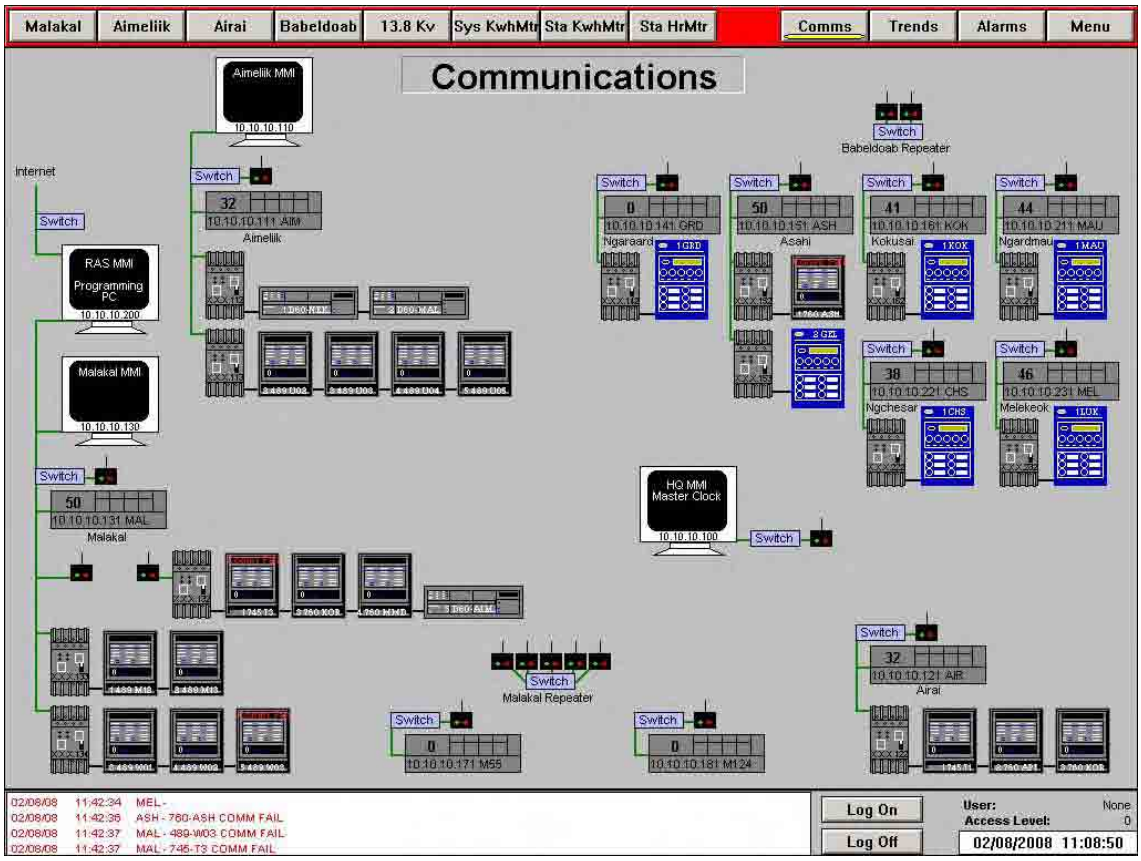


Fig. 2.4.2-21 Hardware Configuration of the SCADA System

There are four monitor symbols on this page which indicate the subject sites for monitoring and control. The monitor at the bottom right has not yet been installed. The one at the top is installed at the Aimeliik Power Plant and the two monitors shown on the left are installed at the Malakal Power Station. Because of the absence of a server, monitoring and control can be conducted by integrating a replacement PC to the LAN when the PC of the system breaks down. However, additional installation of monitoring terminals is not possible because the IP address is already determined.

A LAN is developed at each site (power plant or substation) which are linked to each other via radio. Fig. 2.4.2-22 shows the configuration of the communication system. The LAN at the Malakal Power Plant is connected to the Internet and EPS can have access to the SCADA system via the Internet when the system experiences problems. Because of the Internet connection, the security of the system is ensured by a firewall and gateway arrangements.

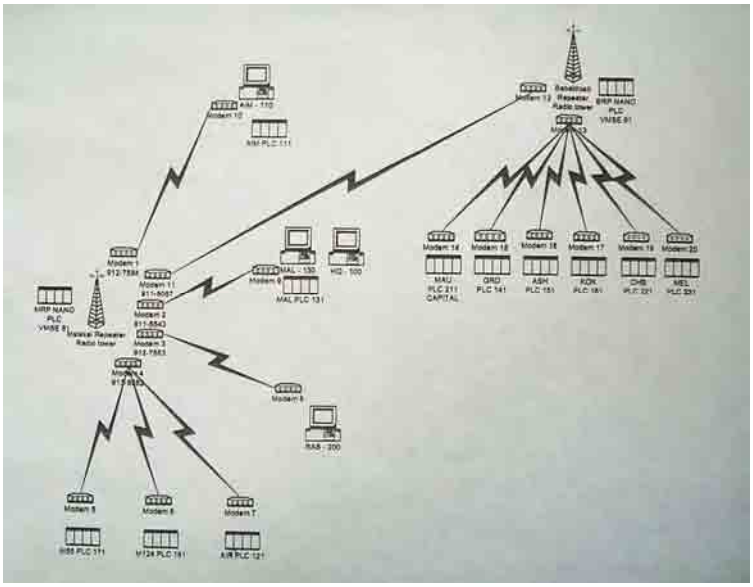


Fig. 2.4.2-22 Configuration of the Communication System

High performance digital protective relays (transformer management relays and others) are used as the terminals at the controlled sites. Fig. 2.4.2-23 shows an example of such protective relays. For the purpose of system and equipment protection, the connected analogue data (voltage and current elements) and state of the switches are transformed to digital data for output on the SCADA system. Some of the protective relays for the controlled equipment were replaced when the SCADA system was introduced.

Fig. 2.4.2-23 Example of Protective Relay

According to the results of interviews with PPUC engineers, different protective relays are used for the following purposes.

- SR489 (made by GE): for the protection of a generator
- SR760 (made by GE): for the protection of a distribution line
- SR745: for the protection of a transformer
- D60 (distance relay made by GE): for the protection of a transmission line

Some substations adopt recloser controllers (made by SEL) which include protective relays.

(3) Page Configuration

Although the monitoring system has a menu page, it is possible to jump from the list of stations at the tope of the overview page to the target page.

(Operating Status of Equipment)

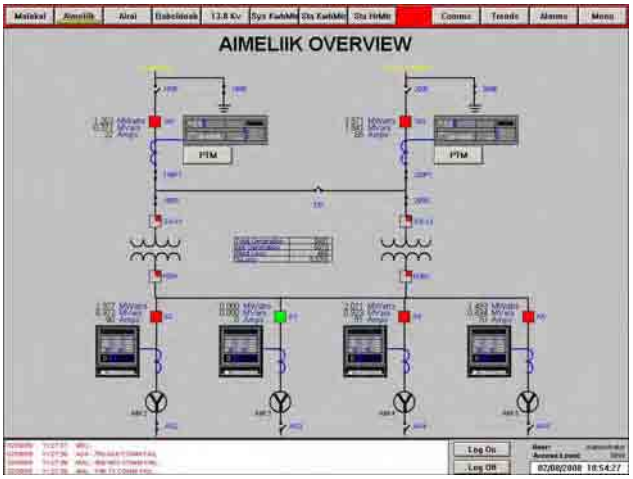


Fig. 2.4.2-24 Power Plant Overview Page

The protective relay panel can be displayed by clicking on the protective relay symbol on the overview page.

Fig. 2.4.2-25 Protective Relay Panel Page

The details are displayed by clicking on "DETAIL" button located in the bottom left-hand corner of the overview page.

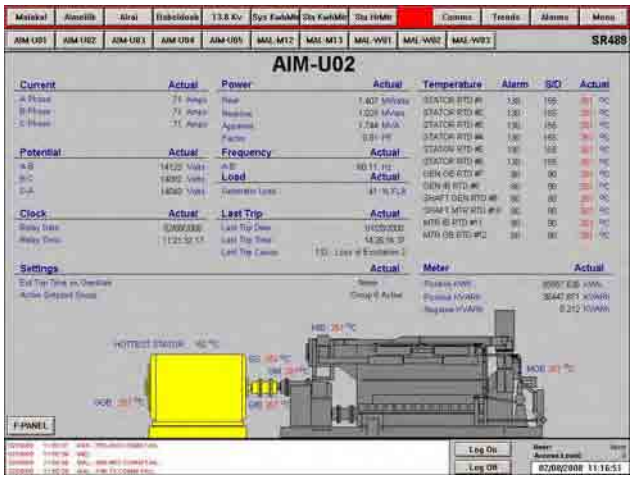


Fig. 2.4.2-26 Generator Detail Page

(4) Warning Display

Equipment breakdown information is displayed on the warning page as shown in Fig. 2.4.2-27.

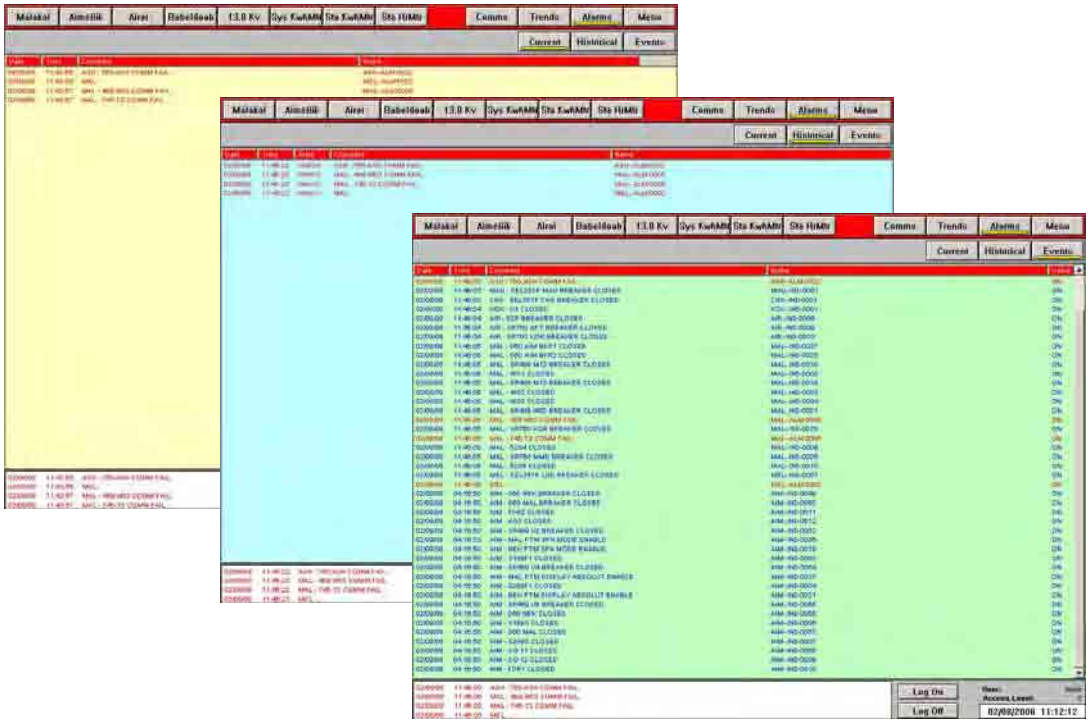


Fig. 2.4.2-27 Warning Page

(5) Operation Records

As shown in Fig. 2.4.2-28, it is possible to produce a graph using the trend display function and the span of such a graph is extremely short (just over one hour). It is necessary to change the entire set-up of the protective relay to change this span. Data cannot be retrieved outside and new data is over-written on old data in sequence. For this reason, the available old data is in the form of a print-out and is not used for analysis (because of the difficulty of doing so).

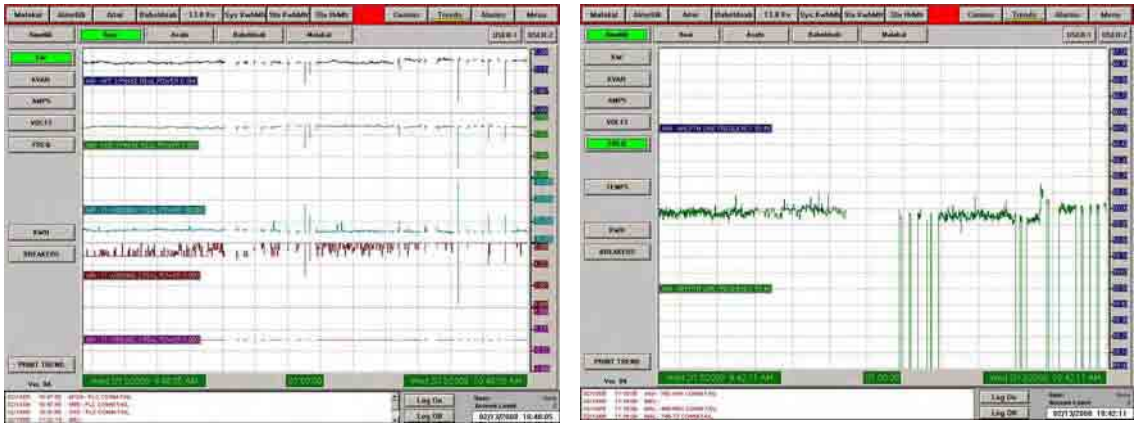


Fig. 2.4.2-28 Graph Created by the Trend Display Function

(6) Equipment Control

The power system is partially displayed on the pages featuring the two power plants, the Airai Substation, other 34.5 kV transmission lines and distribution lines (see Figs. 2.4.2-29 through 32). There is no single page displaying the entire system, making it difficult to quickly establish the operating status of the system. While it is possible to operate the substation circuit breakers from the Malakal Power Plant, the range of equipment which can be controlled in this manner is quite limited (CBs and some reclosers, etc.)

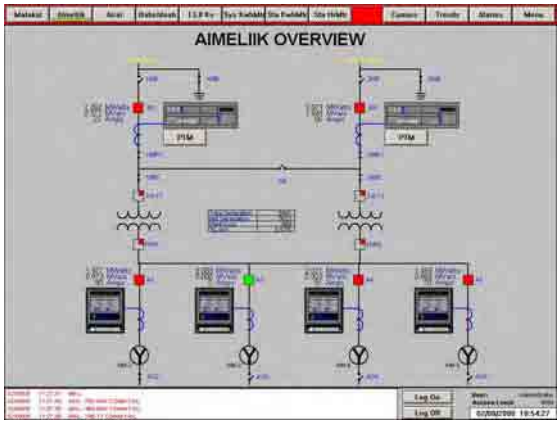


Fig. 2.4.2-29 Control Page (Power Plant)

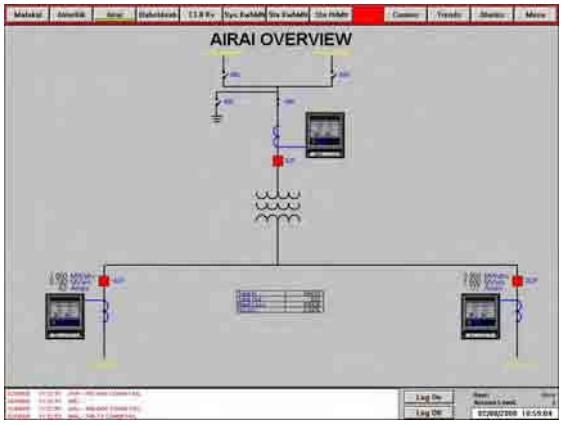


Fig. 2.4.2-30 Control Page (Substation)

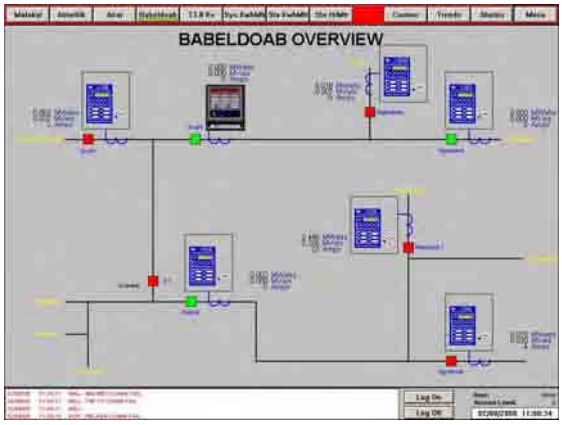


Fig. 2.4.2-31 Control Page (Transmission System)

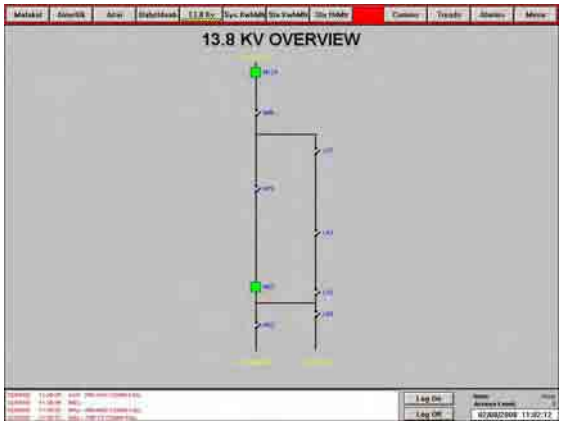


Fig. 2.4.2-32 Control Page (Distribution System)

2.5 Power Development Plans

Plans to improve or expand the power supply facilities have been formulated in Palau and the development of the power sector has been promoted under the development policy for the power sector set forth in the Palau 2020 National Development Plan (PNMDP) formulated in 1997. In October, 2003, a five year plan for the PPUC was prepared by Oceanic Companies (Marshalls), Inc., an American consultancy firm. This plan called the PPUC Strategic Plan 2003 – 2008 features a development plan for the power generation, transmission, distribution and substation facilities, calculation of the development cost, the necessary environmental and social considerations in the face of the planned development, a plan to revise the electricity tariff and other matters. The PPUC Strategic Plan is considered to be the power development plan in Palau and the principal goals, measures to achieve the goals and the present situation are described below.

Table 2.5-1 Goals, Measures and Present Situation described in PPUC Strategic Plan

No.	Goals	Measure(s) to Achieve the Goals	Present Situation
1	Measures to alleviate or deal with social and financial impacts, legal responsibilities, safety and risks to reduce the financial and physical liabilities faced by the PPUC	These measures are designed to urge the PPUC to apply the safety standards (NESC) set forth by the IEEE to its work and materials, to clarify the scope of responsibility of users for power equipment and to form teams to check user equipment while recommending the introduction of an insurance system.	Parts of the NESC are applied to the work.
2	Improvement of the efficiency of power generation at all levels, reduction of the unit power generation cost and arrangements to meet an increased demand in the future	(1) A new power station with four of the latest 5.3 MW generating units will be construction at Aimeliik to cater for the base load as well as the peak load on Koror and Babeldaob Islands. At the same time, a new remote monitoring and control system will be installed at either the Malakal Power Station or the Aimeliik Power Station. (2) Other targets at the Malakal Power Station are the rehabilitation of the existing generator building, facilitation of sound insulation work for the control room at the Malakal Power Station, installation of an information system capable of direct communication with the Aimeliik Power Station and installation of a seabed transmission line to link to the Aimeliik Power Station.	A SCADA system has been in operation since 2003 even though it lacks certain functions. The work to rehabilitate the existing building and to install sound insulation at the control room and an information system for direct communication with the Aimeliik Power Station has been completed.
3	Arrangements to meet the increased load and improvement of the reliability of the transmission, distribution and transforming facilities	(1) Construction of a new Koror substation and a seabed transmission line linking Aimeliik to the Malakal Power Station (2) Improvement of various transmission and distribution grids, including the transmission line to the new capital	
4	Verification of the demand increase by sector and establishment of a demand management option for each sector	(1) Establishment of a comprehensive method to clarify non-technical power loss and selection of a manager to be responsible for investigating the causes of such loss (2) Removal of the street lighting charge from bills for residential users and transfer of the charge to local public bodies (3) Prohibition of illegal connection and commencement of public notice of possible prosecution (4) Assessment of the use of pre-payment meter	(4) Some pre-payment meters are already in use (500 sets procured and 400 sets installed).

