A-3　協議議事録

Memorandum
between
Palau Public Utilities Corporation
and
JICA Project Team
for
The Project for Study on Upgrading and Maintenance Improvement
of
National Power Grid
in
The Republic of Palau

The JICA Project Team (hereinafter referred to as "the Team") consists of Yachiyo Engineering Co., Ltd. Tokyo, Japan (hereinafter referred to as "YEC") and the Kansai Electric Power Co., INC. Osaka, Japan (hereinafter referred to as "KEPCO") visited the Republic of Palau (hereinafter referred to as "Palau") from 9th July to 9th August, 2017 for **the Project for Study on Upgrading and Maintenance Improvement of National Power Grid in the Republic of Palau** (hereinafter referred to as "the Project").

During its stay in Palau, the Team had a series of discussions and exchanged mutual opinions with Palau Public Utilities Corporation (hereinafter referred to as "PPUC") and other concerned authorities of the Government of Palau (hereinafter referred to as "the Palau side") through the explanation of the Inception Report of the Project, conducting the site survey and the collecting necessary data and information for the successful implementation of the Project.

As the result of the discussions, both sides recognized the matters referred to in the document attached hereto.

Koror, 20th July 2017

Mr. Mitsuhisa Nishikawa
Team Leader
JICA Project Team,
Yachiyo Engineering Co., Ltd. (YEC)

Mr. Kijone J. Isechal P.E.
Chief Executive Officer / General Manager
Palau Public Utilities Corporation (PPUC)
The Republic of Palau

ATTACHMENT

1 Explanation of the Inception Report

The Team distributed the Inception report to the Palau side, and explained its contents using the Power Point slides (Appendix-1). Main contents of explanations are as follows:

(1) Summary of the Project including Study principles, Schedules, Study team members, etc.
(2) Approach, method and necessary data & information of the Power demand forecast and evaluation.
(3) Basic policy of Technical transfer
(4) Introduction of prevention measures for the tree contact of Power transmission and distribution lines.
(5) Evaluation method of the Renewable energy introduction.

2 Submission of Questionnaire

The Team submitted and distributed the Questionnaire to the Palau side. Each expert will explain the contents of the Questionnaire to counterpart and agree the date of responses from the Palau side to the Team.

3 Counterpart personnel of the Project

(1) PPUC agreed to assign the full time counterpart personnel to the Team as listed in the Appendix-2.
(2) In addition to the above, the Team requested PPUC to assign young engineers to the counterparts in order to transfer technology acquired through the Project for the next generation.

4 Relevant authorities and offices visited and data & information collected

The Team visited relevant authorities and offices with PPUC counterparts, and collected necessary data and information for the Project up to 19st July 2017 which is listed in Appendix-3.

5 Field Survey Schedule

The Team explained the total field survey schedule to PPUC, which is shown on the Inception report, and PPUC agreed this schedule. The planned schedules of the Team to Palau in year 2017 are as follows:

(1) The planned 2nd field survey schedule is from 17th Sep. to 27th Oct. 2017.
(2) The planned 3rd field survey schedule is from 19th Nov. to 16th Dec. 2017.

Appendix List
Appendix 1: Presentation of Inception Workshop
Appendix 2: Counterpart List
Appendix 3: List of Authorities/Offices visited and Data/Information collected

THE PROJECT FOR UPGRADING AND MAINTENANCE OF NATIONAL POWER GRID IN THE REPUBLIC OF PALAU

INCEPTION REPORT

JULY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
YACHIYO ENGINEERING CO., LTD.
KANSAI ELECTRIC POWER CO., INC.

1.Introduction

The Republic of Palau (hereinafter referred to as "Palau") is located in the Pacific Ocean approximately 3,200 km south of Japan. It is an island country consisting of some 340 islands with a total area and population of 488 km^2 and 17,661 (2015 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 96% of the total population live on these islands (2015 National Census).

The Palau Public Utilities Corporation (PPUC) is currently planning repair and renewal of transmission and distribution network with a view to improving this situation, and there is urgent need to build a reliable transmission and distribution system including verification of the latent capacity for introduction of renewable energy. Against this background, the Government of Palau has made a request to the Government of Japan for formulation of a master plan for renewal transmission and distribution equipment predicated on the introduction of renewable energy, and technical cooperation that will contribute to power interruption countermeasures and reduction of transmission and distribution losses.

This inception report briefs the project description (survey schedule, approach and methodology) as an executive summary. The detail shall be described in the Work Plan attached hereto.

2.Outline of the Request

The request of PPUC is summarized as below:

1. Formulation of master plan targeting year 2030 for the rehabilitation of aging 34.5kV transmission lines and 13.8kV distribution lines (T & D lines) in Koror-Babeldaob power system.
2. Technical support for identifying causes of frequent power outages in Babeldaob and the countermeasures.
3. Proposed countermeasures for reducing transmission and distribution losses and power outages
4. Plans to utilize grid-connected renewable energy (RE), and technical support for energy saving in water supply and sewerage pumps, etc.
5. Review of existing primary energy potential development plans in light of power demand and supply
6. Technical transfer to contribute the improvement of operation and maintenance capacities for the power supply reliability and the reducing losses of the T & D lines.

3.Purpose of the Project

In response to the request made by PPUC, the Team shall conduct the following tasks, considering 2030 as the target year:

1. Formulation of the master plan on upgrading transmission and distribution system in Koror – Babeldaob including utilization of sustainable renewable energy
2. Technology transfer on the operation and maintenance skills of transmission and distribution network

4.Project Team Member

Name	Assignment	Organization
Mitsuhisa NISHIKAWA	Team Leader/Power System Planning	YEC
Masaki KOBAYASHI	Deputy Team Leader / Renewable Energy / System Stabilization Method	KEPCO
Tomoyuki INOUE	Power Demand Forecast	YEC
Nobuyuki KINOSHITA	Power System Analysis (1)	YEC
Kazuaki KONDO	Power System Analysis (2)	YEC
Tatsuhiro TAMURA	Power Transmission & Distribution System	KEPCO
Takashi GENJI	Operation & Maintenance of Power Transmission & distribution System	KEPCO
Makoto ABE	Substation System	YEC
Takaya FUYUKI	Operation & Maintenance of Substation System	KEPCO
Yoshiyuki CHOSO	Economic & Financial Analysis	YEC
Masaya SUGITA	Environment & Social Consideration	YEC
Naoya KISHI	Project Coordinator/Assistant of Power System Planning	YEC

[Remark] YEC: Yachiyo Engineering Co., Ltd.
KEPCO: The Kansai Electric Power Co., Inc.

5.Approach of the Project

[1] Collection and analysis of existing data/information for understanding the present situation of the transmission and distribution system

(1) Latest single line diagram of Koror – Babeldaob network
(2) Specification and operating conditions of the each equipment
(3) Operation record of the system
(4) Relevant codes and regulations
(5) Institutional frameworks
(6) Power demand forecast up to year 2030 prepared by PPUC
(7) Power flow analysis
(8) Primary energy potential
(9)Power sector survey

[2] Technology transfer
(1) Introduction of new solutions
(2) Improvement of the present operation capacity
(3) Improvement of the maintenance capacity
(4) Others

Mutual relation

[3] Formulation of the transmission and distribution master plan
(1) Evaluation of candidate projects by PPUC
(2) Identification of prioritized project by the Team
(3) Basic design of the prioritized projects (Pre-feasibility study)
(4) Strategic Environment Assessment (SEA)
(5) Financial analysis
(6) Formulation of the master plan

6. Methodology and Implementation of the Project

The methodology of the Project implementation shall be conducted in line with the following consideration. The detail of the requested data and information shall be explained by Questionnaire which will be distributed by each expert.

6-1 Essential Information for understanding the present situation

(1) Latest single line diagram of Koror – Babeldaob network

(2) Specification and operating conditions of the equipment

- Diesel engine generator connected to the transmission and distribution line
  - Malakal Power Plant
  - Aimeliik Power Plant
  - Other DEGs if any?
- Transformer stepping down from 34.5-13.8kV to low voltage
- Switchgears
- 34.5kV transmission lines and 13.8kV distribution lines

6. Methodology and Implementation of the Project

(3) Operation record
- Facility running hours
- Faulty record

(4) Relevant codes and regulations
- Operation criteria

(5) Institutional frameworks
- Organization structure, budget, roles etc. of relevant entities (PPUC, MPIIC, etc.)
- IPP's framework

(6) Power demand forecast
- Review of the existing power demand forecast
- Review of the economic development policies, economic growth forecast and development plan
- Power demand forecast

(7) Power flow analysis
- Power flow analysis example

(8) Power sector development plan
- Other donors' project (ongoing/planned)
- Solar PV expansion forecast

(9) Review of the existing survey report on primary energy potential
- Solar PV
- Hydropower
- Wind power
- Ocean Thermal Energy Conversion Generation (OTEC)
- Biomass and disposal
- Other sources which maybe identified through the survey

(10) Power sector survey
- Power and energy policies
- Legal system
- Organization structure
- Power development plan

6. Methodology and Implementation of the Project

6-3 Formulation of the transmission and distribution master plan

(1) Evaluation of candidates projects by PPUC
- Construction of transmission and distribution lines along Compact Road

(2) Identification of prioritized project by the Team

(3) Preliminary design of the prioritized projects (Pre-Feasibility Study)