No.	Goals	Measure(s) to Achieve the Goals	Present Situation
		and commencement of their installation	
5	Establishment of a funding source(s) for the necessary investment in equipment	(1) Submission of a request for the necessary US$ 35 million loan to the US Department of Agriculture (2) Acceleration of the advance building-up of a reserve fund for capital increase as an option for the PPUC and efforts to increase the investment return for the listed goals and special improvements	
6	Improvement of the operation efficiency, management information system and education of human resources and establishment of their targets and result assessment criteria	Optimisation of the operating staff (1) Review of the manpower deployment plan to adapt to unmanned remote monitoring and control technologies with the introduced of an advanced SCADA system (2) Recruitment of a transmission and distribution manager (3) Adoption of the latest generalised information system and staff training (4) Formulation of a comprehensive management plan which centralises the implementation of all measures and necessary training (5) Establishment of productivity and reliability goals which can be specified and measured for each division. The management division must modify the programme every quarter based on the worsening or improving tendency of each division. (6) Establishment of a standardised monthly bulletin indicating the electric energy generated, fuel consumption and technical/non-technical power loss, etc. for the month for its submission to the GM and the Board	(2) A transmission and distribution manager has already been recruited.
7	Improvement of the PPUC's profit from the operating capital	(1) Analysis of the cost, future prospect and investment recovery rate to select 10 programmes (2) Selection of staff members to develop a detailed plan for confirmation of the cost and profit and boosting of the profit (3) Other	
8	Examination of a tariff capable of meeting all costs of the PPUC and ensuring present and future operation without a government subsidy	The employment of a specialist consultant who will set up a new electricity tariff designed to sustain the electricity supply service in the future is recommended.	A request has already been made to a specialist consultant to review the existing tariff (the draft report has been obtained).

As the above table shows, most of the proposed projects under the power generation, transmission, distribution and substation facilities development plan and the social and environmental consideration plan necessitated by the development and the plan to revise the electricity tariff, etc., all of which are proposed by the PPUC Strategic Plan 2003 – 2008, have not been implemented because of the lack of the necessary funding. In the case of the generating facilities, however, the installation of one 5 MW diesel engine generator at the Aimeliik Power Station is planned with a loan from Taiwan and negotiations with the Taiwanese company responsible for the procurement and installation of this generator are in progress. Commencement of the operation of this generator in 2010 is expected.

2.6 Potential of Primary and Renewable Energy in Palau

2.6.1 Endowment Situation of Primary Energies

The preliminary study report on oil and gas deposits in Palau compiled by the Oil and Gas Task Force (OGTF) in August, 2007 describes the endowment situation of such primary energies as oil and gas. The OGTF was established in February, 2007 based on Executive Order No. 241 and its nine members consist of two members appointed by the President, one member each appointed by the Senate and the House of Delegates, one member appointed by the Environmental Quality Protection Board (EQPB), two member appointed by the Chamber of Commerce and Industry (one from the tourism sector and the other from the fisheries sector) and two members appointed by the Governors' Association.

According to this report, the Government of Palau, the Government of Kayangel State and TBMR/Sharp Drilling, Inc. (based in Texas, USA) concluded an exclusive oil drilling agreement for the Velasco Reef sea area. (In fact, TBMR/Sharp Drilling, Inc. concluded a separate but identical agreement with the Government of Palau and the Government of Kayangel State and the sea area occupation fee paid by the oil drilling company is shared by these two governments.) The agreement was subsequently inherited by Palau Pacific Energy, Inc. (PPE) in 1997. So far, even trial drilling has not been conducted because of the absence of reliable seismic survey (geological survey of the seabed using elastic waves) data. Under the agreement, PPE was required to drill the first well within two years and a second well within three and a half years. PPE extended the agreement in 1997, 1998 and 2000 without commencing drilling work for the first well within two years of the signing of the agreement. Because of this, the Government of Palau abandoned the agreement with PPE in 2001 for the reason of default. Meanwhile, the Government of Kayangel State concluded an agreement lasting until 2011 and submitted two applications to the EQPB for permission for trial drilling in the Velasco Reef sea area, citing PPE as the drilling company. The drilling permits for these two applications have been on hold on the grounds that sufficient data has not been gathered to conduct an environmental impact assessment.

As the main industries in Palau, such as tourism and fisheries, rely on the rich marine resources, the Government of Palau has become more cautious in recent years regarding the development of oil. In February, 2003, a study team financed by the World Bank was dispatched to Palau to examine the feasibility of oil development in the Velasco Reef sea area. This study team visited Palau three times between February, 2003 and March, 2004 and concluded that both the Government of Palau and the Government of Kayangel State lack (i) legal as well as technical knowledge concerning oil development and (ii) proper consideration of the environmental aspects and that Palau was, in fact, at a very early stage of oil development. The study team found the urgent establishment of legal, institutional and financial systems regarding the awarding of oil drilling rights and the oil business and also technical standards to be necessary. Accordingly, the study team recommended the postponement of the awarding of new oil drilling rights. It also recommended that a geological survey be entrusted to a professional survey organization to obtain information on the potential of oil reserves in the Velasco Reef sea area because of the shortage of such information backed by geological studies.

In conclusion, no oil or gas has so far been produced in Palau and the potential reserves have not been sufficiently confirmed. In view of the fact that such leading industries in Palau as tourism and fisheries are highly dependent on marine resources, any development of oil or gas

businesses must be carefully conducted by studying the possible impacts, including trial drilling, on the environment in advance.

2.6.2 Potential of Renewable Energy in Palau

Renewable energies were originally introduced in Palau in the 1980's and the current situation of their use is shown in Table 2.6.2-1. 94% of Palau's total population is connected to the distribution grid of the PPUC and a photovoltaic power generation system is principally used on islands which are distant from Koror Island or Babeldaob Island along with an independent diesel power generation system from the PPUC's distribution grid. A photovoltaic power generation system is used by some people on Babeldaob Island which is fully covered by the distribution grid and on Kayangel Island where some diesel generators are used because of the fact that such a system doe not incur an additional cost unless repair of the system or battery replacement is required.

Table 2.6.2-1 Power Supply Sources Other Than the PPUC's Distribution Grid

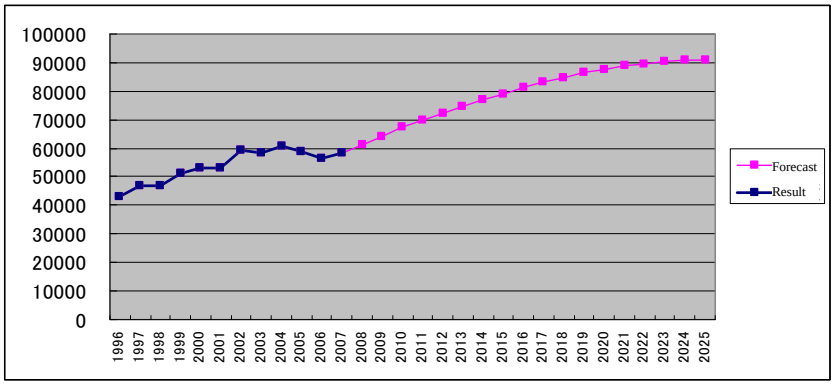
State	Independent Power Generator		No. of Photovoltaic Power Generation Panels
	kVA	Operating Hours	
Babeldaob			
Ngerchelog			3
Melekeok			4
Ngshesar			2
Airai			4
Ngeremlengui			1
Peliliu	500 x 1	12	
Angar	150 x 1	12	
Kayangel	35 x 1	6	30
Sonsorol			11
Hatohobei			14
Total	1,095		79

Source: JICA, Project Identification Study for Renewable Energy in Tonga, Tuvalu and Palau

In Palau, the Energy Office which is directly controlled by the Ministry of Resources and Development (MRD) is responsible for the planning of renewable energy policies in the coming years. According to the report published in February, 2007 for the project identification study for the present master plan, the Energy Office planned to formulate renewable energy policies for the future by mid-2007 but no concrete policies have yet been formulated as its insufficient manpower (the Energy Office is run by its head and one staff member) means that the analysis of past study reports and the gathering of topographical and meteorological data for the purpose of developing renewable energies have not been sufficiently conducted.

Palau participated in the Kyoto Protocol in December, 1999 as a non-Annex I party and numerical targets for the reduction of greenhouse gas emissions have not been imposed. An increase of CO_2 and other greenhouse gas emissions in developing countries where further development is sought to improve the standard of living is almost unavoidable. In fact, the CO_2 emission volume in Palau has substantially increased due to an increase of the oil consumption as shown in Fig. 2.6.2-1. However, Palau is classified in the category of small island developing countries (SID) which are believed to be the most liable to the effects of climate change as in the case of least developed countries (LDC) and it is important for Palau to clarify its own approach to the mitigation as well as adaptation to climate change to protect itself.

As already mentioned in 2.6.1, the oil used in Palau as a source of primary energy is entirely imported and the economic structure of Palau has, therefore, been prone to direct impacts of oil price hikes in recent years. In consideration of this situation, feasible renewable energies are examined through the first and second field surveys, keeping the need to reduce the emission of CO_2 and to alleviate the dependence on oil as a primary energy source through the introduction of renewable energies in mind.



Source: Calculated by the Study Team based on the power demand.

Fig. 2.6.2-1 CO_2 Emission (t-CO_2) by the Power Generation Sector in Palau

(1) Potential for Hydropower Generation

Palau is an island country and the number of river which can be used for hydropower generation is limited. There are two decisive indicators for the potential for hydropower generation, i.e. the effective head provided by a water source and the river surface discharge (river discharge minus the discharge through the ground). As the highest altitude on Babeldaob Island is around 100 m – 150 m, the effective head for the purpose of hydropower generation is inferred to be around 60 m. Vergel3 Consult of the Philippines conducted a survey in November, 2005 on the hydropower generation potential in Palau and selected three river systems, i.e. Diongradid, Ngermeskang and Ngrikill, as potential river systems for hydropower generation from the viewpoints of the retained water available in the river system and the effective head. It concluded that an inflow type hydropower generation system would not produce a sufficient output at any of these river systems in view of the low river discharge and insufficient effective head even if the length of the intake channel is sufficiently stretched. The report for this survey assessed the potential for hydropower generation based on the assumption that a medium to high class rock-fill or earth type dam would be constructed for hydropower generation with a maximum output of 1,000 kW using water from the reservoir. Table 2.6.2-2 shows the expected retained water volume, generator size and number of generators to be installed for each river system with the construction of a dam.

Table 2.6.2-2 Expected Scale of Hydropower Generation by River System

River System	Total Area of River System (km^2)	Catchment Area (km^2)	Surface Area of Reservoir (km^2)	Effective Head (m)	Retained Water Volume ($x10^6m^3$)	Generator Output (kW)	No. of Generators
Diongradid	21.37	9.00	1.73	83	30.02	1,000	2
Ngermeskang	80.73	11.99	1.88	33	33.19	1,000	1
Ngrikill	26.01	9.00	0.63	33	8.38	1,000	1

Source: Vergel3 Consult, Hydropower Potential Assessment Babeldaob Main Island

The survey team of Vergel3 Consult computed the data shown in Table 2.6.2-3 through Table 2.6.2-5 using river discharge data provided by the United States Geological Survey (USGS)

and the National Oceanographic and Atmospheric Administration (NOAA) of the US assuming a generating efficiency (η) of 0.87 (0.87 as the overall efficiency incorporating the turbine efficiency and generator efficiency). Judging from the computation results, some 10% of the estimated power demand of 125 GWh in 2025 by the survey team can be provided by the development of hydropower with three river systems. Vergel3 Consult concluded that a hydropower development plan involving three river systems would prove to be effective because of its effect on reducing the fuel cost for diesel power generation. Table 2.6.2-6 shows the expected reduction of the fuel consumption, fuel cost (based on the 2006 results) and CO_2 emission under such a plan. While the plan appears to be effective for such reduction, it is essential to verify the construction cost and financial capacity of the PPUC as the plan implementation body. As the construction of an embankment type dam assumed here does not assume any effort to maximise its economic efficiency by means of combination with other development plans, etc., a realistic estimate of the cost is essential. Even if such an estimate is conducted, the feasibility of the plan is believed to be low.

However, micro-hydropower generation with the range from 100 to 200 kW is highly possible in Palau because it has plenty of rainfall and a lot of small rivers and streams. Thus, possibility to introduce hydropower that is linked to other water resource development should be evaluated.

Table 2.6.2-3 Power Generation in the Diongradid River System

		River Flow to Reservoir	Total Rever Flow to Reservoir	Rain Fall to Reservoir	Evapolation from Reservoier	Total In-Flow to Reservoir	In-Flow to Generator	Total In-Flow to Generator	Total In-Flow to Reservoir during non-operation	Practical Output	Output	Running Hours of Gen.	Output per Month
	Days	m3/s	×10^6 m3/M	×10^6 m3/M	×10^6 m3/M	×10^6 m3/M	m3/s	×10^6 m3/M	×10^6 m3/M	kWh	kWh	Hours/day	GWh/M
Jan	31	0.71	1.90	0.49	0.16	2.22	1.69	3.02	0.63	1052	1000	16	0.50
Feb	28	0.34	0.82	0.42	0.14	1.10	1.69	1.70	0.48	1052	1000	10	0.28
Mar	31	0.14	0.38	0.31	0.16	0.53	1.69	0.57	0.33	1052	1000	3	0.09
Apr	30	0.57	1.47	0.42	0.15	1.74	1.69	2.55	0.61	1052	1000	14	0.42
May	31	0.99	2.65	0.53	0.16	3.02	2.53	4.24	1.00	1577	1500	15	0.70
Jun	30	1.13	2.94	0.62	0.15	3.41	2.70	4.67	0.98	1683	1600	16	0.77
Jul	31	2.46	6.58	0.68	0.16	7.10	3.38	7.92	0.82	2103	2000	21	1.30
Aug	31	1.56	4.17	0.65	0.16	4.66	3.38	6.03	1.39	2103	2000	16	0.99
Sep	30	0.85	2.20	0.53	0.15	2.58	2.20	3.56	0.83	1367	1300	15	0.59
Oct	31	0.99	2.65	0.57	0.16	3.07	2.53	4.24	1.00	1577	1500	15	0.70
Nov	30	0.51	1.32	0.44	0.15	1.61	1.69	2.37	0.61	1052	1000	13	0.39
Dec	31	0.65	1.74	0.51	0.16	2.09	1.69	2.83	0.65	1052	1000	15	0.47
Total	365		28.83	6.14	1.83	33.13		43.71	9.32				7.19

Source: Vergel3 Consult, Hydropower Potential Assessment Babeldaob Main Island

Table 2.6.2-4 Power Generation in the Ngermeskang River System

		River Flow to Reservoir	Total Rever Flow to Reservoir	Rain Fall to Reservoir	Evapolation from Reservoier	Total In-Flow to Reservoir	In-Flow to Generator	Total In-Flow to Generator	Total In-Flow to Reservoir during non-operation	Practical Output	Output	Running Hours of Gen.	Output per Month
	Days	m3/s	×10^6 m3/M	×10^6 m3/M	×10^6 m3/M	×10^6 m3/M	m3/s	×10^6 m3/M	×10^6 m3/M	kWh	kWh	Hours/day	GWh/M
Jan	31	0.93	2.50	0.53	0.17	2.86	1.84	3.49	0.73	518	500	17	0.26
Feb	28	0.45	1.10	0.36	0.15	1.30	1.84	2.04	0.59	518	500	11	0.15
Mar	31	0.20	0.53	0.34	0.17	0.70	1.84	1.03	0.42	518	500	5	0.08
Apr	30	0.76	1.98	0.48	0.17	2.30	1.84	2.98	0.74	518	500	15	0.23
May	31	1.33	3.56	0.58	0.17	3.97	2.80	5.01	1.19	789	750	16	0.37
Jun	30	1.50	3.89	0.67	0.17	4.40	2.80	4.54	1.46	789	750	15	0.34
Jul	31	3.39	9.07	0.77	0.17	9.67	3.74	9.59	0.38	1052	1000	23	0.71
Aug	31	2.07	5.54	0.72	0.17	6.09	3.74	7.09	1.61	1052	1000	17	0.53
Sep	30	1.13	2.94	0.55	0.17	3.32	2.80	4.54	1.10	789	750	15	0.34
Oct	31	1.33	3.56	0.63	0.17	4.02	2.80	5.01	1.19	789	750	16	0.37
Nov	30	0.68	1.76	0.48	0.17	2.08	1.84	2.78	0.73	518	500	14	0.21
Dec	31	0.88	2.35	0.53	0.17	2.71	1.84	3.49	0.69	518	500	17	0.26
Total	365		38.79	6.64	2.02	43.41		51.60	10.84				3.85

Source: Vergel3 Consult, Hydropower Potential Assessment Babeldaob Main Island

Table 2.6.2-5 Power Generation in the Ngrikill River System

		River Flow to Reservoir	Total Rever Flow to Reservoir	Rain Fall to Reservoir	Evapolation from Reservoier	Total In-Flow to Reservoir	In-Flow to Generator	Total In-Flow to Generator	Total In-Flow to Reservoir during non-operation	Practical Output	Output	Running Hours of Gen.	Output per Month
	Days	m3/s	×10^6 m3/M	×10^6 m3/M	×10^6 m3/M	×10^6 m3/M	m3/s	×10^6 m3/M	×10^6 m3/M	kWh	kWh	Hours/day	GWh/M
Jan	31	0.71	1.90	0.19	0.06	2.03	1.84	2.98	0.75	518	500	14.5	0.22
Feb	28	0.34	0.82	0.12	0.05	0.89	1.84	1.48	0.55	518	500	8	0.11
Mar	31	0.14	0.38	0.11	0.06	0.43	1.84	0.72	0.32	518	500	3.5	0.05
Apr	30	0.57	1.47	0.16	0.06	1.57	1.84	2.29	0.76	518	500	11.5	0.17
May	31	0.99	2.65	0.19	0.06	2.79	2.80	4.07	1.22	789	750	13	0.30
Jun	30	1.13	2.94	0.22	0.06	3.10	2.80	4.24	1.22	789	750	14	0.32
Jul	31	2.46	6.58	0.26	0.06	6.78	3.74	8.34	1.10	1052	1000	20	0.62
Aug	31	1.56	4.17	0.24	0.06	4.35	3.74	6.05	1.65	1052	1000	14.5	0.45
Sep	30	0.85	2.20	0.19	0.06	2.34	2.80	3.48	1.15	789	750	11.5	0.26
Oct	31	0.99	2.65	0.21	0.06	2.81	2.80	4.07	1.22	789	750	13	0.30
Nov	30	0.51	1.32	0.16	0.06	1.43	1.84	2.19	0.72	518	500	11	0.17
Dec	31	0.65	1.74	0.18	0.06	1.86	1.84	2.57	0.84	518	500	12.5	0.19
Total	365		28.83	2.23	0.67	30.39		42.47	11.49			147	3.17

Source: Vergel3 Consult, Hydropower Potential Assessment Babeldaob Main Island

Table 2.6.2-6 Estimated Fuel Cost, Fuel Consumption and CO^2 Emission Reduction Effects of Hydropower Generation Plan

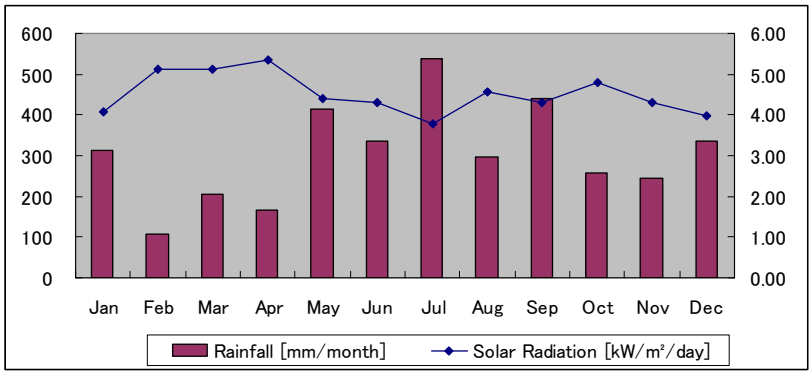
River System	Electric Energy Generated GWh/year	Fuel Consumption m^3	Fuel Cost ¥ million	CO_2 Emission Tons
Diongradid	7.19	1,926	177	5,231
Ngermeskang	3.85	1,033	95	2,804
Ngrikill	3.17	850	78	2,307
Total	14.21	3,809	350	10,343

Sources:

Electric energy generated: Vergel3 Consult, Hydropower Potential Assessment Babeldaob Main Island
Fuel consumption: calculated based on the relevant PPUC results for 2006
Fuel cost: calculated based on the relevant PPUC results for 2006
CO_2 emission: calculated based on the relevant PPUC results for 2006 using the revised guidelines of the Intergovernmental Panel on Climate Change (IPCC), 1998

(2) Potential for Photovoltaic Power Generation

A project to introduce a photovoltaic power generation system to be connected to the distribution grid is currently at the tender and contract stage with the assistance of the European Union (EU). This project involves the installation of 100 KWp panels at the car parking space next to the parliament building in Palau. The tender document for this project gives the amount of solar radiation on the ground surface which is calculated based on the amount of solar radiation and the duration of sunshine observed by a NASA satellite. The amount of solar radiation constitutes an indicator to determine the suitability of photovoltaic power generation and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) established a meteorological data observation station at Aimeliik in 2003 and has since been gathering data on solar radiation on the ground surface. This data is extremely useful for the examination of any future plan to introduce photovoltaic power generation. Fig. 2.6.2-2 shows the mean amount of solar radiation (measured at a level surface) and rainfall data for the last three years gathered by the JAMSTEC. While the amount of solar radiation tends to decrease during the rainy season from May to September (some reference materials consider the rainy season to last until October), the value is still higher than the mean amount of solar radiation measured at the optimal angle of inclination in Japan throughout the year, confirming the potential for photovoltaic power generation in Palau.



Source: JAMSTEC

Fig. 2.6.2-2 Amount of Solar Radiation and Rainfall in Palau (at Aimeliik)

Table 2.6.2-7 shows the theoretical electric energy generated a year if a PV system (with an assumed overall design coefficient of 0.7) is introduced at the car park space of the parliamentary building in Palau. Table 2.6.2-8 shows the fuel consumption, fuel cost and CO_2 emission reduction effects under this project. The fuel consumption and fuel cost are calculated in proportion to the annual electric power generated for which the fuel cost of the generator and the unit fuel cost are used as the coefficients. Meanwhile, the emission of CO_2 can also be calculated proportionally in accordance with the calculation method provided in the revised guidelines of the IPCC in 1998. In other words, regardless of the type of renewable energy, such as hydropower generation or PV power generation, to be introduced, the share of renewable energies in the total demand (or in the total electric energy generated to be more accurate) will directly determine the reduction percentage of the emission of CO_2 in connection with the fuel consumption of the power generation sector. For the selection of a renewable energy to be introduced and the examination of a suitable scale, the lifecycle cost per kWh acts as an important indicator.

Table 2.6.2-7 Power Generation by 100 KWp PV System Near the Parliamentary Building in Palau

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Amount of Solar Radiation ($kW/m^2/day$)	4.07	5.13	5.13	5.35	4.40	4.31	3.79	4.56	4.32	4.81	4.32	3.97	-
Monthly Generation of Electric Energy (MWh)	8.8	10.8	11.1	11.2	9.5	9.0	8.2	9.9	9.1	10.4	9.1	8.6	115.9

Source: Calculated by the Study Team using JAMSTEC data.

Table 2.6.2-8 Fuel Cost, Fuel Consumption and CO2 Emission Reduction Effects of the Installation of a PV System Next to the Parliamentary Building in Palau.

Type of PV System	Electric Energy Generated MWh/year	Fuel Consumption Reduction m^3	Fuel Cost Reduction Million	CO_2 Emission Reduction tons
100 kW PV System	115.9	31.1	2.86	84

Sources:

Fuel consumption: calculated based on the relevant PPUC results for 2006
Fuel cost: calculated based on the relevant PPUC results for 2006
CO_2 emission: calculated based on the relevant PPUC results for 2006 using the revised guidelines of the Intergovernmental Panel on Climate Change (IPCC), 1998

(3) Potential for Wind Power Generation

In 1982, the Department of Energy and the Department of the Interior of the US installed an experimental 1.5 kW wind power generation system on Koror Island but this system was withdrawn in 1985 without ever achieving the rated output. The wind conditions in Palau are heavily dependent on the topography and considerably vary over a short distance of several kilometres. Accordingly, the wind velocity and wind direction data observed by meteorological stations and others is not very effective to assess the potential for wind power generation. At present, no anemovanes are installed in Palau for the purpose of assessing the wind power generation potential. The only available wind data is meteorological data gathered at the Koror Observation Station of the Palau Meteorological Centre, the JAMSTEC's Aimeliik Observation Station and the Ngardmau, Ngermlengui, Ngchesar, Aimeliik and Oikull Observation Stations of the Palau International Coral Reef Centre (PICRC). The data gathered by the PICRC's observation stations is not properly sorted and it is necessary to obtain and sort out the raw data. Fig. 2.6.2-3 through Fig. 2.6.2-5 show the wind velocity data of observation stations other than those of the PICRC.

The guidelines of the New Energy and Industrial Technology Development Organization (NEDO) for the introduction of wind power generation stipulate that the target sites for wind power generation should have a mean annual wind velocity of at least 5 m/sec or 6 m/sec if possible. Based on the currently available wind velocity data for Palau, the potential for wind power generation in Palau is not very high. The present task in relation to the final judgement on the wind power generation potential in Palau is to obtain wind data at an altitude near possible installation sites, taking the likely scale of the system (i.e. generator) into consideration. Palau has highly undulating topography ranging from 50 m to 100 m above sea level with little flat land and the ground surface tends to be covered by trees. Therefore, it is believed that the wind conditions considerably vary from one place to another. These facts must be taken into careful consideration when selecting the wind conditions observation points to assess the wind power generation potential. Energy office is planning to implement wind monitoring from the end of year 2008 by constructing a few monitoring towers with the assistance of EU aiming at evaluating wind power potential in Palau.

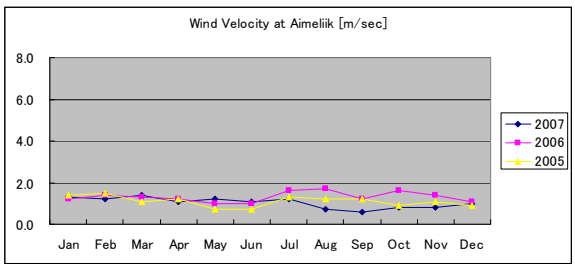


Fig. 2.6.2-3 Wind Velocity at Aimeliik (m/s)

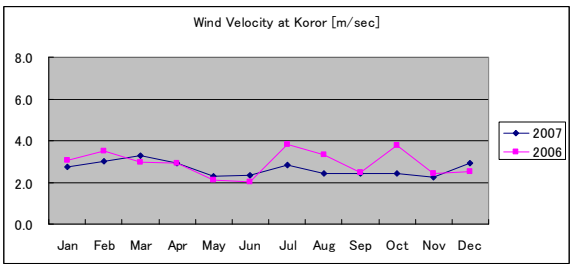


Fig. 2.6.2-4 Wind Velocity at Koror (m/s)

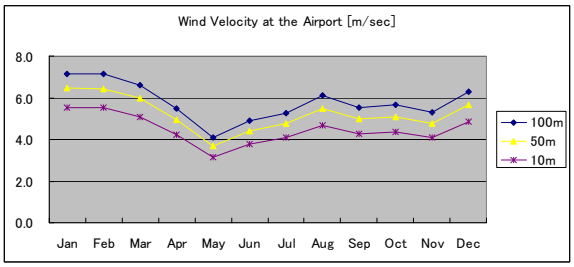


Fig. 2.6.2-5 Wind Velocity at the Airport (m/s)

(4) Others

There are other renewable energies, such as OTEC (ocean thermal energy conversion) and biomass energy, etc. In regard to OTEC, the MRD and Saga University of Japan have signed a cooperation agreement and research work is in progress at 10 sites, including the sea area near the capital of Melekeoku. However, the work is still at the initial research stage and no reports have yet been submitted to provide basic data for the planning of a concrete plan by the Energy Development Office for the introduction of an OTEC system. In the case of biomass energy, its potential in Palau which is a small island country is not very high because the quantities of agricultural waste, livestock dung and waste wood from sawing, etc. which can be used as biomass resources are very small to start with.

3. FINANCIAL AND MANAGERIAL ANALYSIS ON PPUC

3. Financial and Managerial Analysis on PPUC

3.1 Objectives of Financial and Managerial Analysis on PPUC

This chapter is to examine financial and managerial situation of PPUC. It is needed to support the investment project from its inception up to completion, and where necessary, through the project life. In addition, it is to help define the key areas and points for efficient and effective project implementation and necessary obligations by PPUC and the Republic of Palau. The general objective of analysis in this chapter is to ensure that PPUC is managerially and financially capable of implementing the proposed project and/or identify the problem areas to be improved. The specific objectives are to: 1) examine financial structure and management situation of PPUC; 2) examine the situation of current tariff structure and power revenue; 3) examine the balance of operation revenue and expense and identify problem areas for cost recovery; 4) formulate the basic strategies and principles of net revenue improvement; 5) propose the direction of new electricity tariff structure

3.2 Financial Structure and Management as the Executing Agency

3.2.1 Status of PPUC and Control of the Government

PPUC was established under 37 PNCA as a public corporation. In principle, PPUC is an autonomous body. PPUC can determine its financial policies, contract, sue and be sued in its own name. The National Government of Palau retains the right to a limited oversight role. The government has the right to review any documents, or decisions made by PPUC. With the reference to electric rates establishment and revision, PPUC has to prepare a draft and notice it by posting written notice to the President Office and some other government agencies etc, before adopting the new rate schedule. The detailed process is prescribed in PNC37, Section 413. Taking a look at the present situation, however, it seems to be unclear whether PPUC is really autonomous or not.

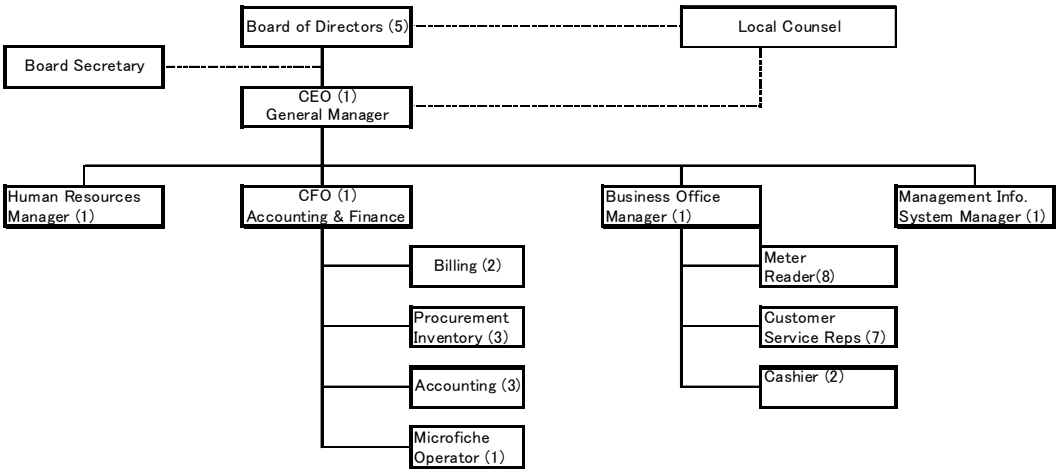
It seems that the Government and the Board of Directors have tendency to check and hold down a rise request proposal of the electricity rates. The tendency will potentially hamper the sustainability of PPUC as an autonomous going-concern. In this context, it is hoped for the Government to review its relationship with PPUC and as well as to give consideration about how strictly the related parties are pursuing management principle of not causing operation net loss. Provided that the Government intention is to allow the deficit ridden character of operation loss, and to extend financial support to PPUC, the current situation may be kept on. If not, PPUC should be more autonomous and implement more strict management in its own responsibility.

3.2.2 Organizational Structure for Business Administration and Management

The following organizational chart delineates the vertical and horizontal accountability structure for PPUC's business management and administration. The Board of Directors directs PPUC. The day-to-day management is directed by CEO. Under CEO, four managers work in the aspect of business administration and management. Four managers are horizontally equal. In the absence of CEO, however, CFO is charged with administrative responsibility, while Power Generation Manager is charged with technical and engineering responsibility.

- CFO (Accounting and Finance)
- Business Office manger
- Management Information System Manager

- Human Resource manager



Source: PPUC

Fig. 3.2.2-1 Organization Chart of Business Administration and Management of PPUC

The Business Office manager is currently charged with tariff collections. The Management Information System primarily provides technical support to the accounting division. He is assigned to the other technical needs of the other departments.

3.2.3 Corporate Planning and Budgeting

PPUC must manage its own financial affairs. PPUC conducts its corporate planning and budgeting in its own right. The Government has the right of oversight, but does not control any detail of PPUC. All its affairs shall be directed and its corporate power shall be exercised by the Board of Directors.
All of the 5 directors of the Board, however, are politically appointed by the President. The Board of Directors takes full responsibility to give directions for PPUC's management and financial policies. In this situation, it looks very doubtful whether PPUC is actually autonomous or not? It seems that the Government can actually keep power on PPUC indirectly. In view of being sustainable and autonomous, it is deemed as essential for these situations to be reviewed and improved.

3.2.4 Financial Management and Control

PPUC is audited annually. The audited annual reports are provided to the Office of the Public Auditor to disseminate the information to the National Government. Financial reporting is prepared monthly, but submitted to the Board of Directors on requested basis. No internal audit activities are conducted by PPUC. PPUC relies on external audit. In view of efficiency and prompt improvement, JICA Study Team proposes that the management of PPUC adopt undertaking regular monitoring and review activities.

3.3 Cost Recovery and Tariff Structure

3.3.1 Existing Tariff Structure

The electricity tariff charging consists of the fixed rate and metered rate. The charged price by metered rate is calculated by multiplication of the consumption volume of electricity and the unit multiplying rate. The metered rate is comprised of the two rates: basic multiplier rate; AFPAC rate. The following table represents current tariff structure of PPUC.

Table 3.3.1-1 Current Electricity Tariff Structure of PPUC

Unit: US$

Charge item			Residential	Commercial/ Government
Monthly Minimum Energy Charge			3	10
Cost per kWh				
	0-500	kWh	0.08	0.10
	501-2000	kWh	0.10	0.10
	2001above	kWh	0.12	0.12
AFPAC May 1, 2008～to date			0.17	0.17

Note:AFPAC (Automatic Fuel Price Adjustment Clause)
Note: Minimum energy charge for residential is US$3 in case of no consumption due to absence etc, and more than 150kWh.
In case of more than 1kWh up to 150kWh, a fixed price of US$ 8 is charged.
Source: PPUC

The electricity tariff of PPUC is subject to the automatic fuel price adjustment clause (AFPAC). AFPAC is the mechanism of tariff adjustment to reflect fluctuation of fuel price. The electricity charge is increased or decreased by 1 cent/kWh for every fuel price change by 12.7 cent/gallon. The issues to be raised, however, are that this rate adjustment mechanism is to take effect quarterly (a review/ 3months). In case of such sharp hike of the oil price in a short term, the AFPAC response tends to be delayed and some shortfall of tariff revenue collection frequently takes place. The current AFPAC rate is 17 cents per kWh, as of May 2008. This rate has been effective since May 1, 2007.

Residential
1) C=0 US$3.00
2) C: 1-150kWh, US$8.00
3) C: 151-500kWh, US$ 3.00+C × (0.08+0.17)
4) C: 501-2000kWh, US$ 3.00+500 × (0.08+0.17)+(C-500) × (0.10+0.17)
5) C: 2001 above, US$3.00+500 × (0.08+0.17)+1500 × (0.10+0.17)+(C-2000) × (0.12+0.17)

Commercial/ Government
2) C: 0-100kWh, US$10.00
3) C: 100-2000kWh, US$ 10.00+C × (0.10+0.17)
4) C: 2000kWh above, US$ 10.00+2000 × (0.10+0.17)+(C-2000) × (0.12+0.17)

Note: C= Monthly Consumption Volume of Electricity (kWh)

The calculation method of AFPAC is deemed as appropriate in view of the fact that the average fuel efficiency of the Aimeliik and Malakal Power Stations is 13.825 kWh /gallon and that the

increase of the unit generation cost linked to a fuel price increase of 12.7 cents/gallon is 0.919 cents/kWh. The problem to be raised, however, is the frequency of the adjustments.
The AFPAC has been constantly on steep upsurge in recent years, as shown below. It actually rose from 2 cents to 17 cents from April 2004 to date. Since the adjustment function does not take effect every month, but only 4 times a year, it has resulted in delayed response in comparison with sharp oil price hike, and eventually in insufficient cost recovery.

Table 3.3.1-2 Revision of AFPAC Rate in Recent Years

Date of Change	FROM(US$)	To(US$)
1-May-08	0.15	0.17
1-Nov-07	0.14	0.15
1-Aug-07	0.13	0.14
1-Nov-06	0.12	0.13
1-Aug-06	0.11	0.12
1-Feb-06	0.09	0.11
1-Aug-05	0.07	0.09
1-Apr-05	0.05	0.07
1-Jan-05	0.04	0.05
1-Jul-04	0.03	0.04
1-Apr-04	0.02	0.03

Source: PPUC

With the reference to the basic rates, PPUC has not raised the basic electric rates since October 2001. AFPAC rates sharply rose from only 2 cents to 15 cents since 2001. Therefore the adjustment portion of the revenue by AFPAC is currently more than the revenue portion by the basic rates.
Taking a look at factors that function as to raise the basic rates, we can enumerate various factors such as inflation in general, needs of equipment renewal, labor cost increase etc. It means that the electricity rate change mechanism should include not only adjustment to oil price hike but also the response to those other factors. In reference to CPI upsurge in Palau for the period, for instance, it has risen at 6.8%, 2.3%, 3% and 2.5% respectively in 2004, 2005, 2006 and 2007. In total, the upsurge rate from 2004 to 2007 is 15.3%, but no change took place in the basic rate for the same period.