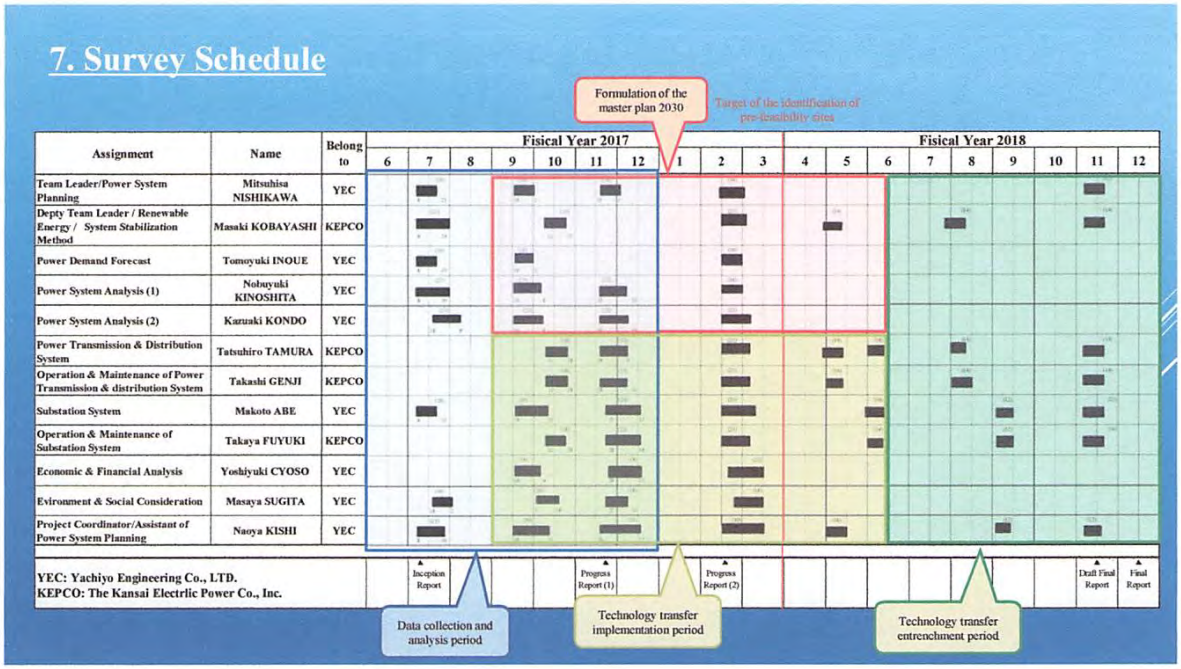
The candidate prioritized projects may include the followings:
- Rehabilitation of Airai Substation
- Rehabilitation of Malakal Substation
- Installation of 2 circuits of 34.5kV transmission line between Aimeliik and Malakal Power Plants

(4) Strategic Environment Assessment (SEA)

(5) Financial analysis
- Transmission and distribution network master plan 2030
- Priority projects
- PPUC's financial condition

(6) Formulation of the master plan

7. Survey Schedule



Assignment	Name	Belong to
Team Leader/Power System Planning	Mitsuhisa NISHIKAWA	YEC
Depty Team Leader / Renewable Energy / System Stabilization Method	Masaki KOBAYASHI	KEPCO
Power Demand Forecast	Tomoyuki INOUE	YEC
Power System Analysis (1)	Nobuyuki KINOSHITA	YEC
Power System Analysis (2)	Kazuaki KONDO	YEC
Power Transmission & Distribution System	Tatsuhiro TAMURA	KEPCO
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Evironment & Social Consideration	Masaya SUGITA	YEC
Project Coordinator/Assistant of Power System Planning	Naoya KISHI	YEC

YEC: Yachiyo Engineering Co., LTD.
KEPCO: The Kansai Electric Power Co., Inc.

8.Items Requested by the Team to the Palauan side

The Palau side is requested to provide the Team for the smooth implementation of the survey with the followings:

1) To provide the Team with available relevant data, information and materials necessary for the execution of the Survey.
2) To prepare the answers for the Questionnaire presented by the agreed date
3) To assign full-time counterparts to the Team during their stay in Palau, to play the following roles as the coordinator to the Team:
   - To make appointments, set up the meetings with authorities, departments and all other organizations and firms whatever the Team intends to visit.
   - To attend the site survey and any other visiting places with the Team and to make any convenience on accommodation, working room, adequate transportation, getting the permissions if required, etc
   - To assist and to advise the Team for their collection of data and information.
4) To secure the permission for taking photographs and to enter into private properties and restricted areas for the Team for proper execution of the Survey, if necessary.
5) To take any measures which deemed necessary to secure the safety of the members of the Team.
6) To make arrangements to allow the Team to bring back to Japan any necessary data, maps and materials related to the Survey, including obtaining approval from the Government of Palau, in order to analyze the Project and prepare the reports.
7) To provide suitable office space and its facilities such as electricity, internet and furniture necessary for the survey activities and operational expenses for utilities.

Upgrading and Maintenance of National Power Grid
in the Republic of Palau

Power Demand Forecasts and Evaluation

Contents

1. Overviews of Demand Evaluation (page 2)

2. Methodologies of Demand Forecasting Models (page 5)

3. Schedule of Power demand evaluation (page 22)

4. Questionnaires on Power demand (page 23)

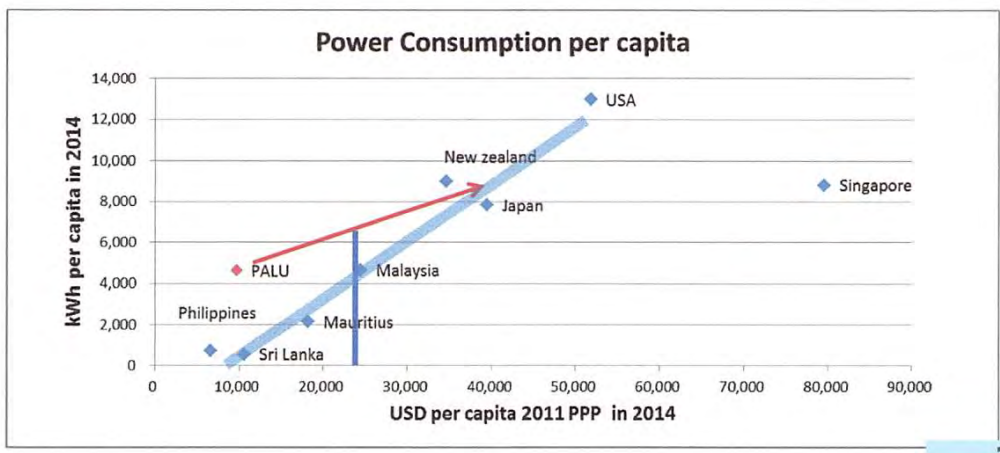
Appendix 1～3 (Page 28～ 30)

July 2017

1. Overviews of Demand Evaluation

(1) Potential Power Consumption of Palau

- Palau power consumption per capita is around 5,000 kWh in 2014～2015, it is nearly same level to Malaysia.
- While, Japan is 8,000 kWh and New Zealand is 8,500 kWh in 2014.
- Palau consumption per capita will increase to around 7,000kWh / capita up to 2040.



(2) The required information for Power demand evaluation

JICA Study team will make a power demand forecasting model for evaluating the existing demand forecasts. The following information are useful for understanding future world energy.

Organization	Reference documents	Published year
ADB	Economic Review 2015, Republic of Palau	August 2016
World Bank	Economy and Energy Data of the World	2017 version
IMF	Economic outlook of Palau	October 2016
United Nations	UN Population Study	2015 version
IEA	World Energy Outlook 2016	2016 version
IEA	Japan Energy Policy	2016 version
IEEJ	Asia/World Energy Outlook	2016 version
IEEJ	IEEJ monthly paper on RE	2016 and 2017
IRENA	Renewable energy opportunities and challenges in Pacific Islands	August 2013

Source: each organization

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(3) Consistency to the other Strategies and Plans

For keeping the consistency among the related strategies and plans in Palau, The following and the latest policies should be studied.

Strategy and plan fields	Study items
National Strategies and Economic development plans	◆ The Next Five Years 2016–2021
Energy policy	◆ Demand Side Management Best Practices Guidebook 2007 or the latest one ◆ A Framework for the Implementation of Palau's National Energy Policy 2009 or the latest one
Power sector policy	◆ Strategic plan 2003 to 2008 or the latest one ◆ Electric rate study 2007 or the Latest one ◆ Power Supply System Management Master Plan2008 , JICA
Renewable energy plan	◆ Renewable Energy Opportunities and Challenges in the Pacific Islands Region 2013, IRENA
Environment plan	◆ Woods and charcoal consumption estimation and policy

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2. Methodologies of Demand Forecasting Models

(1) Model building engine of the Study team

Simple.E : developed by The Institute of Energy Economics, Japan

Windows: Windows 7, 8, 10

MS-EXCEL: 2003, 2007, 2010, 2016 versions

(2) Experiences of the model building by Simple. E

Year	Country	Project title
2017	Nigeria	Power system Master plan
2016	Tanzania	Power system Master plan
2015	Pakistan	Power system Master Plan
2015	Bangladesh	Power system Master Plan
2012	Oman	EE&C Master plan project
2011	Kazakhstan	EE&C project finding survey project
2011	Serbia	EE&C Master plan project
2010	Syria	Power system Master plan
2010	Vietnam	Power system Master plan
2008	Saudi Arabia	EE&C Master plan project
2007	Vietnam	Energy Master pan

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(3) Model flows of the Study team

Economic block

(1) Social economic indices
- Population
- GDP
- Inflation rate

(2) Production activities
- Agriculture & forestry GDP
- Industrial GDP
- Commercial & Service GDP
- Government & Public Services

(3) Energy prices
- Crude oil price
- Electricity tariffs
- Petroleum product prices
- Power Tariffs

(4)Precondition values
- T/D loss
- Own use
- Load factor

(5) Existing energy and power plan
- DSM and EE&C strategy
- Off-grid plan
- RE plan

Power & Energy demand block

(1) Power demand by sector
- Residential - Commercial
- Gov. & Public - T/D loss

(2) Power demand / supply
- PPUC electric energy demand
- PPUC peak demand
- Auto producers
- Off grid supply

(3) State wise number of customer
- State wise population
- Sector wise customer by State
- State wise customers

(4) State wise power demand
- Sector wise power demands by State
- State wise power demands

(5) Energy source of Power sector
- Coal - Gas - Oil - RE

(6) Comparison
- GDP vs Power consumption
- USA, JPN, MLY, SIN, PLN etc.

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(4) Categories of power demand model of Palau

Sector demand category	Power supplier category	State demand category
◆ Commercial	◆ PPUC	◆ Aimeliik
Existing demand	Commercial	◆ Ariai
Additional demand	Gov & Public	◆ Koror
◆ Gov. and Public	Residential	◆ Melekeok
Existing demand	T/ D loss	◆ Ngaraard
Additional demand	Own use	◆ Ngardmau
◆ Residential	◆ Auto producers	◆ Ngaremlengui
Existing demand	◆ Rural Off grid	◆ Ngatpang
Additional demand		◆ Ngchesar
◆ T/ D loss		◆ Nerchelong
		◆ Ngiwal
		◆ Koror+Babeldaob

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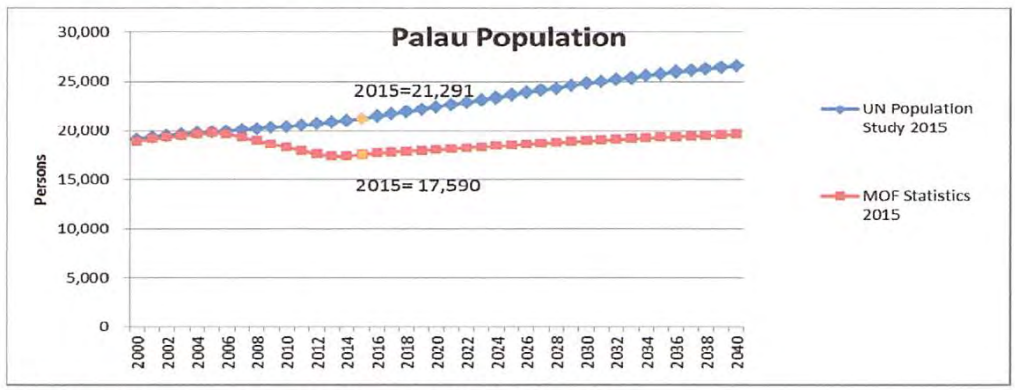
(5) Main preconditions

a. Number of Population



Source: July 2017 tentative forecasts by Study team

- There are two kinds of number of population
- UN Population Study shows 21,000 persons in 2015
- MOF Statistics data shows 17,000 persons in 2015
- Which is correct?

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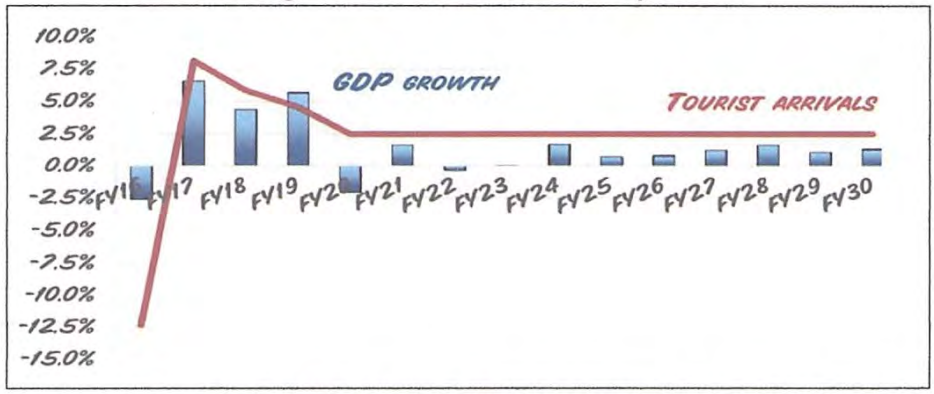
b. GDP growth rate

< Palau GDP growth rate forecasted by ADB >



Source: Base scenario in Fiscal Year 2015 Economic Review (Page 121) by ADB

- After 2020, Palau tourism is forecasted with low growth of 2.5%
- Koror Airai Sanitation Project (KASP) are invested during 2017-20
- The renewed compact with $40 million for infrastructure is implemented during 2017- 24.

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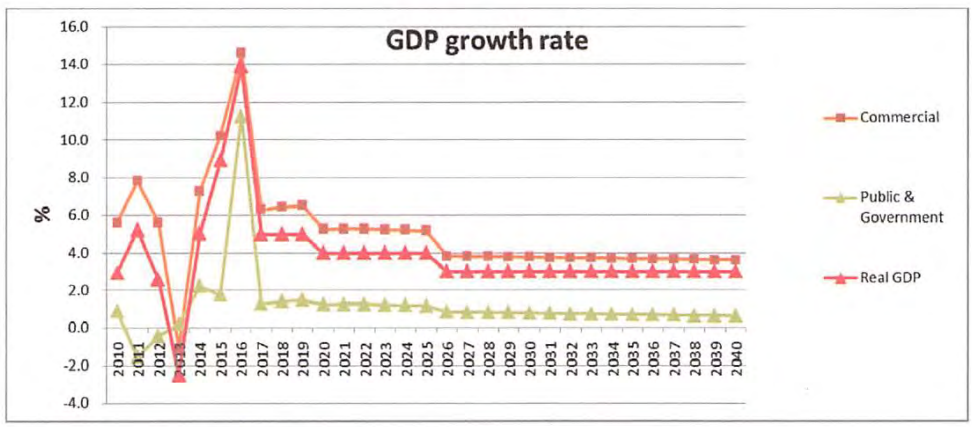
< GDP growth rate as Scenario >



Source: JICA Study team after referring ADB study

- As one scenario, is it available for annual GDP growth rates with 3%～4% to be set by the most likely growth rates up to 2040 ?
- As other scenario, the Government targeted GDP growth rate are selected.

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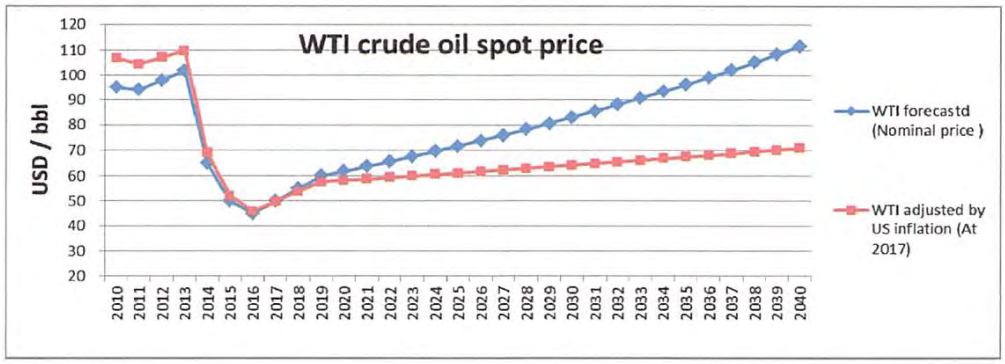
c. Crude oil price



Source: JICA Study team after referring IEA and IEEJ report

US$/bbl

Organization	Scenario	2016-17	2020	2030	2040
International Energy Agency	Reference scenario	50	80	113	128
The Institute of Energy Economics, Japan	Reference scenario	50	75	100	125

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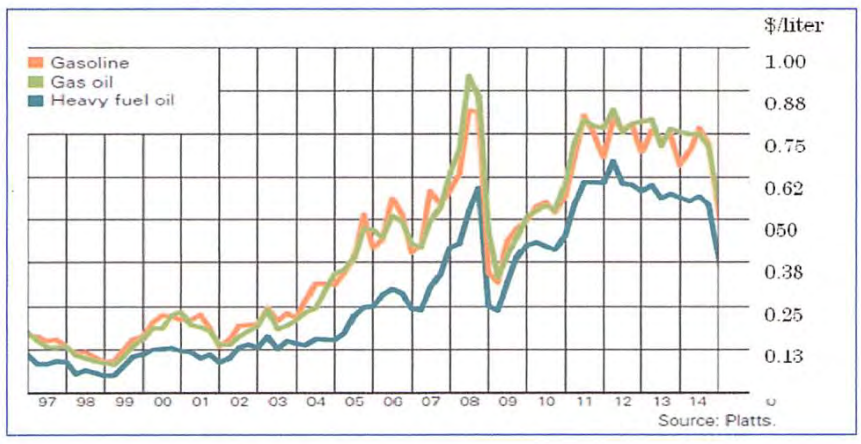
d. US Gulf Coast oil price



Source: IEA database, the original source is PLATTS.

- US Gulf Coast oil products exporting prices are nearly equivalent to Singapore oil exporting prices.
- US Gulf Coast oil product prices are depended to WTI spot price. Therefore, Gas oil (diesel) and heavy oil prices imported from Singapore can be forecasted by WTI.