Table 3.3.1-3 Revision of Basic Rate in Recent Years

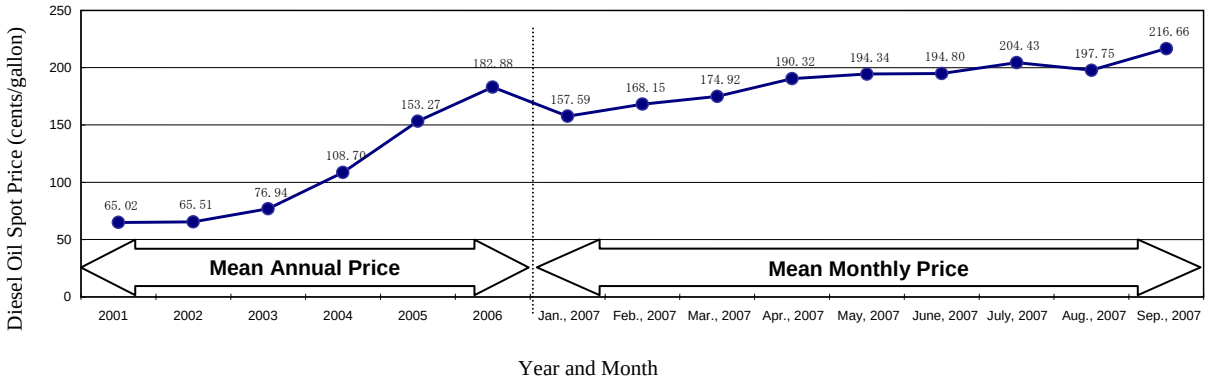
Unit: US$

		Change of Basic Electric Rate					
User Type	Consumption Range	Oct.1997	Apr.1998	Oct.1998	Apr.2000	Jun.2000	Oct.2001
Residential	0-500kWh	0.1	0.09	0.08	0.1	0.09	0.08
	501-2000kWh	0.12	0.11	0.1	0.12	0.11	0.1
	2000 above	0.14	0.13	0.12	0.14	0.13	0.12
Commercial	0-2000kWh	0.12	0.11	0.1	0.12	0.11	0.1
	2001-5000	0.14	0.13	0.12	0.14	0.13	0.12
	5000 above	0.14	0.13	0.12	0.16	0.13	0.12
Government	0-2000kWh	0.12	0.11	0.1	0.12	0.11	0.1
	2001-5000	0.14	0.13	0.12	0.14	0.13	0.12
	5000 above	0.14	0.13	0.12	0.16	0.13	0.12

(Source): PPUC

For the reference, let's take a look at the recent change of diesel price. The diesel oil used in Palau is imported from Singapore. PPUC uses No. 2 diesel oil for power generation in the all islands of Malakal, Aimeliik, Peleliu, Angaur. As shown in the following figure, the FOB price of Singapore surprisingly rose by nearly three times in the period from 2001 to September 2007.

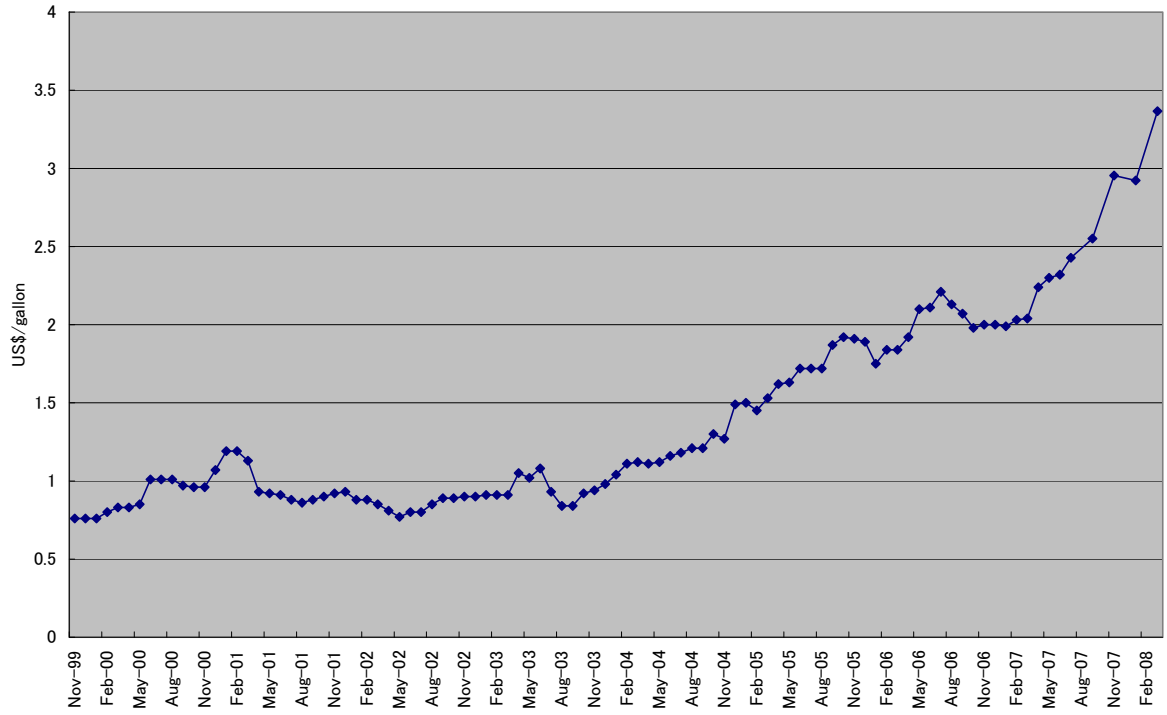
As such, the rapid increase of the diesel oil price has been adversely affecting the cash flow of the PPUC.



Source: US Department of Energy, EIA Home Page

Fig. 3.3.1-1 Recent trend of the Diesel Oil Price (FOB) in Singapore

In addition, the following figure represents the PPUC's actual procurement price of diesel fuel oil since October 1999, on the monthly basis calculation. Until 2003, the price hike move was fluctuating, not increasing on the straight upsurge curve. The increase pace, however, has been on the steep rising curve since 2004 as shown below.



Source: Calculated and Prepared by JICA Study Team, on the Basis of PPUC Data

Fig. 3.3.1-2 PPUC's Procurement Price of Diesel Oil

Let's take a look at the rates of the other countries of Pacific Islands, in order to consider about whether the electric rate of Palau is comparatively cheap or expensive. Since the rate charging system differs among countries, it is necessary to set up a certain assumption. For instance, let's

compare the rates to be applied to residential customer, in case that they consume around 500 kWh as of 2007 or 2006 (if 2007 data is not available). As clearly shown in the figure, Palau's rate is the lowest level. The rates in Tuvalu and North Mariana are slightly higher than Palau. UNELCO Vanuatu charges US$ 0.73 /kWh, 3.3 times higher than Palau. This is because, a sort of penalty rate is charged for the consumers who use more than 120 kWh. The rate rises, depending on consumption volume: US$0.31/kWh for the range of 0-60 kWh; US$ 0.46/kWh for the range of 60-120kWh; US$ 0.84/kWh for above 120 kWh.

Table 3.3.1-4 Comparison of the Electric Rates of Pacific Island Countries

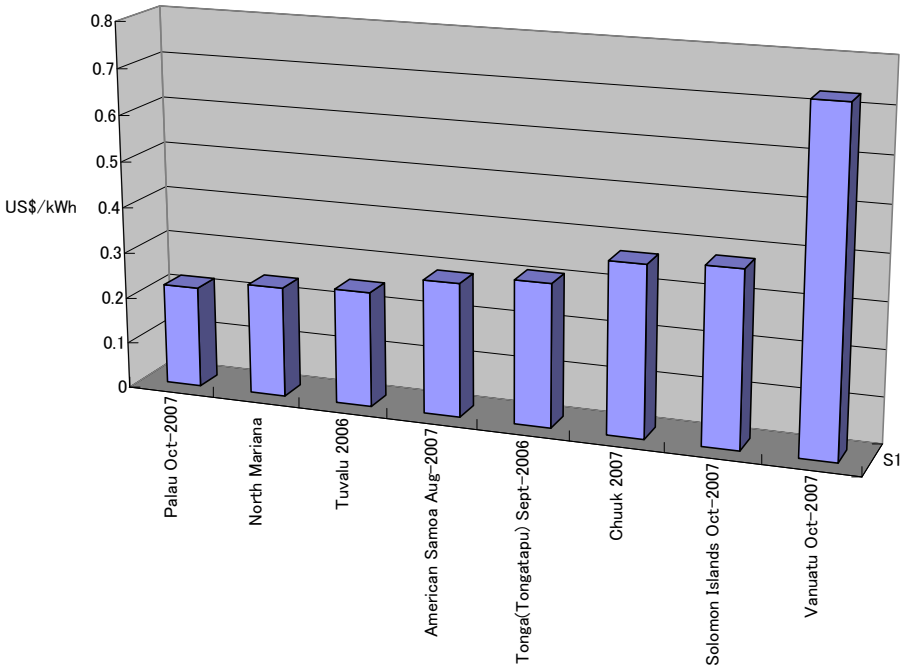
Unit: US$/kWh

Country	Rate
Palau Oct-2007	0.22
North Mariana	0.24
Tuvalu 2006	0.25
American Samoa Aug-2007	0.29
Tonga(Tongatapu) Sept-2006	0.31
Chuuk 2007	0.37
Solomon Islands Oct-2007	0.38
Vanuatu Oct-2007	0.73

Source: Calculated and Prepared by JICA Study Team, on the Basis of Data of Pacific Power Association

Assumption for calculation:

This is the calculation of the average rate per kWh, in case that a residential customer consumes around 500 kWh in each country. (The monthly average consumption of residential customer in Palau is around 430 as of FY2007.)



Source: Calculated and prepared by JICA Study Team, on the basis of data of Pacific Power Association

Fig. 3.3.1-3 Comparison of the Electric Rates of Pacific Island Countries (2007 or 2006)

In general, Pacific island countries are small in terms of population size, and it seems to be difficult to take advantage of scale of economy. Therefore, the electric rates of Pacific island countries are comparatively higher than those of developed countries. In case of Tokyo metropolitan area of Japan, the electric rate for residential customers who use around 500kWh

is charged as US$ 0.191/ kWh as of December 2007. The following table shows the international comparison among developed countries: Japan, USA, Germany, France, Italy, S. Korea etc. All of them are less than US$0.2/ kWh and less than those of Pacific island countries. It is unfortunate that Pacific islands people have to pay more for electricity than the richer developed countries. However, this is a the fact that we must recognize.

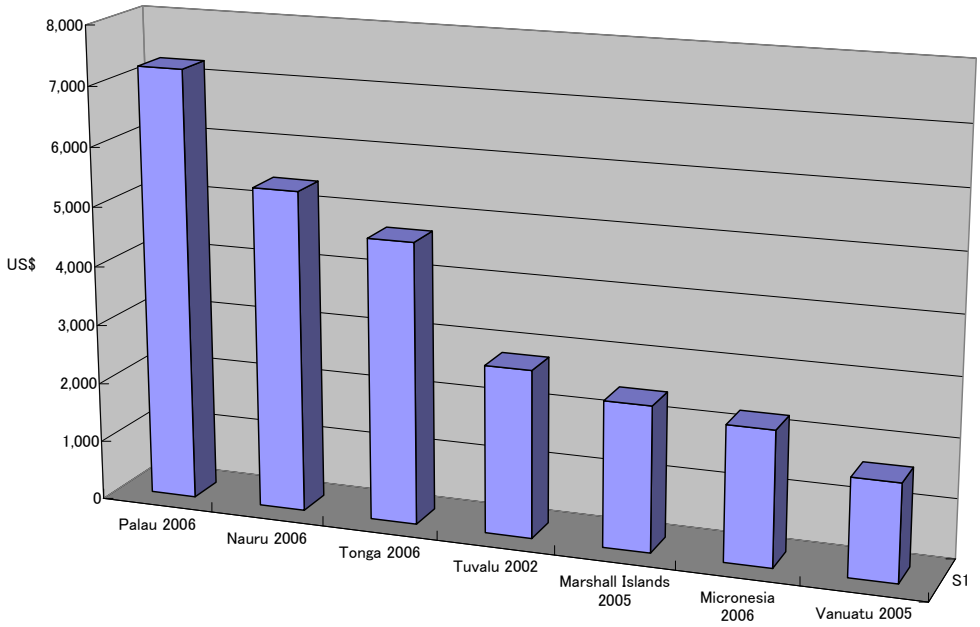
Table 3.3.1-5 the Electric Rates of Developed Countries as of 2003

Unit: US$/kWh

Japan	USA	Germany	UK	France	Italy	Korea
0.186	0.087	0.176	0.116	0.127	0.186	0.074

Source: Calculated and Prepared by JICA Study Team, by using the data of OECD/IEA, Energy Prices and Taxes 1st Quarter, 2005.

On the other hand, Palau' per capita GDP is the highest level (US$ 7,267) among Pacific Island Countries, as shown above the following figure. Cook Island is the richest (US$ 8,362), followed by Palau as the second. However, the per capita GDP of Solomon Islands, Vanuatu, F.S. Micronesia, Marshall Islands and Samoa are respectively US$706, 1,641, 2,266, 2,441 and 2,595. It can be said that the electricity rate of Palau is comparatively low, although Palau is substantially richer than neighbor Pacific island countries, in the context of Pacific Island Countries. In a sense, it is thought to be successful as national management that the electricity rate of Palau could be sustained on a comparatively lower level. However, it could be possible as PPUC has not accumulated money reserve for equipment renewal. It is deemed as essential in near future to reinstall new power plants in response to the aging and forthcoming malfunctioning. In view of sustainable power supply for future, the tariff of PPUC might be modified as to enable power plant renewal or expansion.



Source: Prepared by JICA Study Team, by using ADB Key-Indicators2006

Fig. 3.3.1-4 Comparison of Per Capita GDP of Palau and the other Pacific island countries

3.3.2 Electricity Bill Collection

(1) Achievement Performance of Electricity Bill Collection

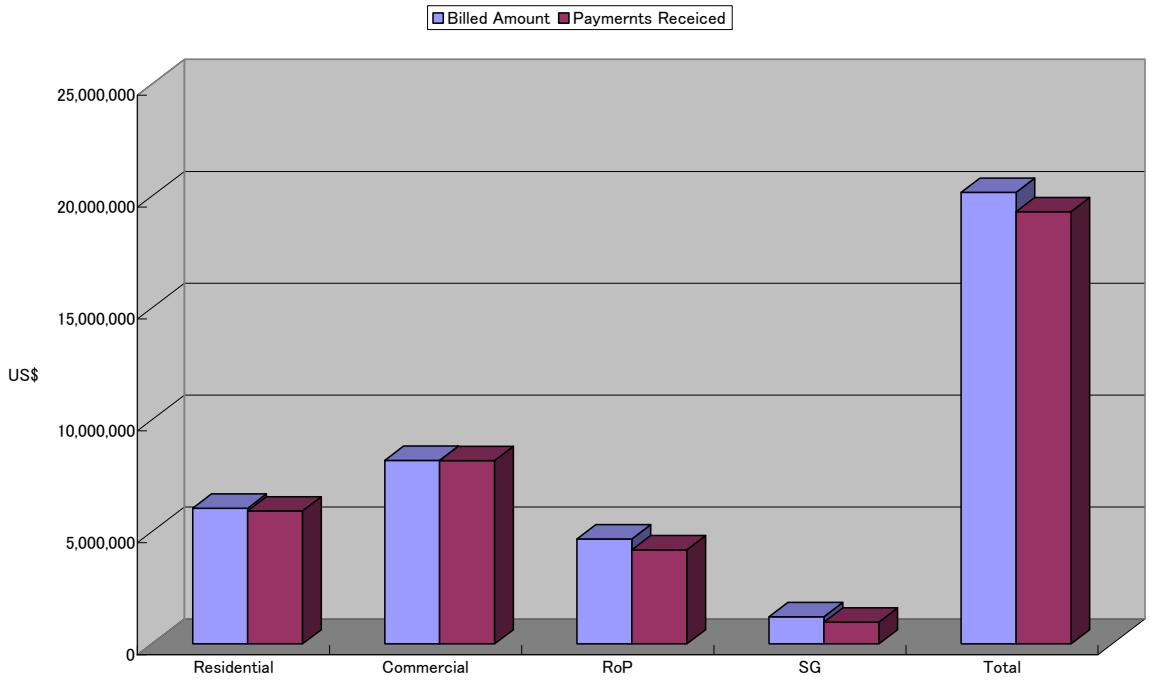
As for the last FY 2007, PPUC's total amount of electricity bill accounted for US$ 20.18 million. On the other hand, the total amount of payments received for FY 2007 accounted for US$ 19.32 million. As a result, the achievement percentage of electricity bill collection was 96%. (It is calculated by US$19.32 million / US$ 20.18 million = 96%).
Let's take a look at the performance by customer classification. The achievement rates of bill collection from commercial and residential customers were 100% and 96%, respectively. On the other hand, those from RoP and SG are regrettably 90% and 80%, respectively. Although the private sector must pay regularly by month, the national governments and state governments are usually several months behind in arrears with electricity bills. The overdue bills for RoP and SG for several months are finally paid by check, when the Government has enough cash to pay the accumulated bills. The time lag, however, causes necessity of short-term borrowings to PPUC. It is recommendable for the Governments to make payments regularly without delay.

Table 3.3.2-1 The Achievement Rate of PPUC's Bill Collection
(FY2007(Oct.2006～Sept.2007))

Unit: US$

	Residential	Commercial	RoP	SG	Total
A/R Beginning Balance	485,650	578,188	490,620	237,837	1,792,295
Billed	6,065,729	8,205,380	4,693,902	1,216,302	20,181,313
Payments Received	5,940,438	8,196,136	4,206,381	969,604	19,315,848
Adjustments	−154,468	−69,130	−100,508	−51,172	−372,528
A/R Ending Balance	456,473	518,302	877,633	432,824	2,285,232
Collection Achievement Rate	96%	100%	90%	80%	96%

Source: Prepared by JICA Study Team on the basis of PPUC's data



Source: Prepared by JICA Study Team on the basis of PPUC's data

Fig. 3.3.2-1 The Achievement Rate of PPUC's Bill Collection
(FY2007(Oct.2006～Sept.2007))

For the first half of FY 2008 (Oct.2007～Mar.2008), the achievement ratio is stably the same as 96% as a whole. (The calculation is done as US$ 10.02 million / US$10.44 million = 96%)

(2) Methods of Electricity Bill Collection

The customers make payments to PPUC in response to its electricity bills as follows:

- ✓ Customers visit PPUC's office and pay the billed amount at the desk.
- ✓ Automatic drawdown from customers' bank account by credit card charge
- ✓ Customers visit a bank and pay the billed amount to PPUC's bank account of Bank Pacific or Bank of Hawaii
- ✓ Deduction from salary
- ✓ Payment by check (Government)
- ✓ Pre-paid system

It is the most dominant way that customers visit PPUC's office and pays the billed amount at the electricity payment desk. More than 90% of the customers pay in this way.
Automatic drawdown from the bank account is rarely used, a very few customers use this method.
In case of government employees, electricity bills are deducted from their salary. A few private companies adopt this same method of deducting from the employees' salary.

The national governments and state governments are usually behind in arrears with the electricity bills for several months. The accumulated overdue bills are altogether paid off by check to clear off the debt when the governments have enough cash.

PPUC began to use a pre-paid system in order to prevent delayed bill collection from July 2007. At present, around 480 pre-paid meters are put into operation. Furthermore, PPUC intends to set up one thousand more pre-paid meters for the problem debtors.
Since the introduction of the pre-paid system was not until July 2007, the amount of electricity collection through pre-paid system accounts for only less than 2%. For the 1st half of FY 2008, the sum has accounted for approximately US$ 200,000. On the monthly average, the bill collection through pre-paid system is around US$ 33,000. The trend is upward.

With the reference to the steps taken for the delayed payments, PPUC firstly gives a reminding notice to the customers whose bills have not paid for more than 30days. Secondly, if the customer does not respond to pay off the balance, PPUC disconnects the electricity supply.
In case that the customer concerned cannot afford to clear off on the spot at one time, PPUC makes a negotiable contract with the customer. It includes a monthly payment schedule for a certain period (several moths or more than one year) in consultation with the customer. The interest rate is 1% per month.

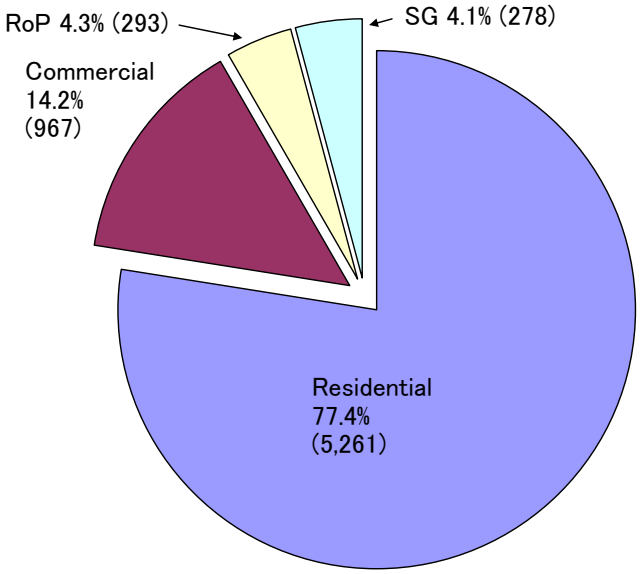
Provided that the problem customer is a disabled or a very aged person, PPUC takes a flexible step.

PPUC spends a substantial time and cost for the effort of money collection and counter-measures for delayed payment or not paying. The pre-paid system is hoped to make good contributions and to save the time and cost.

3.3.3 Analysis on Structural Characteristics of Revenue and Expenditure

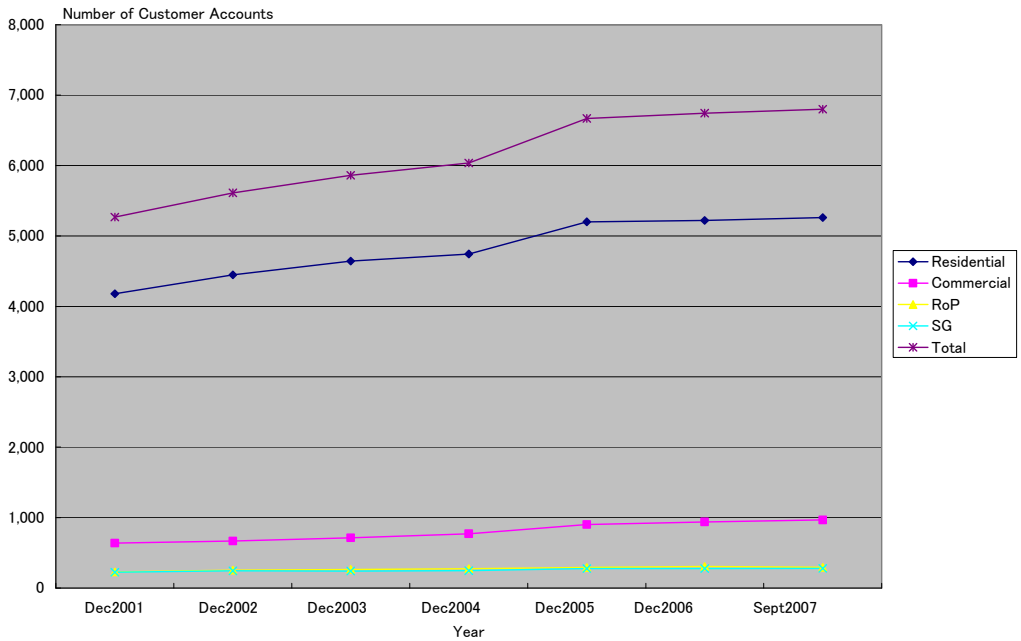
(1) Customer and Consumption

According to PPUC's classification, there are mainly three types of customers: 1)residential, 2)commercial and 3) government. The government can be classified further into the national government (Republic of Palau: RoP) and state governments (SG). The total number of customers accounts for 6,799 as of September 2007. In terms of the account numbers, residential customer accounts occupy 77.4% (5,261), commercial 14.2% (967), RoP 4.3% (293) and SG 4.1% (278).



Source: Calculated and Prepared by JICA Study Team, on the Basis of PPUC Data

Fig. 3.3.3-1 PPUC's Customer Accounts by Customer Classification as of September 2007



Source: Calculated and Prepared by JICA Study Team, on the Basis of PPUC Data

Fig. 3.3.3-2 Growth of Customer Accounts Number (Dec.2001-Sept.2007)

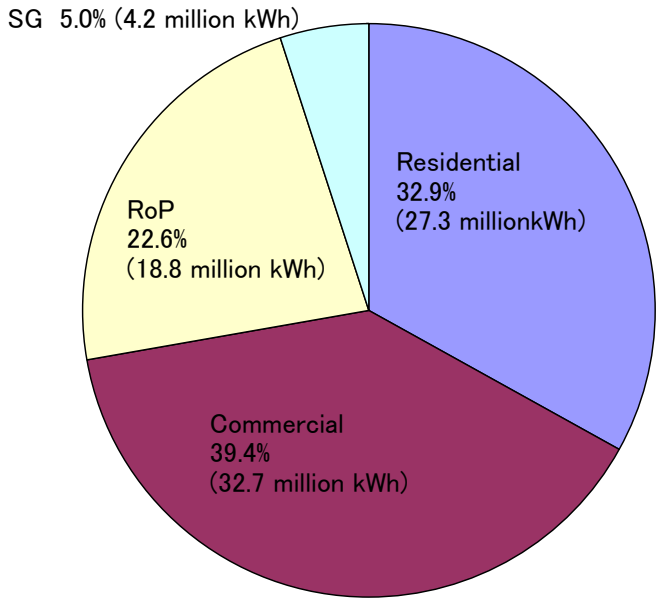
The total number of customer accounts has increased from 5,268 (Dec. 2001) to 6,799 (Sept. 2007) for 5.75 years. The total increase accounts for 1,531. The average yearly increase is 266 accounts per annum. The commercial accounts showed a higher increase rate (7.5% per annum) in comparison with the other user type classifications (Residential: 4.1%, RoP:4.5%, SG:3.9%). As a result, The commercial accounts share has been gaining ground very gradually from 12.1% to 14.2%, while the residential accounts has been losing its ground from 79.3% to 77.4%.

Table 3.3.3-1 Growth of Customer Accounts from Dec.2001 to Sept.2007

	Residentia	Commercial	RoP	SG	Total
Sept.2007/Dec.2001	1.26	1.52	1.29	1.25	1.29
Annual growth rate	4.1%	7.5%	4.5%	3.9%	4.5%

Source: Calculated and Prepared by JICA Study Team, on the Basis of PPUC Data

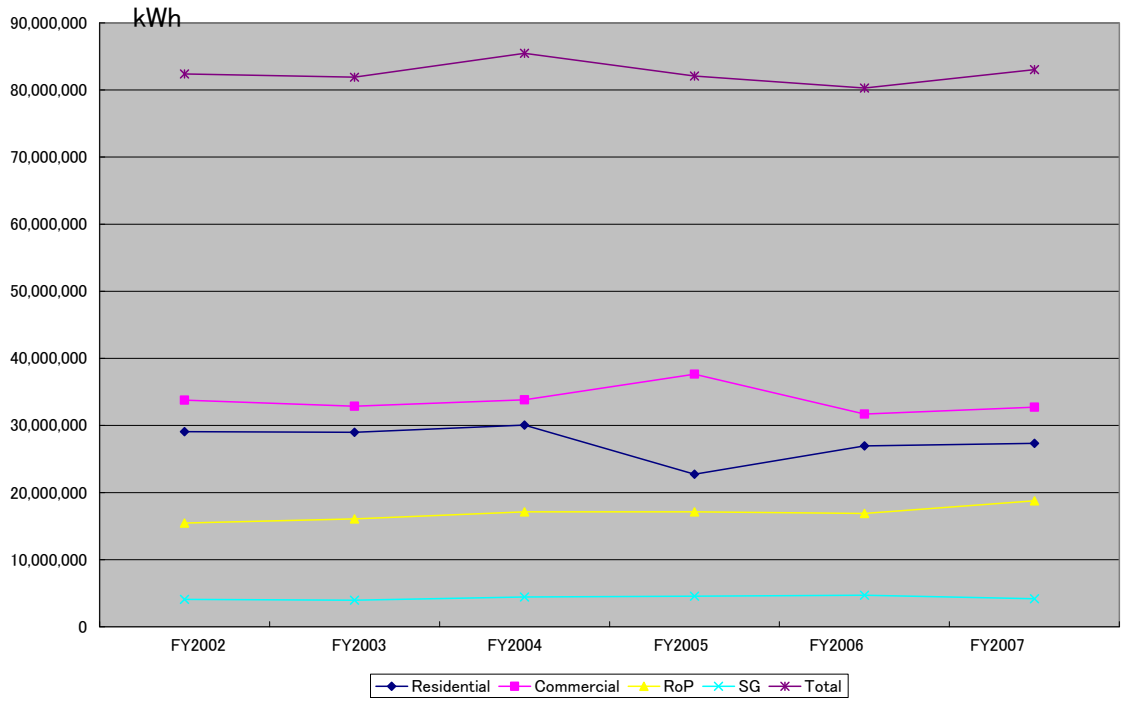
In terms of power consumption volume, the following figure shows each customer classification type's share for FY 2007 (Oct. 2006 – Sept. 2007). Currently, the commercial customers consume 32.7 million kWh (39.4%), the residential consumer 27.3 million kWh (32.9%), RoP 18.8 million kWh (22.6%), and SG 4.2 million kWh (5.0%).



Source: Calculated and Prepared by JICA Study Team, on the Basis of PPUC Data

Fig. 3.3.3-3 The Current Power Consumption Share by User Type

In recent years, the overall power consumption volume has not increased so much. The yearly consumption of Palau has been stayed around 80 million kWh in total. This fact can be attributed to several reasons. According to PPUC, public awareness of saving energy has well penetrated. On the other hand, this might be presumably because the power supply capacity has not grown in the past decade. As a result, the power consumption volume has been stagnant. It is presumed that potential demand will be bigger than actual consumption.

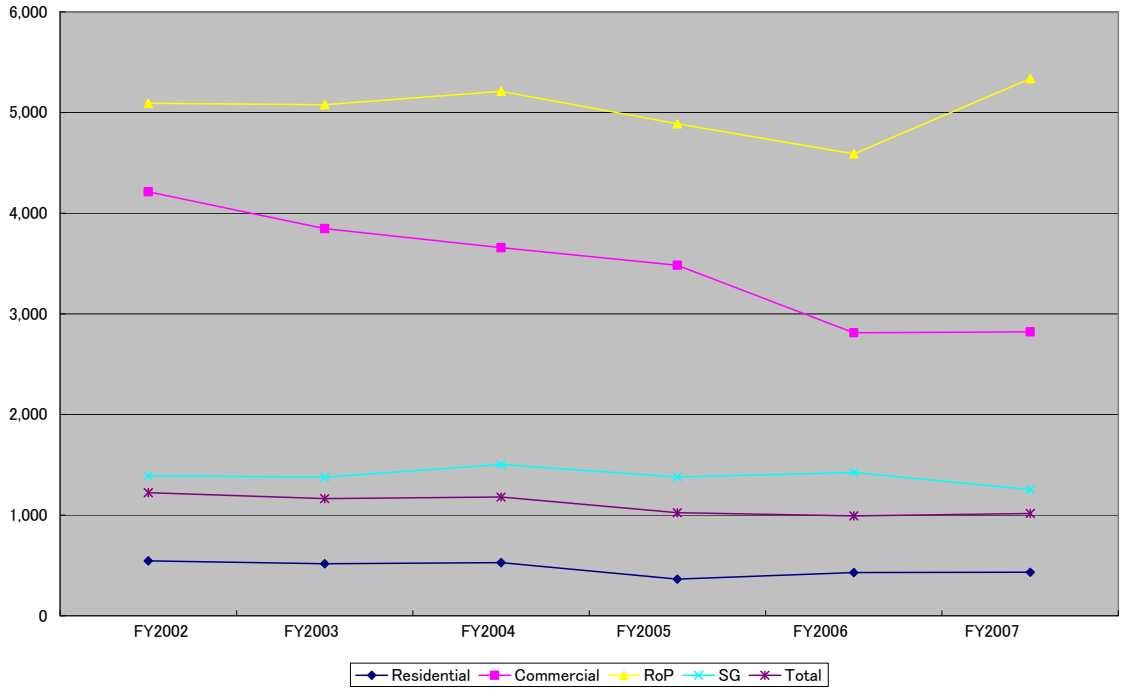


Source: Calculated and Prepared by JICA Study Team, on the Basis of PPUC Data

Fig. 3.3.3-4 Power Consumption Volume in Recent Years by User Type Classification

As shown above, the number of customer accounts steadily continued to increase, but the consumption volume has been stagnant in recent years. As a result, the power consumption per account has been generally on decreasing trend.

In terms of residential user, the monthly consumption volume per account decreased from the range of 500~550 kWh for the years of FY2002-FY2004 to around 430 kWh in FY2007. The average decrease rate is around 4.5% per annum. The commercial consumption per account has decreased more drastically from 4,213kWh/month (FY2002) to 2,821kWh/month (FY2007). The decrease rate is 7.7% per annum. On the other hand, the government sector has not decreased its consumption per month per account so much as shown below. The curve has been fluctuating, but not on a steady decreasing trend.



Source: Calculated and Prepared by JICA Study Team, on the Basis of PPUC Data

Fig. 3.3.3-5 The Recent Trend of Power Consumption Volume per Account per Month by User Type

Table 3.3.3-2 The Recent trend of Power Consumption Volume per Account per month

Unit: kWh/account

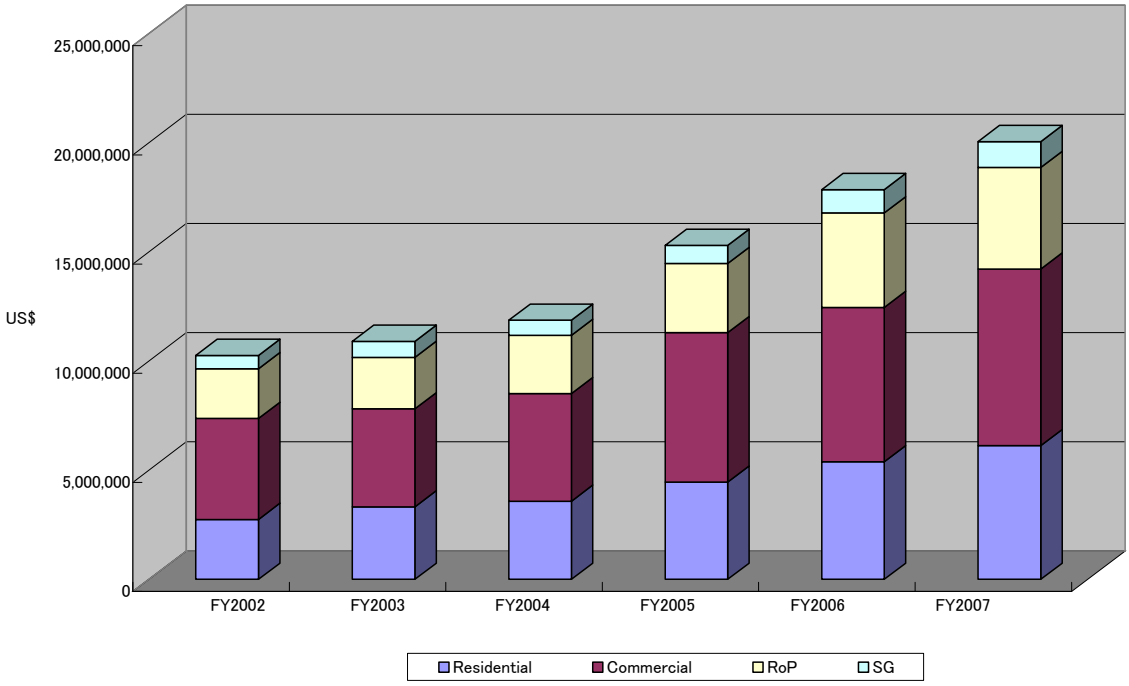
Year	Residential	Commercial	RoP	SG	Total
FY2002	545	4,213	5,093	1,391	1,223
FY2003	520	3,847	5,078	1,377	1,165
FY2004	528	3,657	5,212	1,503	1,180
FY2005	364	3,482	4,888	1,380	1,025
FY2006	430	2,812	4,590	1,424	992
FY2007	433	2,821	5,338	1,253	1,018

Source: Calculated and Prepared by JICA Study Team, on the Basis of PPUC Data

(2) Revenue and Expense

Operating Revenue

Irrespective of stagnant trend of consumption volume, the operating revenue of PPUC has climbed up from US$8,658,402 (FY2000) to US$20,050,833 (FY2007). Nominally, it substantially increased by 2.3 times larger. The increase rate is 15% per annum. These increases, however, were caused mainly by AFPAC and the cost recovery has not been sufficient as mentioned in the preceding sections. The fact is that PPUC have only managed to recover a substantial part of the fuel cost increase with the mechanism of AFPAC, but not completely, because of the delayed response of quarterly adjustment. In addition, AFPAC can cover only fuel cost increase, but it does not include the other factors such as general inflation and equipment renewal etc.