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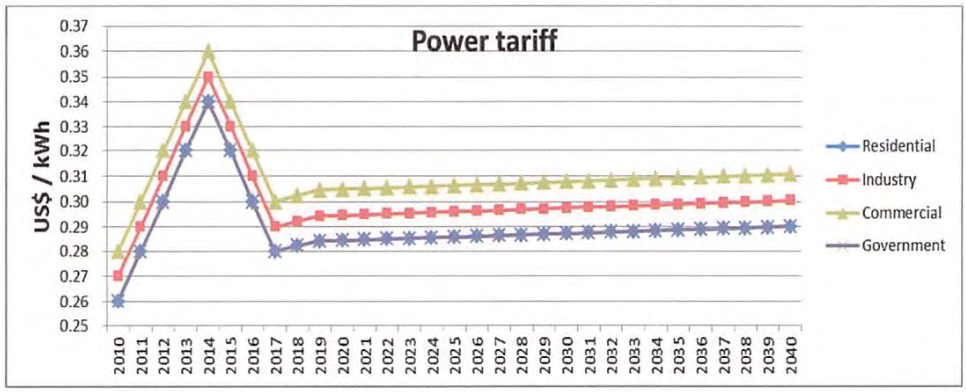
e. Power tariffs



Source: Just assumption as of July 2017

- Study team will survey the power tariff formula and ask the future trends to the authorities like Energy Administration and PPUC.
- The increase of power tariffs brings to rise EE&C mind, as the results, the power demand is suppressed.

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f. Energy Efficiency & Conservation

Sector	Items	Unit	2017	2018	2019	2020	2025	2030	2035	2040
Commercial	EE&C rate	Saving%	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	EE&C Indicator	2017=100	100.0	99.5	99.0	98.5	96.1	93.7	91.4	89.1
Gov & Public	EE&C rate	Saving%	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	EE&C Indicator	2017=100	100.0	99.5	99.0	98.5	96.1	93.7	91.4	89.1
Residential	EE&C rate	Saving%	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	EE&C Indicator	2017=100	100.0	99.5	99.0	98.5	96.1	93.7	91.4	89.1

Source: July 2017 tentative preconditions by JICA Study team

- EE&C activities of "Energy Efficiency Action Plan 2007" are described in "Power System Improvement Plan 2008" conducted by JICA.
- Study team will survey the progress of the latest EE&C policies.
- EE&C rate with 0.5% in the table is world average from 2013 to 2040 by IEA report in 2016.

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g. Number of customer of power grid

	2000	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030	2035	2040
Aimeliik	89	124	128	122	121	123	124	151	171	182	191	199	206
Ariai	508	689	707	682	654	664	673	671	699	735	770	800	825
Koror	3,614	4,214	4,299	4,214	4,174	4,291	4,411	4,701	5,020	5,353	5,679	5,967	6,202
Melekeok	85	127	137	154	173	146	124	83	83	88	92	96	100
Ngaraard	115	152	154	149	147	140	134	111	109	114	120	124	128
Ngardmau	53	63	66	61	58	63	68	77	79	83	88	92	95
Ngaremlengui	87	117	124	120	116	118	120	142	159	169	179	187	194
Ngatpang	71	81	90	82	74	68	62	57	62	66	70	73	76
Ngchesar	87	101	100	98	97	101	105	115	122	129	136	142	146
Nerchelong	91	122	129	146	164	150	137	123	132	140	147	154	159
Ngiwal	68	86	90	94	98	107	118	175	206	223	238	252	264
Total	4,868	5,876	6,024	5,923	5,876	5,969	6,075	6,407	6,842	7,283	7,710	8,087	8,396

Source: July 2017 tentative forecasts by Study team

- Number of customer are forecasted by number of population.
- The state population are forecasted by elasticity to the growth rate of the country population.
- Study team has to collect the actual data of the customers from 2007 to 2016 for the forecasting.

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h. New loads

	Unit	States	2015	2016	2017	2018	2019	2020	–	–	–	–	–	–	2040
Additional loads	kW	Aimeliik													
Commercial	kW	Ariai													
	kW	Koror													
	kW	–													
	kW	–													
	kW	–													
	kW	Koror+Babeldaob													
Additional loads	kW	Aimeliik													
Public use	kW	Ariai													
	kW	Koror													
	kW	–													
	kW	–													
	kW	–													
	kW	Koror+Babeldaob													
Auto producers	kW	Aimeliik													
	kW	Ariai													
	kW	Koror	800												
	kW	–													
	kW	–													
	kW	–													
	kW	Koror+Babeldaob													
Off grid	kW	Aimeliik													
	kW	Ariai													
	kW	Koror						500	500	1000	1000	1000	1000	0	0
	kW	–													
	kW	–													
	kW	–													
	kW	Koror+Babeldaob						500	500	1000	1000	1000	1000	0	0

- Study team should survey the new loads getting the cooperation of the related authorities.
- The power demands of additional loads basically are supplied by PPUC, and auto producers and off grid users do not use PPUC.

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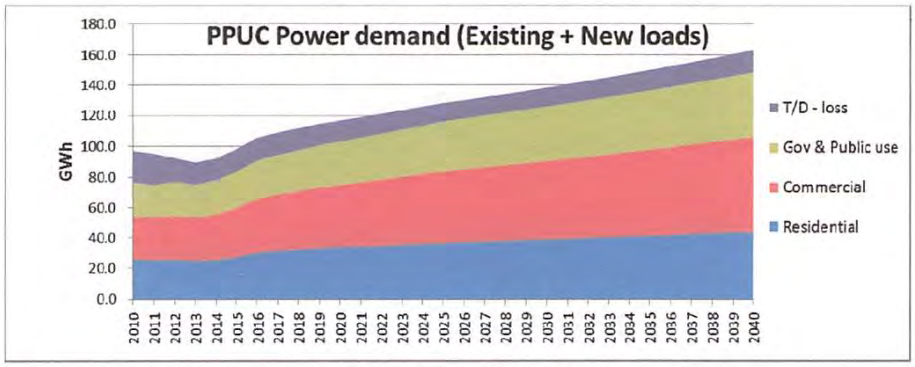
(6) Output samples

a. Power demand by sector



Source: July 2017 tentative forecasts by Study team

Growth rate of the above unit %

	2020/2015	2025/2020	2030/2025	2035/2030	2040/2035	2040/2015
Residential	4.2	1.8	1.1	1.2	1.4	2.0
Industry	0.0	0.0	0.0	0.0	0.0	0.0
Commercial	5.0	2.8	1.7	1.8	1.9	2.6
Public use	3.2	2.7	1.9	1.9	1.9	2.3
T- loss	-1.0	-2.7	1.1	1.6	1.7	0.1
Forecast total	3.5	1.9	1.5	1.6	1.7	2.1

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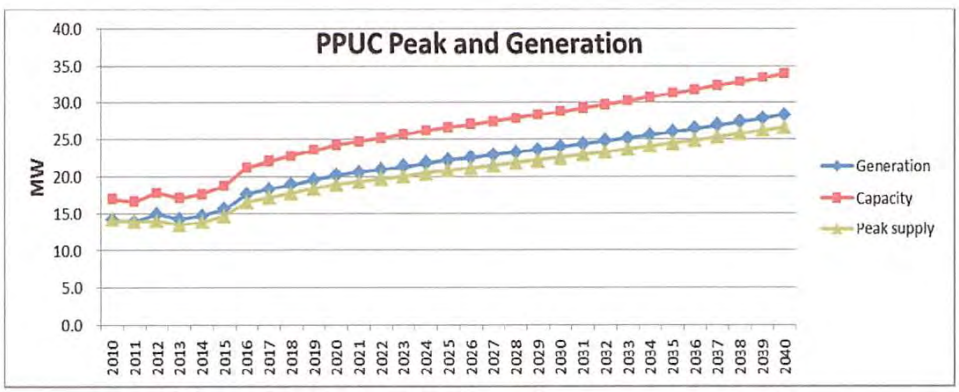
b. Peak demand of PPUC



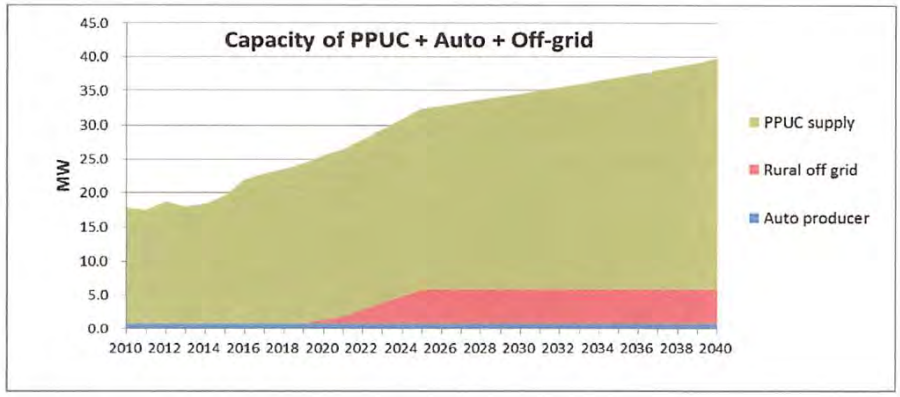
Source: July 2017 tentative forecasts by JICA study team

Growth rate of the above unit %

	2020/2015	2025/2020	2030/2025	2035/2030	2040/2035	2040/2015
Capacity	5.2	1.9	1.5	1.6	1.7	2.4
Generation	5.2	1.9	1.5	1.6	1.7	2.4
Peak demand	5.2	1.9	1.5	1.6	1.7	2.4