Source: Prepared by JICA Study Team, on the basis of PPUC data

Fig. 3.3.3-6 PPUC's Recent Increase of Revenue from Electricity Sales By User Type Classification, FY2002-2007

Table 3.3.3-3 PPUC's Revenue from electricity sales by user type category

Unit: US$

Year	Residential	Commercial	RoP	SG	Total
FY2002	2,744,590	4,624,896	2,278,272	607,495	10,255,253
FY2003	3,318,575	4,496,116	2,354,608	729,455	10,898,754
FY2004	3,580,978	4,928,828	2,664,873	692,694	11,867,373
FY2005	4,457,653	6,845,104	3,165,292	827,760	15,295,809
FY2006	5,384,911	7,070,616	4,331,962	1,062,991	17,850,480
FY2007	6,128,269	8,084,317	4,649,841	1,188,406	20,050,833

Unit: %

Year	Residential	Commercial	RoP	SG	Total
FY2002	26.8	45.1	22.2	5.9	100
FY2003	30.4	41.3	21.6	6.7	100
FY2004	30.2	41.5	22.5	5.8	100
FY2005	29.1	44.8	20.7	5.4	100
FY2006	30.2	39.6	24.3	6.0	100
FY2007	30.6	40.3	23.2	5.9	100

Source: Prepared by JICA Study Team, on the basis of PPUC data

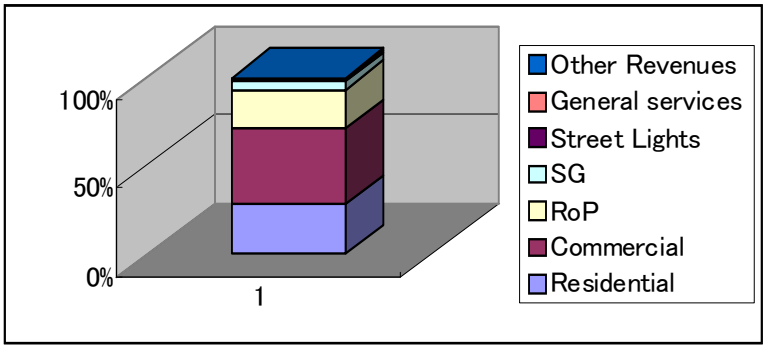
In terms of occupancy rate by user type, the commercial customers's share is largest (40%), followed by residential (30%) and government (30%).

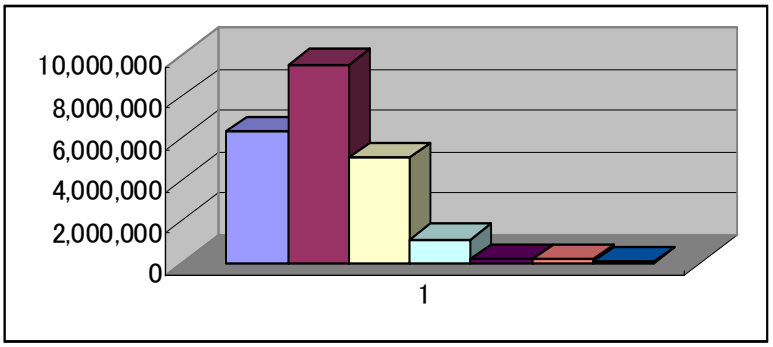
The operating revenue of PPUC is generated mostly from electric power sales, but a very small portion is generated from non-electric power sales such as connection fees, late payment charges, pole attachment fees etc. In FY 2006, power sales generated 98% of operation revenue, and 97% in FY 2005. From FY 2007, PPUC started to collect revenue for electricity provision for street lights, which accounted for around US$151,000.

The latest budget for operating revenue for FY 2008 is shown below:

Table 3.3.3-4 PPUC's FY 2008 Budget of Operating Revenue

Item	Revenue (US$)	%
Residential	6,286,700	28.1
Commercial	9,568,000	42.8
RoP	5,034,900	22.5
SG	1,087,100	4.9
Street Lights	154,800	0.7
General services	157,400	0.7
Other Revenues	56,600	0.3
Total	22,345,500	100.0





Source: Prepared by JICA Study Team on the basis of PPUC's Authorized Budget for FY 2008

Fig. 3.3.3-7 PPUC's FY 2008 Budget of Operating Revenue

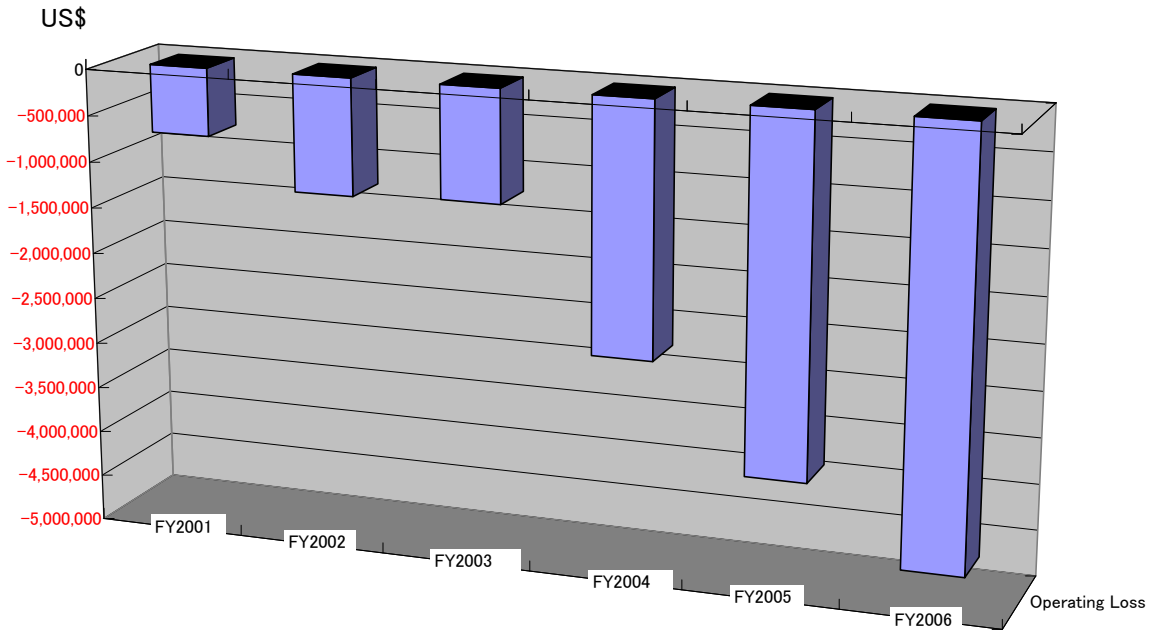
Operating Loss

The following table shows the recent situation of revenue and expenditure, based on the audited financial statements, FY2001-FY2006. The operation of PPUC has turned out to be constantly loss, and the annual amount of operating loss has been steadily increasing from US$ 735,673 (FY 2001) to US$ 4,686,601 (FY 2006).

Table 3.3.3-5 Recent Operating Loss, Non-Operating Revenue and Change in Net Assest

Item	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Operatring Revenue						
Power	11,107,747	10,189,964	10,808,975	11,739,414	15,073,865	17,482,734
Other	419,747	231,545	302,522	242,266	414,559	321,351
Sub-Total	11,527,494	10,421,509	11,111,497	11,981,680	15,488,424	17,804,085
Bad Debts	0	0	0	0	288,788	-86,396
Net Operating Revenue	11,527,494	10,421,509	11,111,497	11,981,680	15,777,212	17,717,689
Opersating Expenses						
Generation-Fuel Cost	7,265,841	6,279,414	6,977,392	8,403,772	12,656,688	15,530,247
Generaton-Other Cost	1,091,123	1,277,842	1,217,513	1,631,389	2,444,890	2,355,184
Depreciation	2,248,848	2,234,400	2,236,790	2,239,607	2,356,631	2,506,465
Distribution and Transmissions	809,893	1,046,461	1,044,065	1,561,029	1,165,961	1,059,226
Administration	814,595	826,033	771,060	691,437	838,435	786,834
Engineering Services	32,867	20,983	83,667	198,050	189,640	166,334
Sub-Total	12,263,167	11,685,133	12,330,487	14,725,284	19,652,245	22,404,290
Operating Loss	-735,673	-1,263,624	-1,218,990	-2,743,604	-3,875,033	-4,686,601
Non Operating Revenue	1,197,687	2,595,672	1,110,422	571,669	1,276,885	673,376
Net Income (1)	462,014	1,332,048	-108,568	-2,171,935	-2,598,148	-4,013,225
Net Income (2) : (1)+Depreciation	2,710,862	3,566,448	2,128,222	67,672	-241,517	-1,506,760

Source: Statements of Revenues, Expenses and Changes in Fund Equity, Audited by Deloitte, Touche Tohmatsu

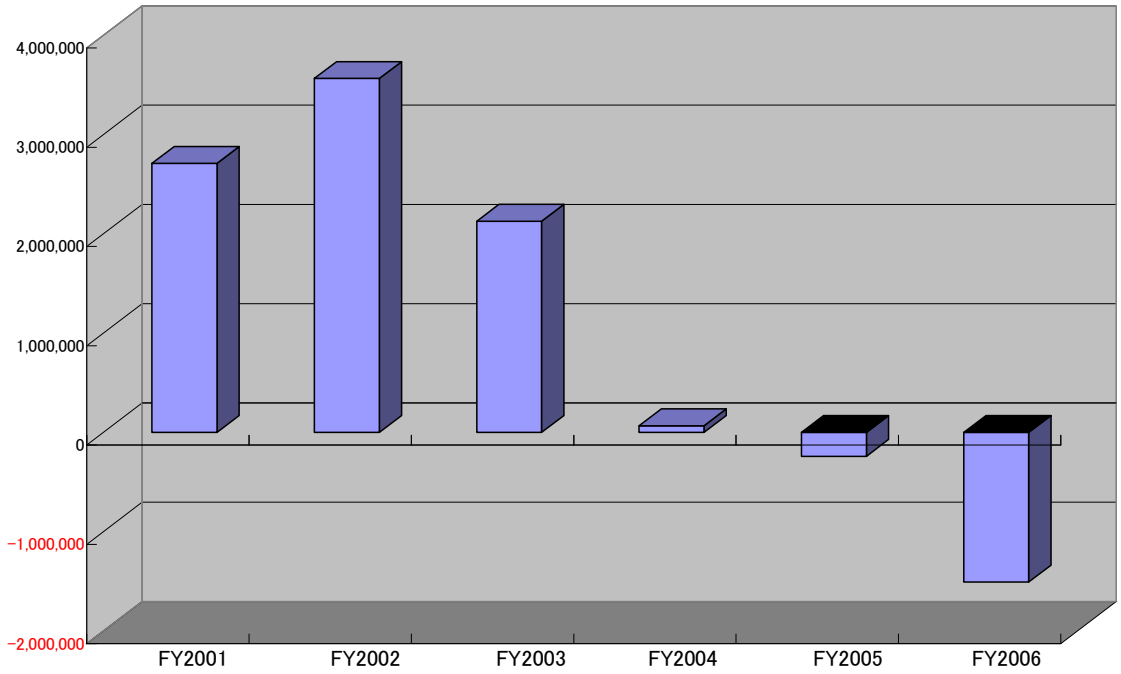


Source: Prepared by JICA Study Team, on the basis of Statements of Revenues, Expenses and Changes in Fund Equity, Audited by Deloitte, Touche Tohmatsu

Fig. 3.3.3-8 Operating Loss of PPUC

Until 2002, the operating loss was balanced by non-operating revenue (US federal grants; RoP supplemental appropriation; interest income etc.). After 2002, however, such supplements from non-operating revenue could not come to offset the annually and steadily increasing operating loss. The changes in net assets fell under zero in FY2003. Although the operating loss situation has been worsened year by year in recent years, the RoP national government has not extended a supplemental budget appropriation since 2002. The last appropriation was done in 2001. The US federal grants have not been increasing irrespective of such constant operating loss situation as well. In this context, it is deemed as essential for

PPUC to improve the situation of revenue and expenses fundamentally, in order to be a sustainable entity.



Source: Prepared by JICA Study Team, on the basis of Statements of Revenues, Expenses and Changes in Fund Equity, Audited by Deloitte, Touche Tohmatsu

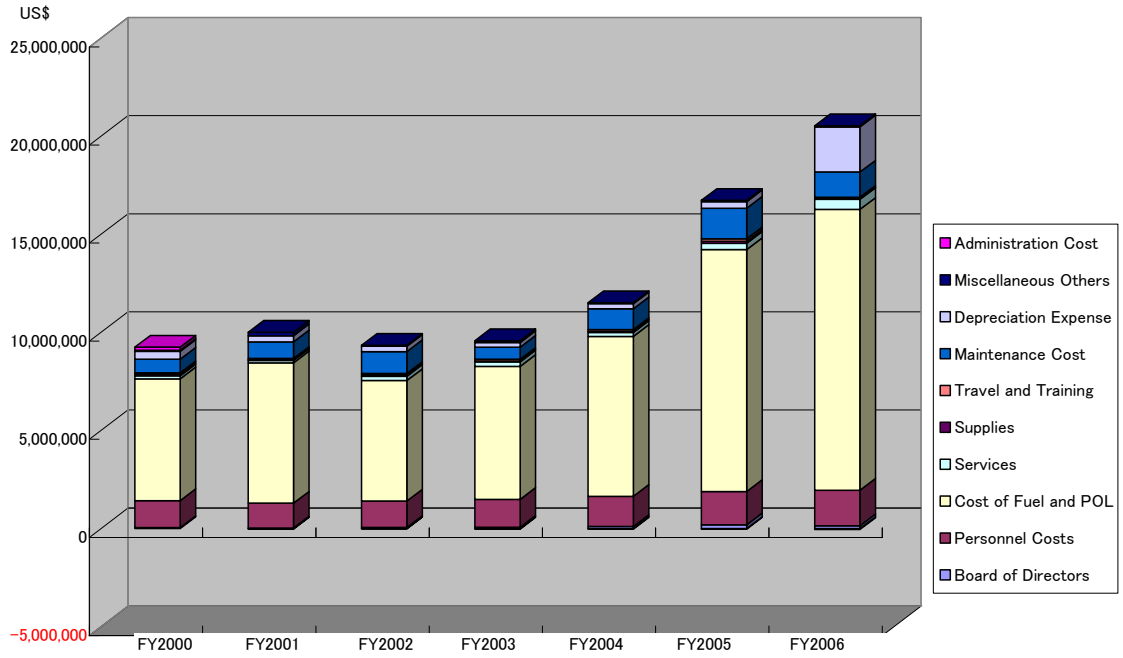
Fig. 3.3.3-9 Net Income of PPUC, FY2001-FY2006

Since depreciation is not actually cash disbursement, the modified calculation of Net Income (2) is done by adding back depreciation amount. In the case, Net Income (2) could be kept marginally plus until FY 2004. However, it fell under zero in FY 2005.

Operating Expense

In order to make both ends meet, PPUC will have to take a course of actions: 1) to increase revenue or 2) to decrease expense, or 3) mixture of the two ways.

The following figure shows the breakdown of operating expense in recent years. As Financial Statements does not represent a detailed breakdown by items, JICA Study Team adopts to use, herein, the data and information examined in “2007 Electric Rate Study’’

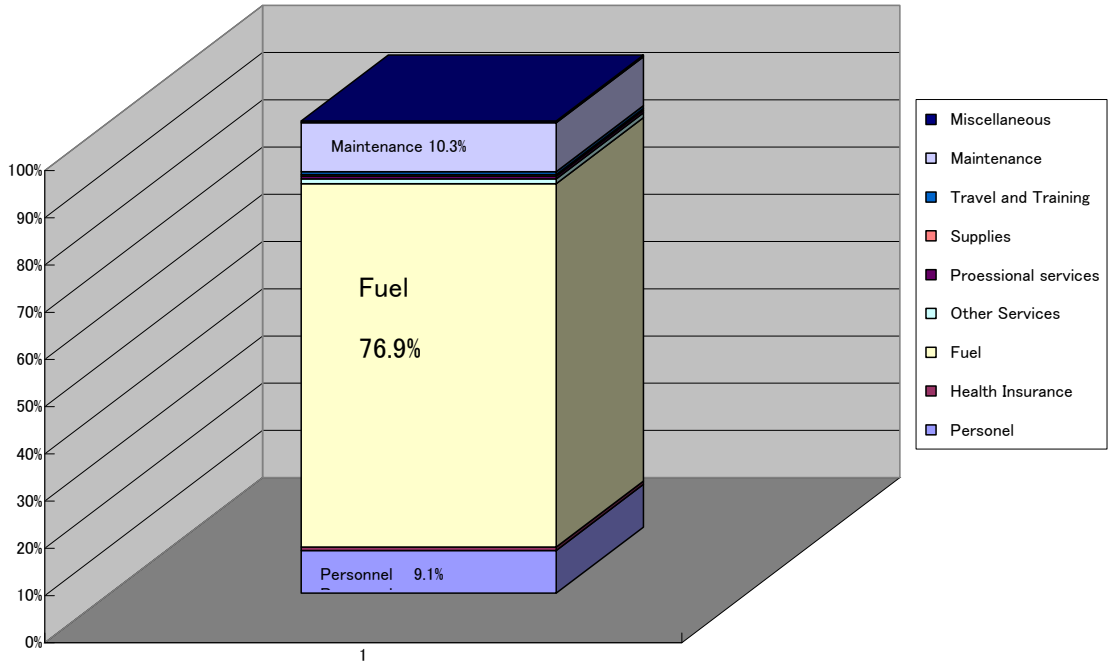


Source: Prepared by JICA Study Team, by using the PPUC data used in "2007 Electric Rate Study"

Fig. 3.3.3-10 Breakdown of Operating Expense by Items in Recent Years

Definitely shown above, fuel cost is overwhelmingly the most significant item. The total operating expense has increased from approximately 9 million (FY2000) to 20 million. Particularly for these last 4 years, the operating expense has showed a steep rise.
Provided that PPUC could reduce the fuel cost substantially, PPUC's financial viability would be improved largely. The extent of the other items' influence is very small, in comparison with fuel. Even if PPUC may have exerted so much effort for cost reduction in the other items, we can expect to achieve a very small gain except the fuel cost reduction.

In reference to the on-going budget for FY 2008, the following table shows the budget for the operating expenses by item. The depreciation cost is not included, since depreciation is not actual cash expense. Bad debt is not included either, as the item is not included in the category of operating expense, but in the category operating revenue in the financial statements of PPUC.



Source: Prepared by JICA Study Team, by using the information of the authorized budget for FY 2008
Note 1: Depreciation cost is excluded
Note 2: bad debt expense cost is excluded

Fig. 3.3.3-11 PPUC's budget for Operating Expenses for FY 2008

In terms of money amount, the operating expenses budget accounts for US$ 25.1 million. If excluding the depreciation cost and bad debt expense, it accounts for US$22.4 million, of which fuel expense accounts for US$17.2 million (approx. 77%). It is noteworthy to mention that this projection of fuel expense is based on the average price of FY 2007, which is only US$ 2.3/gallon. However, PPUC's actual procurement price of diesel oil has been far beyond US$2.3/gallon, since the beginning of FY2008. The unit price of actual procurement was US$2.9/gallon from October 2007 to January 2008, and rose to US$3.4/gallon in March 2008, and further more to US$3.7/gallon in May. Realistically speaking, the price is unlikely to decrease for the time being. JICA Study Team estimates that the annual average price of FY2008 procurement will be around US$3.4/gallon under the assumption that the average price will be near around the price of just in the middle of FY2008 (March price). In this case, the difference of fuel cost between the budget estimate and actual procurement will reach US$8.6 million.

This financially means that the operating loss of PPUC may be enlarged from US$ 2.7 million (FY 2008 Budget of PPUC) will reach or exceed US$ 10 million. PPUC should have given more consideration on fuel price hike, when making budget planning. As the FY 2008 budget is already made, PPUC should take prompt actions for revenue increase steps by revision of electricity tariff, revision of the budget, or both ways.

3.3.4 Fundamental Direction for Cost Recovery Improvement

In order to improve PPUC's financial performance, there will be two ways. One is cost reduction and the other is revenue increase.