18

c. Country power capacity (PPUC+ Auto + Off grid) as one example



Source: July 2017 tentative forecasts by JICA study team

Growth rate of the above unit %

	2020/2015	2025/2020	2030/2025	2035/2030	2040/2035	2040/2015
PPUC peak demand (On grid)	5.2	1.9	1.5	1.6	1.7	2.4
Auto producers (Off grid)	0.0	0.0	0.0	0.0	0.0	0.0
Rural grid (Off grid)	0.0	58.5	0.0	0.0	0.0	0.0
PPUC+ Auto+ Rural (Country)	5.5	5.6	1.2	1.3	1.4	3.0

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d. State power demand (PPUC only)

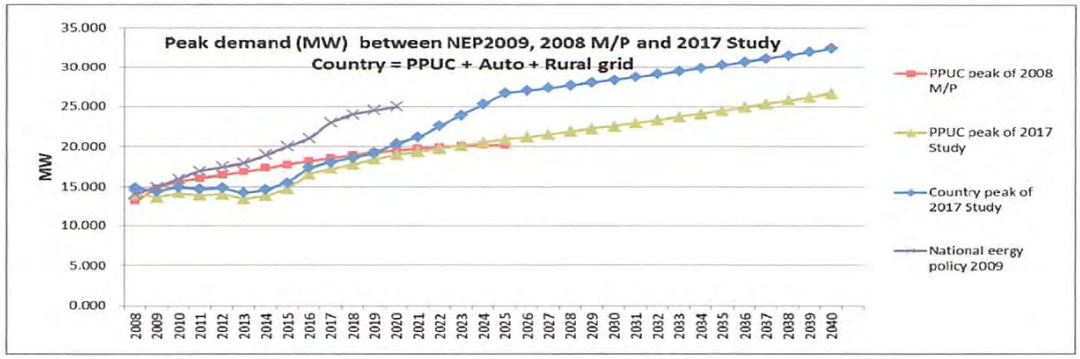
MW	2010	2015	2020	2025	2030	2035	2040
Aimeliik	0.30	0.36	0.48	0.52	0.56	0.61	0.66
Ariai	2.32	2.30	2.81	2.99	3.15	3.35	3.58
Koror	10.69	11.26	14.71	16.25	17.61	19.19	20.96
Melekeok	0.31	0.24	0.29	0.31	0.34	0.36	0.39
Ngaraard	0.17	0.15	0.18	0.19	0.20	0.21	0.23
Ngardmau	0.04	0.04	0.05	0.05	0.06	0.06	0.07
Ngaremlengui	0.10	0.12	0.16	0.17	0.19	0.20	0.22
Ngatpang	0.08	0.08	0.10	0.11	0.12	0.13	0.14
Ngchesar	0.05	0.06	0.07	0.08	0.08	0.09	0.09
Nerchelong	0.06	0.06	0.08	0.09	0.09	0.10	0.11
Ngiwal	0.06	0.09	0.13	0.14	0.15	0.17	0.18
Total	14.19	14.75	19.04	20.91	22.55	24.47	26.65

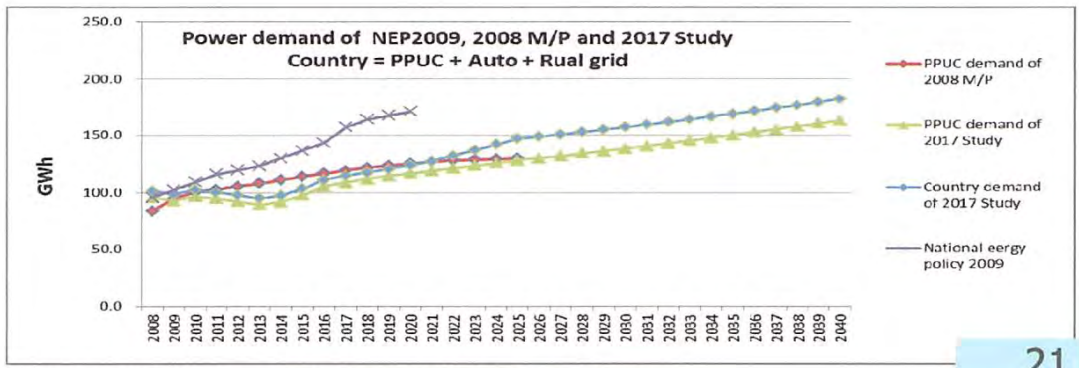
e. State power demand (PPUC + Auto + Off grid)

MW	2010	2015	2020	2025	2030	2035	2040
Aimeliik	0.30	0.36	0.48	0.52	0.56	0.61	0.66
Ariai	2.32	2.30	2.81	2.99	3.15	3.35	3.58
Koror	11.49	12.06	16.01	22.05	23.41	24.99	26.76
Melekeok	0.31	0.24	0.29	0.31	0.34	0.36	0.39
Ngaraard	0.17	0.15	0.18	0.19	0.20	0.21	0.23
Ngardmau	0.04	0.04	0.05	0.05	0.06	0.06	0.07
Ngaremlengui	0.10	0.12	0.16	0.17	0.19	0.20	0.22
Ngatpang	0.08	0.08	0.10	0.11	0.12	0.13	0.14
Ngchesar	0.05	0.06	0.07	0.08	0.08	0.09	0.09
Nerchelong	0.06	0.06	0.08	0.09	0.09	0.10	0.11
Ngiwal	0.06	0.09	0.13	0.14	0.15	0.17	0.18
Koror+Babeldaob	14.99	15.55	20.34	26.71	28.35	30.27	32.45

20

f. Comparison of NEP2009, M/P 2008 and Study team 2017





21

Source: July 2017 tentative forecasts by JICA study team

3. Schedules of Power demand evaluation

MM /YY	Contents
July 2017	(1) Collection of power demand data & strategies (2) Discussing the methodology (3) Discussing the existing power demand forecasts
In Japan	Building the demand model and evaluation of existing power demand
Sep 2017	(1) Discussing Results of Study team forecasts (2) Discussing Evaluation results of the existing demand forecasts (3) Getting the recommendation
In Japan	Getting recommendation and revising the report
Feb 2018	(1) Explaining the model and building technology (2) Explaining the final report to stakeholders

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4. Questionnaires on Power demand

4.1. Questionnaires to MOF

NO	Questionnaires	Period	Comments
1.1	2015 Census results	2015	Provide the documents
1.2	State population estimation	2006-2016	11 states in Koror+Babeldaob
1.3	Future foreign workers	Up to 2030	
1.4	Future population Growth rate	up to 2030	
2.1	Country & State wise GDP	2006-2016	11 states in Koror+Babeldaob
2.2	Future GDP growth rate	Up to 2030	
2.3	Future tourism of Palau	Up to 2030	
2.4	Availability of COMPACT after 2024	Up to 2030	
2.5	Economic Review 2015 by ADB		How about it
2.6	Latest economic plan （NMDP)		Provide the documents
3.1	New big Projects	Up to 2030	11 state area
3.2	Subsidy to PPUC		
3.3	Budget to Energy Administration		
3.4	Others		

4.2 Questionnaires to Energy Administration

	Questionnaires	Period	Comments
1.1	Fossil energy import	2010-2016	Diesel, Gasoline, Fuel oil
1.2	Fossil Energy Stock pilling plan	Up to 2030	
1.3	Woods and charcoal data	2010 to 2016	
1.4	PV installation	2010 to 2016	
1.5	Power demand forecasts	Up to 2030	Have any forecasts
2.1	Latest Energy policy	Up to 2030	Fossil energy policy (Mar 2012)
2.2	Progress of DSM and E&C Policy	Up to 2030	
2.3	Renewable energy policy	Up to 2030	IRENA study and others
2.4	Off grid plan	Up to 2030	

4.3 Questionnaires to PPUC

No	Questionnaires	Period	Comments
1.1	Sector wise power consumption	2006-2016	Comm, Gov., Residential
1.2	State wise power consumption	2006-2016	11 state area
1.3	Peak demand	2006-2016	
1.4	State wise number of customers	2006-2016	11 state area
2.1	Existing Power Demand Forecasts	Up to 2030	
2.2	Current and future Load factor	Up to 2030	
2.3	Current and future own use rate	Up to 2030	
3.1	New big power consumers	Up to 2030	Investment plans
3.2	Off grid plan in targeted states	Up to 2030	
3.3	Current Auto producers and plans	Up to 2030	
3.4	Renewable Energy introduction Plans	Up to 2030	IRENA report 2013
3.5	Latest power tariff plan	Up to 2030	

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4.4 Evaluation of 2008 Power System Master Plan

Evaluation will be implemented with MOF , Energy Administration and PPUC.