As analyzed above, the PPUC's structure of expenditure has a striking characteristic. It is the fact that fuel cost is by far the largest expense item. Even if PPUC may make efforts of cost

recovery improvement in the other aspects, the result will be very trivial. It is urgent and far more important for PPUC to reduce fuel cost. If it is impossible or very difficult in short term, PPUC's should consider about revenue increase steps. The revenue increase which means to increase tariff, will probably, be inevitable in the short term, because the fuel cost reduction can be done with new power generation equipment installment. It will take a few years, although tariff increase will have to be avoided as much as possible, in view of keeping stability of public life.

3.4 Main Steps to be Taken for Improvement of Financial Performance and Operation Efficiency of PPUC

3.4.1 Switch from Diesel Fuel Oil to Heavy Fuel Oil

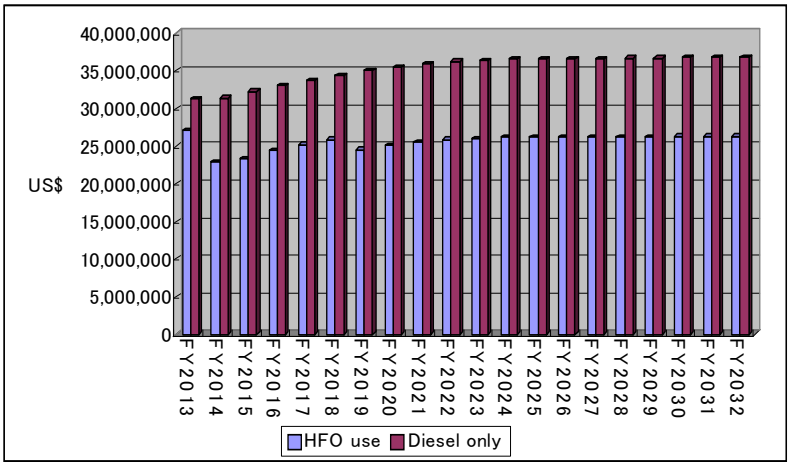
As analyzed in the preceding sections, fuel cost is the main and key driver of operation expense of PPUC. The second large item is maintenance. Fuel cost and maintenance occupy approx. 77% and 10% respectively. In order to improve PPUC's operation, it is deemed as essential to reduce fuel cost. In general, heavy fuel oil is much cheaper than diesel oil. The price of HFO is around 55-60%. HFO is widely used for industrial purpose not only by electricity utility companies but also various industrial makers.
One of the issue to be raised and solved is logistics. Pacific countries are not using HFO at present. They are using only diesel for the purpose of power generation. The two oil major companies which provide PPUC with diesel oil, does not supply HFO in Pacific areas. Guam, however, is using HFO currently. Provided that Palau can make an arrangement to procure HFO like Guam Power Authority, it will enable PPUC to reduce fuel cost substantially. In the chapter 5, such technical and logistic issues are examined and it will be very possible to solve those issues. However, as the procurement is a result of business negotiation, the final confirmation will be dependent on further business negotiations. Let's make a hypothetical assumption and conduct comparison of fuel expense between the present situation and the situation of having assumingly installed new power generation equipments. In the latter case, we may assume the fuel consumption of using two fuels: 80% (HFO) and 20% (Diesel). JICA Study Team hypothetically presumes that the fuel expense of US$ 25 million will be reduced down to around US$ 15 million. (The budgetary appropriation of FY 2008 for fuel cost is around US$ 17 million. As aforementioned in the preceding section, this calculation is based on the assumption of US$2.27/gallon. In fact, the unit price is, however, much higher and still rising. The fuel cost will actually reach approximately US$ 25 million. It will be a very possible scenario.) There will be a potentiality that PPUC will be able to make such a substantial reduction as US$ 8 to 10 million per annum. Although there are some issues to be solved, it will be worthwhile to make strenuous effort for finding solutions for them. The assumption is based on the technical design to be proposed by JICA Study. For further detail of technical assumption, please see the chapters and sections concerned in this report.

The following graph shows the future projection (FY2013-FY2032) of fuel expense reduction and comparison between the continued use of diesel oil only and the situation of fuel change (HFO80%, Diesel 20%). This is endorsed by the technical design of new Aimeliik Power Plant, but we have to find a logistic solution for procurement of HFO. If successful, it will lead to a revolutionary and pioneer event of realizing a big improvement of cost reduction in Pacific islands areas.

Comparison of fuel cost between the two scenarios (FY2013-FY2032)

Unit:US$

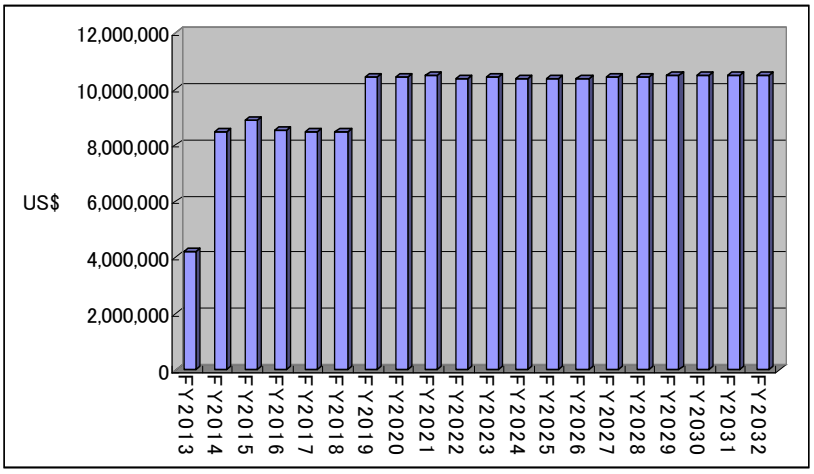
Fiscal Year	HFO use	Diesel only
FY2013	27,063,279	31,301,272
FY2014	22,921,160	31,397,146
FY2015	23,400,613	32,280,452
FY2016	24,463,957	32,994,048
FY2017	25,236,274	33,712,261
FY2018	25,851,253	34,327,239
FY2019	24,563,877	35,008,638
FY2020	25,059,643	35,499,535
FY2021	25,467,029	35,931,267
FY2022	25,858,888	36,241,971
FY2023	26,026,267	36,460,749
FY2024	26,211,156	36,594,239
FY2025	26,238,584	36,621,668
FY2026	26,266,560	36,649,644
FY2027	26,245,862	36,677,639
FY2028	26,257,646	36,705,654
FY2029	26,269,449	36,733,688
FY2030	26,297,503	36,761,742
FY2031	26,325,577	36,789,816
FY2032	26,353,671	36,817,909



Projected Difference (Amount: US$) between Two Scenarios (FY2013-FY2032)

Unit:US$

Fiscal Year	Diference
FY2013	4,237,993
FY2014	8,475,987
FY2015	8,879,839
FY2016	8,530,090
FY2017	8,475,987
FY2018	8,475,987
FY2019	10,444,762
FY2020	10,439,892
FY2021	10,464,239
FY2022	10,383,083
FY2023	10,434,482
FY2024	10,383,083
FY2025	10,383,083
FY2026	10,383,083
FY2027	10,431,777
FY2028	10,448,008
FY2029	10,464,239
FY2030	10,464,239
FY2031	10,464,239
FY2032	10,464,239



Switch: Fuel will be changed from diesel to HFO (Consumption: HFO80%, Diesel 20%)
Continue: PPUC will continue to use diesel oil.
Source: Projected by JICA Study Team, based on the technical design proposed by JICA Study Team

Fig. 3.4.1-1 Comparison of Fuel Expense Projection by Two Alternative Scenarios

In addition, the installation of new electric power generators will lead to improvement of operation efficiency. The energy consumption efficiency of new power generation generators will be better than the currently used ones. The existing plant generates power with the efficiency of 13.5kWh/gallon of diesel oil, but the power plants to be newly installed are assumed to generate electric power with the efficiency of 16.5 kWh/gallon of HFO. It will come up to around 20% efficiency improvements.
On the other hand, in case of HFO use, an increase of power consumption within the power station concerned may be caused. It will lead to a certain cost increase. Those minus effects are included as well in the calculation as shown above. In total, the cost reduction effect to be realized will be enormous.

3.4.2 Revision of Electricity Tariff of PPUC

The big expense reduction through fuel switch will be enabled by the realization of replacement of Aimeliik Power Plant. It will take a few years to proceed until the start of new power plant

operation. Currently, PPUC is working on the rehabilitation of two generators of Aimeliik. The rehabilitation is estimated to result in 11.4% reduction of fuel for the two generators for 3-4 yaers. (13.3 kWh/gallon → 15 kWh/gallon at most). It means around approximately 2.8% reduction (US$ 0.62 million) for fuel consumption. For the forthcoming several years, PPUC will not be able to make any big changes in the aspect of cost reduction. It seems however, that, PPUC is not in a position to just wait and see until the replacement of Aimeliik Power Plant. It will raise an urgent necessity to improve PPUC financially. The immediate step to be taken for PPUC is definitely to increase revenue with means of electricity tariff revision.

In terms of the current situation of PPUC in financial aspect, it is a paramount need to make both ends meet between operating expense and operating revenue. In order to be really autonomous and sustainable, PPUC's constant operating loss situation must be changed into constant operating profit. PPUC does not have to earn a big operating profit, but PPUC has to earn a slightly plus income. PPUC does not tend to be dependent on non-operating revenue.

The following table is the operating expense of PPUC for FY 2008 budget with the modification made in fuel expense by JICA Study team.

Table 3.4.2-1 Operating Expense for FY2008, Forecasted by JICA Study Team

Operating Expenses	Amount(US$)	%
Personel	2,031,900	6.2
Health Insurance	138,100	0.4
Fuel	**25,000,000**	76.4
Other Services	230,420	0.7
Proessional services	121,500	0.4
Supplies	81,950	0.3
Travel and Training	139,500	0.4
Maintenance	2,317,540	7.1
Depreciation	2,590,600	7.9
Miscellaneous	84,750	0.3
Total	**32,736,260**	100.0

Source: Prepared by JICA Study Team, on the basis of PPUC's budget for FY2008, with the modification done by JICA Study team

Note 1: Fuel expense projection is modified

Note 2: Bad debt expense is eliminated

Note 3: Depreciation remains as it is. Depreciation is not actual cash outflow. For preparation of future capital renewal, however, PPUC should accumulate a certain money reserve. Otherwise, it will have to depend on the Government or foreign assistance.

The 2007 Electric Rate Study estimates the fuel cost at US$ 18.55 million by using the assumption of the unit price of diesel oil at US$2.5. It is a little bit higher than the PPUC using rate of US$ 2.27. However, those two forecasts of the rates look very optimistic than the actual procurement price trend in recent days. For FY2008, the average procurement price is estimated to be around US$3.4/gallon by JICA Study Team.

Table 3.4.2-2 Fuel Cost Forecast Comparison

	Unit Price of Diesel Oil, used	Fuel Expense Forecsted
PUCC's Budget for FY2008	US$ 2.27	US$ 17,229,540
The Electric Rate Study	US$ 2.50	US$ 18,550,000
JICA Study Team Forecst	US$ 3.40	US$ 25,000,000

Source: "The 2007 Electric Rate Study", "PPUC's Budget FY2008", and JICA Study Team's forecast on the basis of the current price as of January 2008. (JICA Study Team's projection includes the cost reduction expectation to be caused by the on-going rehabilitation of Aimeliik's two generators.)

In terms of basic principle for cost recovery of PPUC, it should be more clarified and undergo change for a self-sustaining body. Taking a look at PPUC's non-operating revenue for these several years, PPUC can expect neither any subsidy from the Government nor substantial amounts of grants from United States. PPUC should be much more self-sustainable and independent. Beased on such recognition, PPUC must achieve a balance of operation revenue and expenses. In view of preparing for future equipment replacement, the balance should be achieved without excluding depreciation expense. The 2007 Electric Rate Study does not include depreciation expense in the corresponding money outflow forecast to be recovered by the operating revenue. JICA Study Team's recommendation is that PPUC should make full cost recovery to include future capital asset renewal as well. In other words, the power revenue will have to make cost recovery for approximately US$ 33 million. JICA Study Team estimates that the electricity consumption will account for approx. 84,000,000 kWh.
In order to ensure financial sustainability of PPUC, PPUC is hoped to charge around 39 cents per kWh as electricity rate as a whole.

Table 3.4.2-3 Overall Electricity Rate for Cost Recovery to Ensure Sustainability of PPUC FY 2008

Total Power Consumption Forecasted (FY2008)	**84,000,000kWh**
Total Revenue to be Collected for Cost Recovery (FY2008)	**US$ 33,000,000**
Overall electricity rate to be charged	**US$ 0.39**

Source: Calculated by JICA Study Team, on the basis of PPUC data

As a matter of fact, the world upsurge trend of energy price will continue for the time being. Without taking any steps to this oil price hike, PPUC will surely be faced with financial difficulty very soon. For this financial year of 2008, it will already be very probable that the operating loss will go beyond US$ 10 million. Taking a look at this financially gloomy situation, the revision of PPUC's electricity tariff should be done immediately.
As aforementioned in the section of current rate analysis, the electricity rate of Palau has been the lowest among the countries in Pacific areas. However, GDP per Capita of Palau is relatively high. (Cook Island is the richest, followed by Palau.). The poster of electricity comparison among Pacific Island Countries as of 2004 is attached on the wall in Malakal Power Plant. It shows the lowest by far among those countries. PPUC has tried to raise tariff from time to time, but in vain so far.

(1) Strategy for Electricity Tariff Revision

In terms of revising and raising tariff rate, we should keep in mind about following things:

- **Achieve full cost recovery in view of sustainability**
- **Don't integrate the basic rate and AFPAC into one simple tariff structure. Please continue to have the system of AFPAC to ensure accountability to the public for price adjustment for fuel cost escalation**
- **Be prompt for fuel price hike (Adopt monthly review of AFPAC)**
- **AFPAC should be revised and developed from just adjustment item to a fully corresponding item to cover the whole fuel cost**
- **Complete consensus building within a few months, and adopt new electricity tariff, at latest from the beginning of FY 2009**

<u>When should PPUC embark on the adoption and implementation of new electricity tariff?</u>
As analyzed in this chapter, it is urgent and paramount need to raise tariff as soon as possible. Otherwise, PPUC financial situation will be worsened rapidly. On the other hand, such revision and increase of tariff must undergo a certain process prescribed by PNC 37, Sec.413.

After the process, the new tariff shall be adopted. In this connection, probably several months will elapse until the adoption of new tariff rate. At latest until the end of FY2008, however, it is hoped that PPUC will adopt a new tariff and construct a balanced financial structure of revenue and expense.

What should be kept in mind for building a new tariff structure?

Firstly, PPUC must increase overall electricity rate by 40-50% in order to avoid the financial distress which will take place soon if PPUC cannot make any corrections for operation loss structure. For these seven years, AFPAC has gradually increased, but no change has happened to basic rate since October 2001. The whole structure of electricity tariff including of both basic rate and AFPAC should be urgently revised. For these seven years, a part of fuel cost has been recovered but insufficiently. The current rate of AFPAC (0.17/kWh) which is now effective from May 2008 is far behind the full-recovery level. In order to clearly reflect the actual cost structure, JICA Study Team proposes that the basic structure shall be revised as follows:

AFPAC	■ Recover fuel cost completely ■ Monthly revision , for prompt reflection of fuel price change
Basic rate / Customer Charge	■ Recover the other cost (except fuel cost) completely ■ Annual revision, to reflect the annual budgetary estimate and corporate planning ■ Keep the structure of customer charge as it is

Consensus about full cost-recovery principle among the Board of directors, the Management and the Government and strict responsibility to achieve the goal

This is like the essentially needed condition for PPUC to achieve full cost recovery. Taking a look at the adopted budgets of PPUC for the recent years, operating loss has been constantly forecasted and built-in in the budgets for these years at the time of adopting the budgets. This will indicate that neither Board of Directors nor the Management has been keen about importance of recovering all the operation expenses. Maybe the Government does not like to increase tariff for political reason and have not been inclined to facing the situation of drastic change. Without the change in mind and common recognition of full cost recovery, the revision plan is just a plan and will not be implemented. In case that operation loss may be caused in PPUC, strict responsibility shall be born to the Board of Directors and the Management. Such instruction or direction must be necessary.

(2) Short-term Measures (FY2019-2012)

For this period, there is no possibility to change fuel for cost reduction, since Aimeliik Replacement Project will start operation from FY2013. It means that PPUC must continue to use diesel for the next coming 5 years.

In view of preparing equity portion requirement for the forthcoming projects, PPUC must accumulate cash reserve or make arrangements with the Government of Palau to provide equity portion. In order to be an autonomous and sustainable corporation, PPUC is hoped to raise electricity rate and accumulate the necessary cash reserve.

Based on the basic principles and strategies, JICA Study Team will propose a new tariff structure as follows:

Underlying assumption:

In FY 2009, the operating revenue should catch up with the operating expense (US$37 million), which is projected in accordance with JICA Study Team's power consumption forecast and the latest price of diesel oil procurement (May 2008).

In addition, PPUC should give consideration about the matter that commercial and government customers will be more endurable to electricity tariff rate increase than residential customers. In this connection, a certain alleviation steps for residential customers should be considered by PPUC and the Government of Palau. The basic rates and customer charges have not been changed for a long time, while AFPAC rates have been changed once in a while. In terms of AFPAC, PPUC shall apply lower rate to residential customers than commercial/ government customers. PPUC shall not change the rates of customer charges and basic rates.
For FY 2009, the revenue from residential customers will occupy 31.6%, and that from commercial/government customers will occupy 68.4% respectively. After the adopting the proposed change as shown below, the contribution share will be changed as 72.4% from commercial/government, and 27.6% from residential. To some extent, electricity payment load for residential customers will be relieved.