C/P	Evaluation items	Periods
MOF & Energy Administration	◆ Country and state population growth rates ◆ GDP and sectoral GDP growth rates ◆ Progressing Energy Efficiency Action Plan ◆ Power utilization of water supply and sewerage system	2010-2025
PPUC	◆ Increasing number of customers registered ◆ Changing yearly peak demands ◆ Sectoral power demands ◆ Schedule of new big consumers ◆ Loss reduction of transmission and distribution system ◆ Load factor target ◆ Own use ratio target	2010-2025
	◆ Transferring from Auto producers to PPUC grid ◆ Infrastructure development around capital area. ◆ Grid connections from independent RE system	2010-2025

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Thank you

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Appendix 1. Targeted state and the state population

State Population in 2015

unit person

Forecats of State population	2015
Total	21,291
Aimeliik	334
Ariai	2,455
Koror	13,754
Melekeok	277
Ngaraard	413
Ngardmau	185
Ngaremlengui	350
Ngatpang	282
Ngchesar	291
Nerchelong	516
Ngiwal	382
Koror+Babeldaob	19,239
Others (Angaur+Hatohobei	2,052
Total	21,291

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Appendix 2. World Power and Energy Documents collected

Organization	Reference documents	Published
ADB	Economic Review, Republic of Palau	August 2016
ADB	Private Sector Assessment for Palau	2016
ADB	Country Operation Business Plan	November 2016
ADB	Actions for Palau's Future 2009-2014	2009
World Bank	Palau Economic Energy data	2017 version
IMF	Economic outlook of Palau	October 2016
IMF	2014 Article IV Consultation : Staff report	May 2014
United Nations	UN Population Study	2015 version
IEA	World Energy Outlook 2016	2016 version
IEA	Japan Energy Policy (for EE&C and RE)	2016 version
EIA	International Energy Outlook	2016 version
EIA	Energy Transition Initiative	2015
IEEJ	Asia/World Energy Outlook	2016 version
IEEJ	IEEJ monthly paper on World Renewable energy	2016 and 2017
BP	BP Statistics	2016

IEA: International Energy Agency
BP: British Petroleum (International Oil Company)
PEC: Pacific Energy Conference
SPC : Secretariat of Pacific Community
PEC: PACIFIC ENERGY CONFERENCE
EIA: Energy Information Agency of DOE, USA
IEEJ: The Institute of Energy Economics, Japan
MOF: Ministry of Finance, Palau
PPUC: Palau Public Utilities Corporation

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Appendix 3. Palau Economy and Power Documents collected

Organization	Documents	Published
MOF	Population Statistics	2006-2015
MOF	Population Census 2005 (Bureau of Budget and Planning)	2005
MOF	National Account Statistics	2006-2015
MOF	The Next Five Years 2016–2021	2015
MOF	Electric Power Statistics	2000-2011
Energy Admi	National Energy Policy	2010
Energy Admi	DSM Best Practices Guidebook 2007	2007
Energy Admi	Electric rate study 2007	2007
PPUC	Total installed electricity capacity	2011
World Bank	Reliable and Affordable Off-Grid Electricity Services	2015
JICA	Power Supply System Improvement Master Plan	July 2008
IRENA	Renewable Energy Opportunities and Challenges	August 2013
PEC	Pacific Energy Conference 2016	2016
SPC	Palau Country Energy Security Indicator Profile 2009	2012
Consultant	National Report , Palau	May 2013
Consultant	Installation of Solar PV Systems	March 2017

30

Japan International Cooperation Agency

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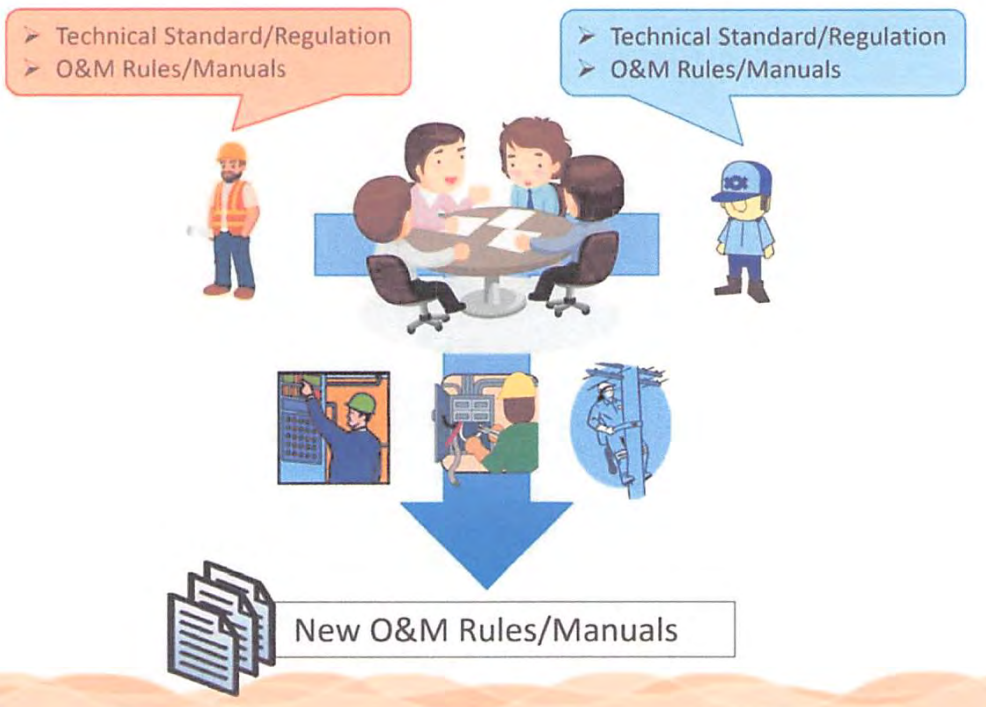
Consulting Engineers & Architects

Kansai Electric Power

Technical Transfer

July, 2017

Technical Transfer Policy



Technical Transfer Projects

3

Site1: Nekken Feeder

- ✓ Installation of Tube(Conductor Cover), Ivy/Vine Shutter and Overcurrent Indicator
- ✓ Establishment of Suitable Tree Management System

Site2: Aimeliik Substation

Basic Skill Training

- ✓ Fault Calculation and Analysis
- ✓ Protection Relay Setting Coordination

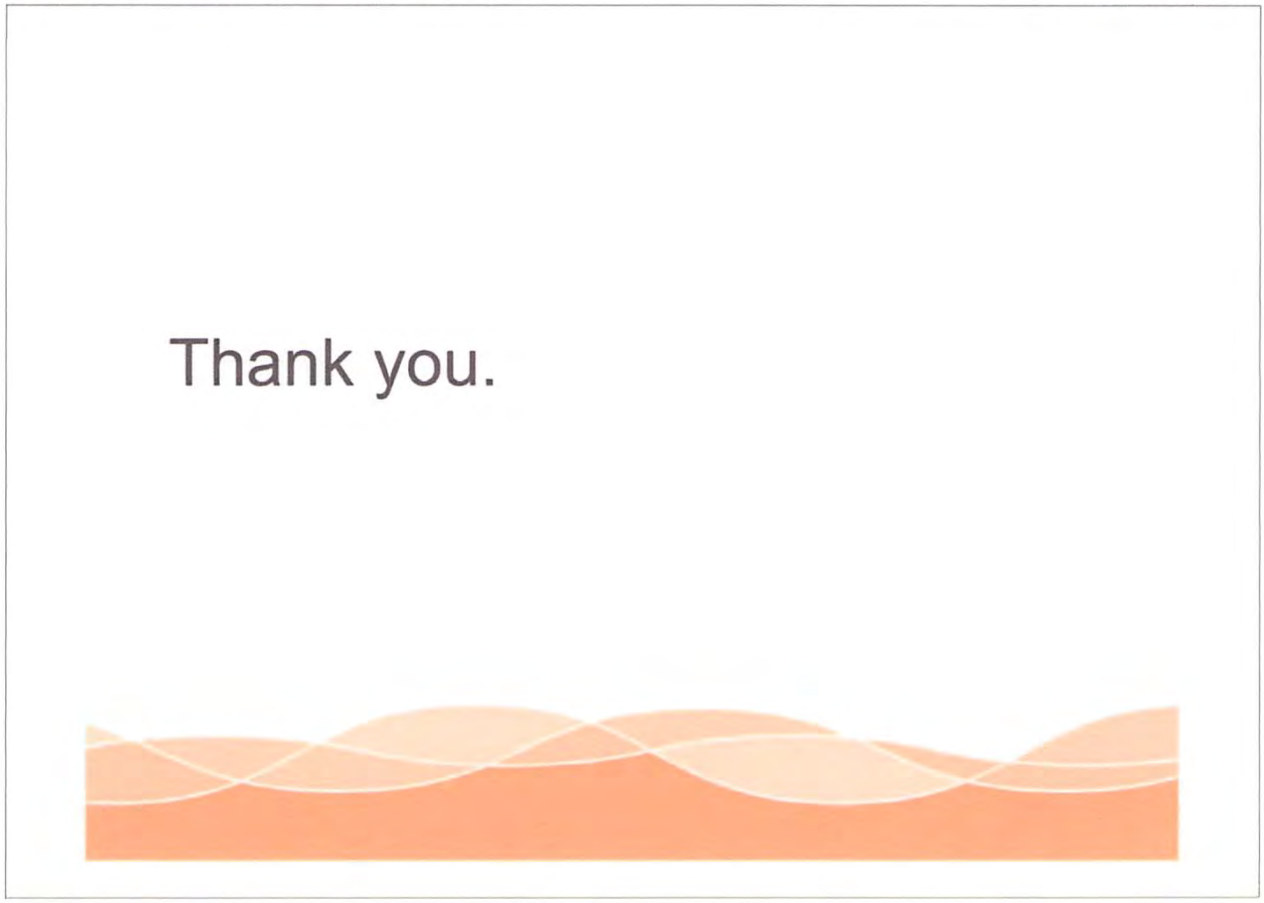
Site3: Airai – Koror - Malakal

- ✓ Establishment of Suitable Inspection and Patrol Rule/Standard
- ✓ Efficient Operation of Power System - Reuse of Re-closer

Our Slogan

4

Think together, Work together


Thank you.

Japan International Cooperation Agency

YACHIYO ENGINEERING CO.,LTD.
Consulting Engineers & Architects

Kansai Electric Power

Countermeasures against tree touch

July 2017

Countermeasures

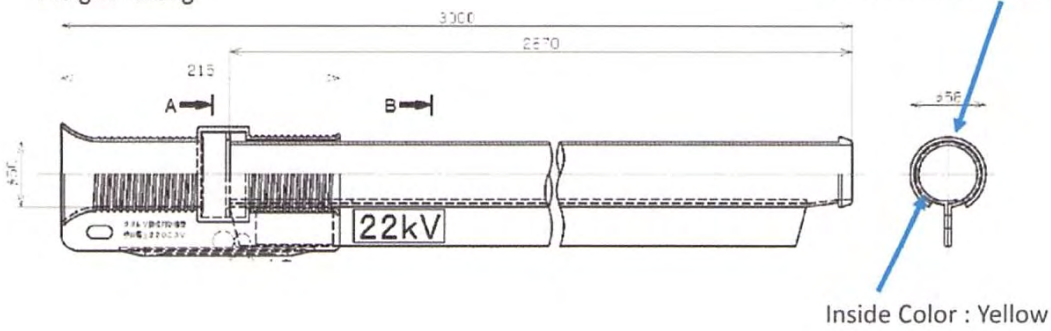
1. Tube (Conductor Cover) and Installation Tool
2. Ivy/Vine Guard for Pole and Stay Wire
3. Overcurrent Indicator

Tube (Conductor Cover)

3

Flame proof

Weight : 2.3kg

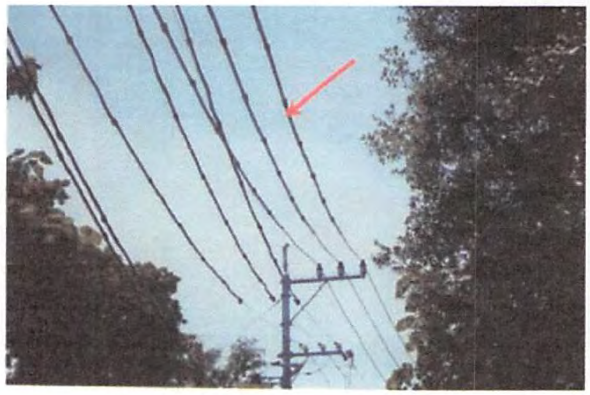


Tube (Conductor Cover)

4

Tube (Conductor Cover)

5



Installation Tool

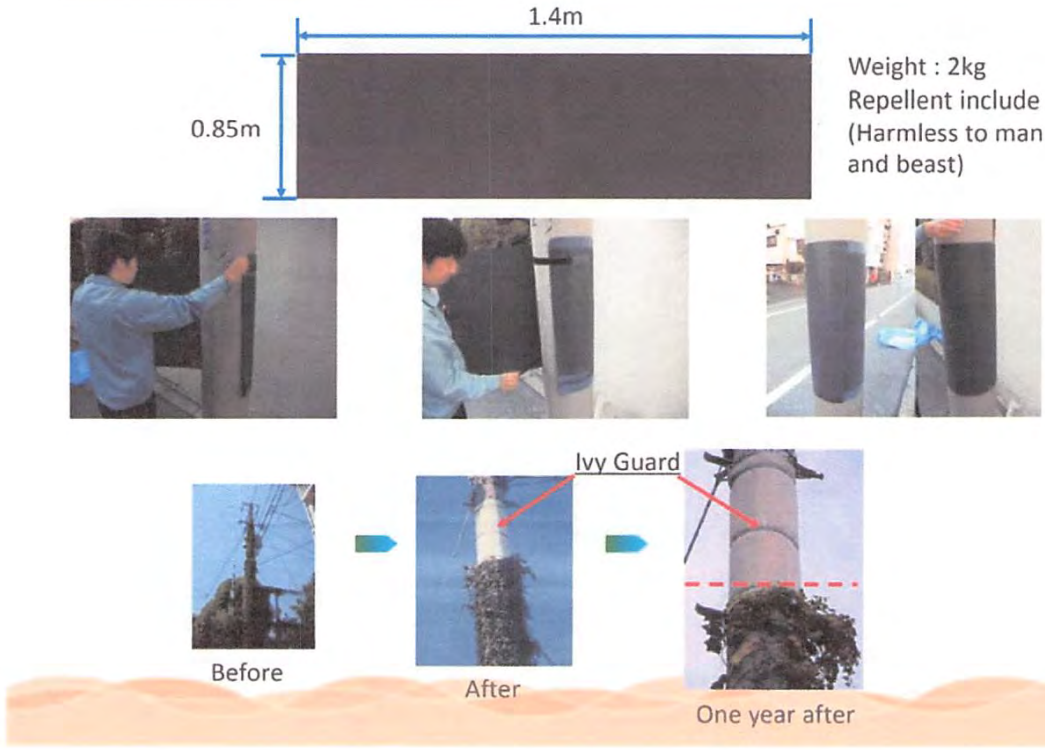
6

Weight : 7kg

- ✓Designed for installation and uninstallation of tubes in de-energized line work
- ✓Electric drill helps continuous installation work of the tubes

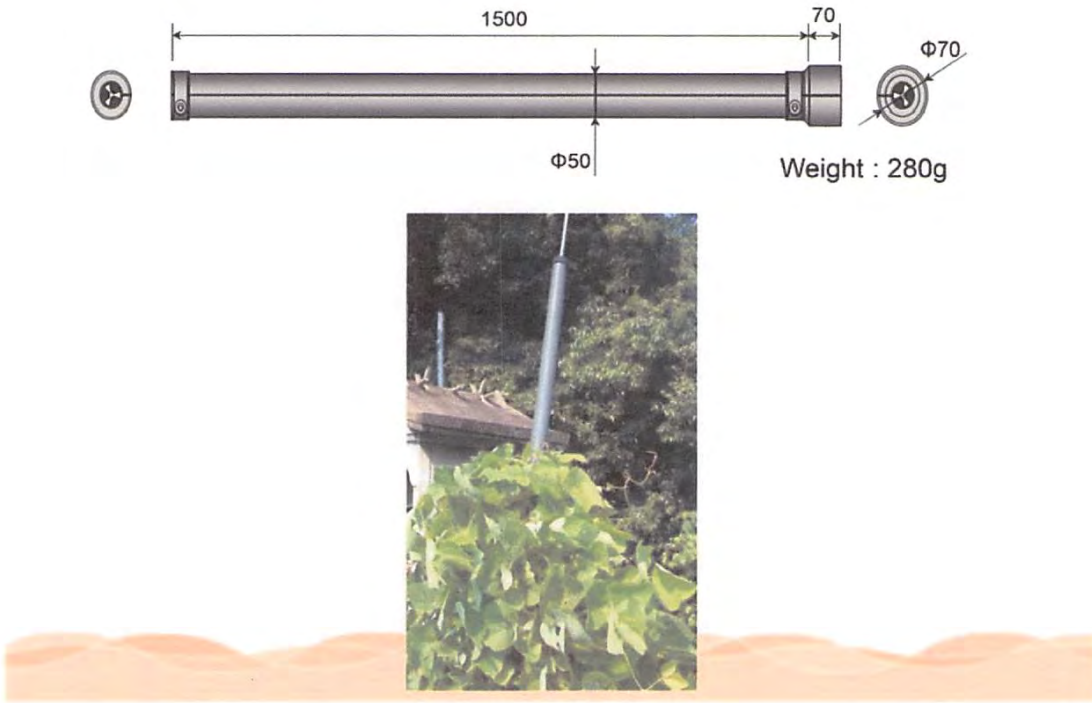
Ivy/Vine Guard for Pole

7



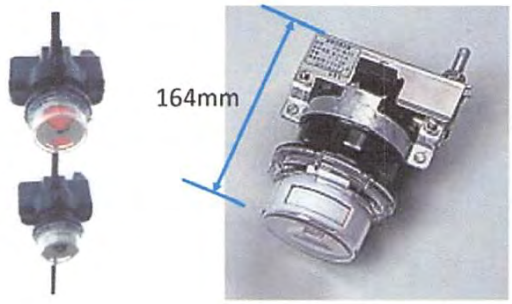
Ivy Guard for Stay Wire

8



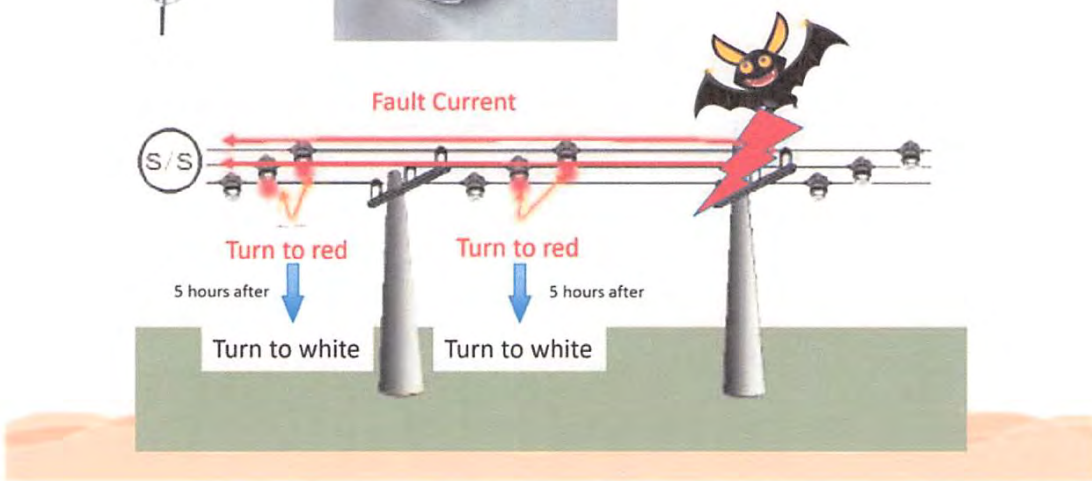
Overcurrent Indicator

9



Weight : 2kg

2A is needed to operate



Thank you.