Table 3.4.2-4 New Electric Tariff Rate to be proposed for the Target Year FY 2009
(Case 1: Even Imposing Option)

Unit: US$

Charge item			Residential	Commercial/ Government
Monthly Minimum Energy Charge			3	10
Cost per Kwh				
	0-500	Kwh	0.08	0.10
	501-2000	Kwh	0.10	0.10
	2001above	Kwh	0.12	0.12
AFPAC Oct. 2008-Sept. 2009			0.31	0.31

Note:AFPAC (Automatic Fuel Price Adjustment Clause)
Source: Proposed by JICA Study Team in consideration of the aforementioned strategies and principles

Table 3.4.2-5 New Electric Tariff Rate to be proposed for the Target Year FY 2009
(Case 2: Residential Customer Preferential Option)

Unit: US$

Charge item			Residential	Commercial/ Government
Monthly Minimum Energy Charge			3	10
Cost per Kwh				
	0-500	Kwh	0.08	0.10
	501-2000	Kwh	0.10	0.10
	2001above	Kwh	0.12	0.12
AFPAC Oct. 2008-Sept. 2009			0.26	0.33

Note:AFPAC (Automatic Fuel Price Adjustment Clause)
Source: Proposed by JICA Study Team in consideration of the aforementioned strategies and principles

Assumption on AFPAC

- ✧ FY 2009 electricity consumption forecasted by JICA Study team: 95,000,000 kWh
- ✧ FY 2009 fuel cost projected by JICA Study Team: US$ 29,000,000
- ✧ Diesel oil unit price: the same as the current price as of March 2008
- ✧ The AFPAC tariff charging shall be done on the whole consumption of kWh

Assumption on the composition of customers, FY 2009

- ✧ The total customers: 6,920
- ✧ Breakdown: a) Residential:5,355; b) Commercial: 984; c) RoP: 298; d) SG:283

Assumption on the operating expense, FY2009

- ✧ The total operating expense: US$37,000,000
- ✧ Fuel expense: US$29,000,000
- ✧ The other expenses: US$8,000,000

Assumption on the revenue contribution between residential customers and Commercial/ government customers

Share of Electricity Payment for FY2009 under the "even-share" Option

Residence	31.60%
Commercial/Government	68.40%

Share of Electricity Payment for FY2009
Under the "Residential-Preferential" Option

Residence	31.60%
Commercial/Government	68.40%

Provided that PPUC adopts the proposed tariff rate schedule in FY 2009, the following table shows the projected result of revenue for PPUC

Evenly-Imposing Option

Table 3.4.2-6 Projected Revenue from Residential Customers, the Target Year of FY2009

Projected Revenue from Residential Customers, under the Proposed New Tariff Structure, FY2009

Monthly use of Electric Power (kWh)	Number of billings	Customer Charge Rate (US$)	Revenue1 from Customer Charge (US$)	FY2009 Projected Sales (kWh)	Basic Rate (US$/kWh)	Revenue2 from Basic Rate Charge (US$)	AFPAC Rate (US$/kWh)	Revenue3 from AFPAC (US$)	Total Revenue (US$)
0-500 kWh	45,296	3	135,888	10,044,754	0.08	803,580	0.31	3,113,873	4,053,341
501-2000 kWh	10,355	3	31,065	14,673,456	0.1	1,467,345	0.31	4,548,771	6,047,181
Over 2000kWh	8,607	3	25,821	3,823,052	0.12	458,766	0.31	1,185,146	1,669,733
Total	64,260		**192,774**	28,541,261		**2,729,691**		**8,847,790**	**11,770,255**

Source: calculated by JICA Study Team

Table 3.4.2-7 Projected Revenue from Commercial Customers, the Target Year of FY2009

Projected Revenue from Commercial Customers, and Government under the Proposed New Tariff Structure, FY2009

Classification of Customers	Number of billings	Customer Charge Rate (US$)	Revenue1 from Customer Charge (US$)	FY2009 Projected Sales (kWh)	Basic Rate (US$/ kWh)	Revenue2 from Basic Rate Charge (US$)	AFPAC Rate (US$/ kWh)	Revenue3 from AFPAC (US$)	Total Revenue (US$)
Commercial	11,808	10	118,080	37,511,511	0.10	3,751,151	0.31	11,628,568	15,497,799
RoP	3,576	10	35,760	19,691,727	0.10	1,969,172	0.31	6,104,435	8,109,367
SG	3,396	10	33,960	4,385,612	0.12	526,273	0.31	1,359,539	1,919,772
Total	0		**187,800**	66,559,221		**6,246,596**		**19,092,542**	**25,526,938**

Source: calculated by JICA Study Team

Option of Providing Preferential Rate for Residential Customers (Commercial/Government customers will pay more)

Table 3.4.2-8 Projected Revenue from Residential Customers, the Target Year of FY2009

Projected Revenue from Residential Customers, under the Proposed New Tariff Structure, FY2009

Monthly use of Electric Power (kWh)	Number of billings	Customer Charge Rate (US$)	Revenue1 from Customer Charge (US$)	FY2009 Projected Sales (kWh)	Basic Rate (US$/kWh)	Revenue2 from Basic Rate Charge (US$)	AFPAC Rate (US$/ kWh)	Revenue3 from AFPAC (US$)	Total Revenue (US$)
0-500 kWh	45,296	3	135,888	10,044,754	0.08	803,580	0.26	2,611,636	3,551,104
501-2000 kWh	10,355	3	31,065	14,673,456	0.10	1,467,345	0.26	3,815,098	5,313,508
Over 2000kWh	8,607	3	25,821	3,823,052	0.12	458,766	0.26	993,993	1,478,580
Total	64,260		**192,774**	28,541,261		**2,729,691**		**7,420,727**	**10,343,192**

Table 3.4.2-9 Projected Revenue from Residential Customers, the Target Year of FY2009

Projected Revenue from Commercial Customers, and Government under the Proposed New Tariff Structure, FY2009

Classification of Customers	Number of billings	Customer Charge Rate (US$)	Revenue1 from Customer Charge (US$)	FY2009 Projected Sales (kWh)	Basic Rate (US$/ kWh)	Revenue2 from Basic Rate Charge (US$)	AFPAC Rate (US$/ kWh)	Revenue3 from AFPAC (US$)	Total Revenue (US$)
Commercial	11,808	10	118,080	37,511,511	0.10	3,751,151	0.33	12,378,798	16,248,029
RoP	3,576	10	35,760	19,691,727	0.10	1,969,172	0.33	6,498,269	8,503,201
SG	3,396	10	33,960	4,385,612	0.12	526,273	0.33	1,447,252	2,007,485
Total	0		**187,800**	66,559,221		**6,246,596**		**20,324,319**	**26,758,715**

In total, the operation revenue of PPUC is expected to account for approx. US$37 million. It shall be almost equivalent to the projected operation expense.

However, this base case option will look as a substantial and drastic rate up from the viewpoint of consumers. Although it is urgent need for operation revenue to catch up with operation expense, there will be some options for PPUC and the Government to increase the electric tariff step by step. The followings will be two options:

- **2nd Option:** It shall take **two years** to catch up and make both ends meet (FY2009-2010)
- **3rd Option:** It shall take **three years** to catch up and make both ends meet (FY2009-2011)

From the viewpoint of stable consumer policy, the 2nd or the 3rd option will be more appropriate than the base case option. In case of adopting such prolonged process, PPUC must secure consent of the Government to provide subsidy to PPUC. Otherwise, deficit-ridden financial structure will be worsened furthermore, and PPUC will face serious financial distress.

Based on the case of providing preferential rate to residential customers, the following table shows the rate increase and catching-up process for both-ends-meet by stage-by-stage approach.

Alternative Option 2 2-Year Step Up Option

Table: Proposed Electric Tariff Schedule of PPUC
(1st Year: FY2009) Unit: US$

Charge item			Residential	Commercial/ Government
Monthly Minimum Energy Charge			3	10
Cost per Kwh				
	0-500	Kwh	0.08	0.10
	501-2000	Kwh	0.10	0.10
	2001above	Kwh	0.12	0.12
AFPAC Oct. 2008-Sept. 2009			0.21	0.24

Table: Proposed Electric Tariff Schedule of PPUC
(2nd Year: FY2010) Unit: US$

Charge item			Residentia	Commercial/ Governm ent
Monthly Minimum Energy Charge			3	10
Cost per Kwh				
	0-500	Kwh	0.08	0.10
	501-2000	Kwh	0.10	0.10
	2001above	Kwh	0.12	0.12
AFPAC Oct. 2009-Sept. 2010			0.26	0.33

Alternative Option 3 3-Year Step Up Option

Table: Proposed Electric Tariff Schedule of PPUC
(1st Year: FY2009) Unit: US$

Charge item			Residential	Commercial / Government
Monthly Minimum Energy Charge			3	10
Cost per Kwh				
	0-500	Kwh	0.08	0.10
	501-2000	Kwh	0.10	0.10
	2001above	Kwh	0.12	0.12
AFPAC Oct. 2008-Sept. 2009			0.20	0.23

Table: Proposed Electric Tariff Schedule of PPUC
(2nd Year: FY2010) Unit: US$

Charge item			Residentia	Commercial / Government
Monthly Minimum Energy Charge			3	10
Cost per Kwh				
	0-500	Kwh	0.08	0.10
	501-2000	Kwh	0.10	0.10
	2001above	Kwh	0.12	0.12
AFPAC Oct. 2009-Sept. 2010			0.23	0.28

Table: Proposed Electric Tariff Schedule of PPUC
(3rd Year: FY2011) Unit: US$

Charge item			Residential	Commercial / Government
Monthly Minimum Energy Charge			3	10
Cost per Kwh				
	0-500	Kwh	0.08	0.10
	501-2000	Kwh	0.10	0.10
	2001above	Kwh	0.12	0.12
AFPAC Oct. 2010-Sept. 2011			0.26	0.33

The followings will show the projected process of catching up.

2nd Option

	1st Year (FY2009)	2nd Year (FY2010)
Operation Revenue	US$ 36.13 million	US$ 39.19 million
Operating Expense	US$ 36.63 million	US$ 38.65 million
Operating Loss or Profit	▲US$ 6.5 million	+ US$ 0.54 million

3rd Option

	1st Year (FY2009)	2nd Year (FY2010)	3rd Year (FY2011)
Operation Revenue	US$ 29.23 million	US$ 35.03 million	US$ 40.17 million
Operating Expense	US$ 36.63 million	US$ 38.65 million	US$38.78 million
Operating Loss or Profit	▲US$ 7.40 million	▲US$ 3.62 million	+ US$ 1.39 million

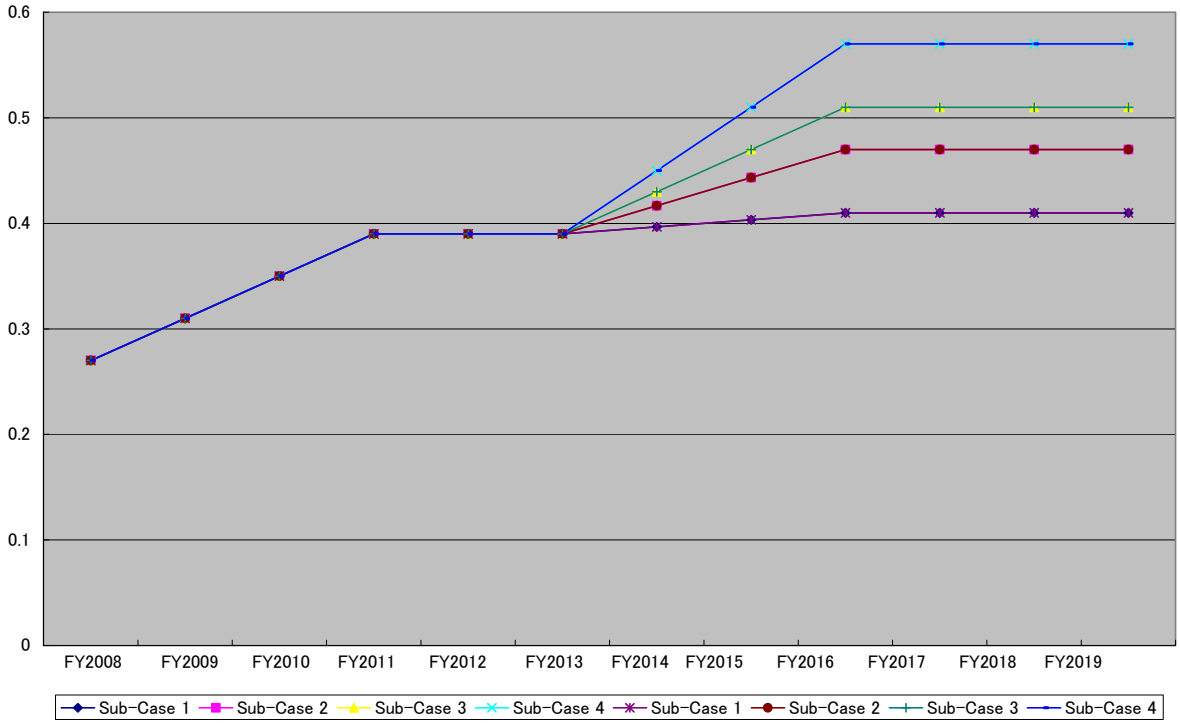
(3) Long Term Measures (FY2013~: After the operation start of the new Aimeliik Power Plant)

From FY2013, the new Aimeliik Plant will start operation with either use of only diesel or use of HFO 80% and diesel 20%. In order to determine which fuel PPUC will use, the following financial calculation shall be conducted:

1) Case of continuing to use diesel oil

The condition and assumptions will not change from the afore-mentioned in the short term measures. However, there is possibility that recent oil price hike may continue for the forthcoming 4~5 years. In the chapter 5 of this report, JICA Study Team proposes to install new power generation equipments. It is deemed as essential for PPUC to get sound financial return to recover the investment cost and necessary operation cost through the operation of new power generation equipments. The following financial forecast calculation shall examine how much overall electricity rate will be appropriate for PPUC to be financially sound (FIIR shall be more than 10%).

- Sub-case1: Fuel cost will be the same level as current (Diesel: US$ 3.6/gallon)
  Basically, PPUC shall charge US$0.41/kWh: Overall electricity rate shall rise by 2 cents from US$39/kWh.
- Sub-case2: Fuel cost 20% up from now
  PPUC will have to raise overall rate of electricity tariff up to US$ 0.47/kWh.
- Sub-case3: Fuel cost 30% up from now
  PPUC will have to raise overall rate of electricity tariff up to US$ 0.51/kWh.
- Sub-case4: Fuel cost 40% up from now
  PPUC will have to raise overall rate of electricity tariff up to US$ 0.57/kWh.



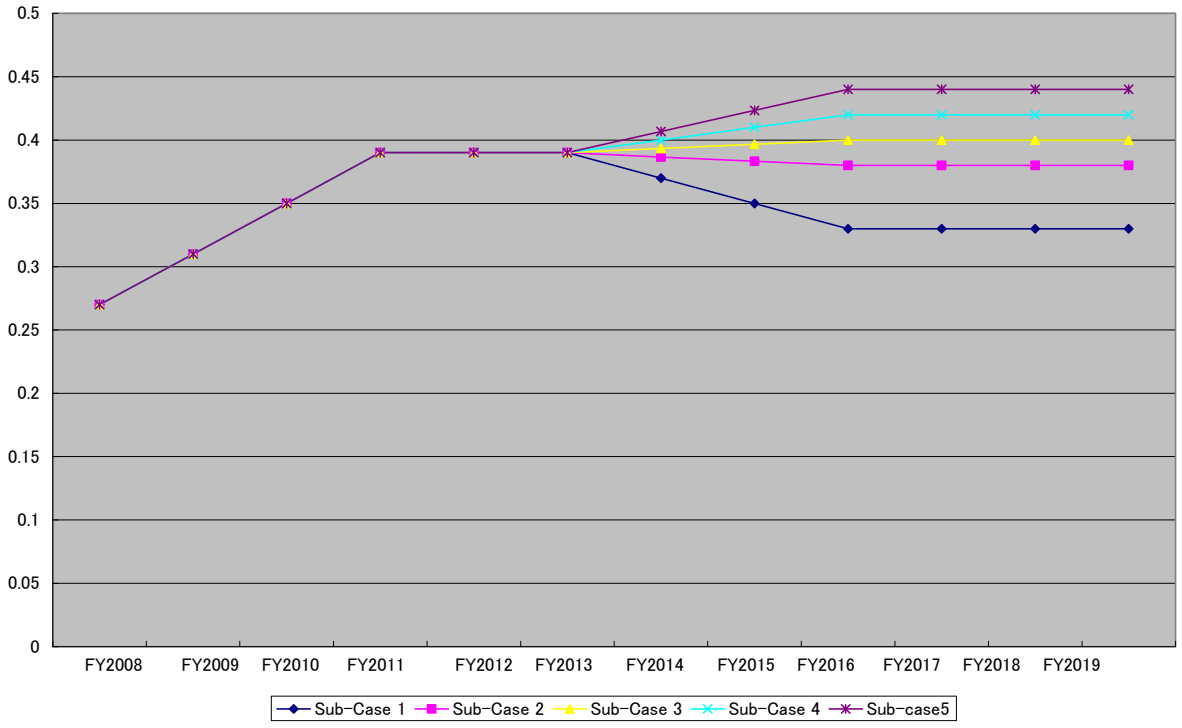
Source: projected and Prepared by JICA Study Team

Fig. 3.4.2-1 Forecasted Scenario of Electricity Tariff Rate Future Trend (Diesel use case)

2) Case of changing fuel from diesel to HFO

This case is to implement fuel change from diesel to HFO. The main item of operation expense will be changed largely. Let's see about to how much extent this case will absorb the shock of oil price hike.

- Sub-case 1: Fuel cost will be the same level as current
  Due to the benefit of big fuel cost reduction, PPUC can afford to make reduction of electricity tariff with the big margin to be generated. Overall electricity rate shall fall down to the level of probably around US$ 0.33/kWh from US$0.39/kWh..
- Sub-case2: Fuel cost 20% up from now
  Still, PPUC will not have to raise overall rate of electricity tariff. The rate shall stay on almost the same level, and get down to US$0.38/kWh by only 1 cent.
- Sub-case3: Fuel cost 30% up from now
  PPUC will still not have to raise overall rate of electricity tariff so largely: only 1 cent up to US$ 0.40/kWh.
- Sub-case4: Fuel cost 40% up from now
  PPUC will have to raise overall rate of electricity tariff , but only 3 cents up to US$ 0.42/kWh.
- Sub-case5: Fuel cost 50% up from now
  PPUC will have to raise overall rate of electricity tariff up to US$0.44/kWh by 5 cents.



Source: projected and Prepared by JICA Study Team

Fig. 3.4.2-2 Forecasted Scenario of Electricity Tariff Rate Future Trend (HFO use case)

3.5 The new actions currently taken by PPUC promptly response to the revision direction proposed by JICA Study Team

As said above, JICA Study Team has analyzed and pointed out the fundamental issues in the aspect of management and finance, and proposed the revision direction particularly concerned about the const recovery structure and the electricity tariff level and structure. Throughout the process of dialogue with PPUC Management, JICA Study Team has held intensive discussions and sincerely communicated with PPUC Management to lead to prompt actions for the improvement. PPUC has clearly understood necessity of securing sustainable operation and management to take prompt actions for the proposed directions essentialness of taking prompt actions for the proposed directions. As a result, PPUC has commenced to persuade the Palauan Government to understand the situation and held conferences with national people. On June 5, 2008, the prompt effort has resulted in the passage of the bill to revise PPUC's electricity tariff. The content is as follows:

- Commercial customers and Governments
  - Comprehensively the title charge shall be US$ 0.425/kWh
  - The basic rate shall be US$11
- Residential customers
  - By the range of electricity consumption rage, the title charge shall be:

  0~500 kWh : US$0.30/kWh
  500~2000kWh: US$0.38/kWh
  More than 2000kWh: US$0.425/kWh
  - The basic rate shall be US$3

As said above, the bill for the proposed revision is a very challenging content to raise the electricity rate up to one and a half times higher. As it were, it will be the almost equivalent content to fulfill the JICA Study Team's proposal at one time, although it does not include the proposal to keep the two streams of revenue source of AFPAC and basic rate and it does not take a gradual approach to increase step by step. (JICA Study Team has considered it essential to keep transparency of tariff fluctuation to be accompanied with fuel cost change.) If actually implemented, it will be a new and significant step to improve the const recovery structure. However, it is noteworthy that the increase portion is very large, considering that this is just one time rate-increase-opportunity. Taking a look at this challenge from the viewpoint of Palau national people, the rate change seemed to have taken place all of a sudden, and that the increase portion is incredibly large. Therefore, many happenings of turns and twists might occur before the rate increase is actually implemented and firmly established. It might be probable that the veto by the president will be used to turn down the bill. As things stand now, we should make preparations in view of firm establishment and actual implementation. Somehow, the utmost effort made by PPUC for these rate revisions should be appreciated very much.