Japan International Cooperation Agency

YACHIYO ENGINEERING CO.,LTD.
Consulting Engineers & Architects

Kansai Electric Power

Evaluation for Renewable Energy Integration Capacity in the Republic of Palau

July, 2017

Technical Challenges

	Technical Challenges	Measures
1	Frequency Fluctuation (Short-period)	• LFC/AFC • Batteries
2	Excess Electricity (Long-period)	• Demand Creation • RE Output Rejection • Batteries
3	Voltage Rise in Distribution System	• Demand Creation • Voltage Control Equipment
4	Lack of Transmission/Distribution Facilities	• New Transmission/Distribution Facilities

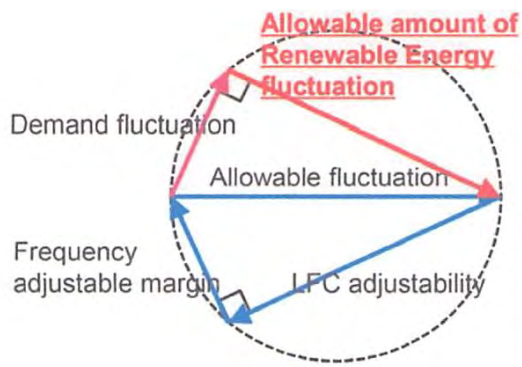
Evaluation Method to Determine the Renewable Energy Integration Capacity 3

Frequency Fluctuation (Short-period) ➡ Algebraic Method

Excess Electricity (Long-period) ➡ HOMER Pro

Algebraic Method 4

$$\sqrt{(LFC\ adjustability)^2+(\text{Frequency adjustable margin})^2} \geq \sqrt{(\text{Demand fluctuation})^2+(\text{Allowable amount of Renewable Energy fluctuation})^2}$$



【Required Specifications】
①LFC adjustability
⇒Specifications for generator /Operation method
②Frequency adjustable margin
⇒Total demand (kW)
⇒Power System constant (%kW/Hz)
⇒Allowable frequency fluctuation (Hz)
③Demand fluctuation
⇒Demand Data
④Allowable amount of Renewable Energy fluctuation
⇒Past record (e.g. Solar radiation intensity data)

HOMER Pro

5

The HOMER Pro® microgrid software by HOMER Energy is the global standard for optimizing microgrid design in **all** sectors, from village power and island utilities to grid-connected campuses and military bases. Originally developed at the National Renewable Energy Laboratory, and enhanced and distributed by HOMER Energy, HOMER (Hybrid Optimization Model for Multiple Energy Resources) nests **three powerful tools in one software product,** so that **engineering and economics work side by side:**

HOMER simplifies the task of designing distributed generation (DG) systems—both on- and off-grid. HOMER's optimization and sensitivity analysis algorithms allow you to evaluate the economic and technical feasibility of a large number of technology options and to account for variations in technology costs and energy resource availability. Working effectively with HOMER requires understanding its three core capabilities; **simulation**, **optimization**, and **sensitivity analysis**; and how they interact.

http://www.homerenergy.com/HOMER_pro.html

HOMER Pro

6

<Simulation>

At its core, HOMER is a simulation model. It will attempt to simulate a viable system for all possible combinations of the equipment that you wish to consider. Depending on how you set up your problem, HOMER may simulate hundreds or even thousands of systems.

HOMER simulates the operation of a hybrid microgrid for an entire year, in time steps from one minute to one hour.

http://www.homerenergy.com/HOMER_pro.html

HOMER Pro

7

<Optimization>

•HOMER examines all possible combinations of system types in a single run, and then sorts the systems according to the optimization variable of choice.

•HOMER Pro features our new optimization algorithm that significantly simplifies the design process for identifying least-cost options for microgrids or other distributed generation electrical power systems. HOMER Optimizer™ is a proprietary "derivative free" optimization algorithm that was designed specifically to work in HOMER.

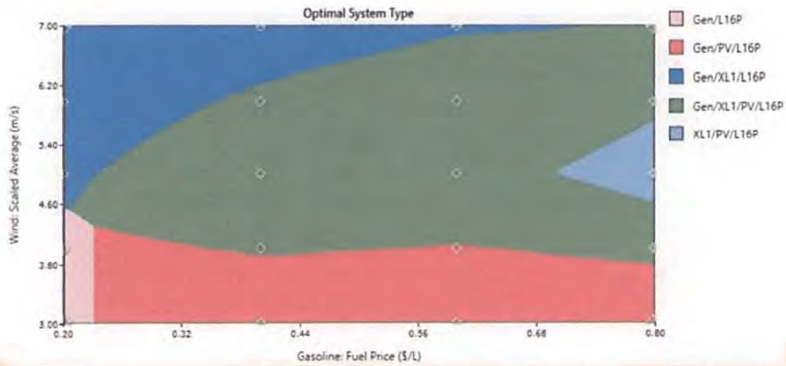
http://www.homerenergy.com/HOMER_pro.html

HOMER Pro

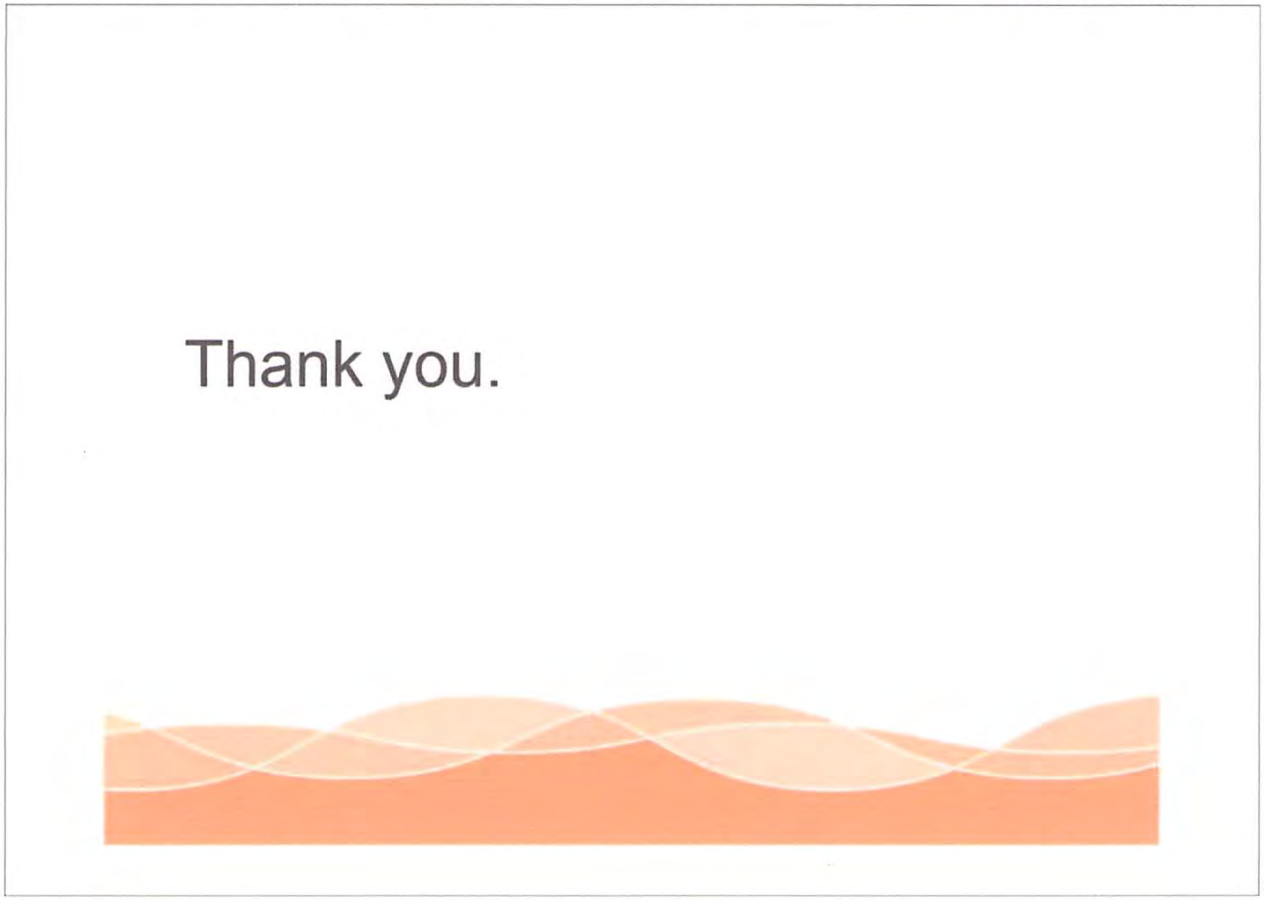
8

<Sensitivity Analysis>

•HOMER lets you ask as many "What if?" questions as you'd like, because you cannot control all aspects of a system, and you cannot know the importance of a particular variable or option without running hundreds or thousands of simulations and comparing the results.
•HOMER makes it easy to compare thousands of possibilities in a single run. This allows you to see the impact of variables that are beyond your control, such as wind speed, fuel costs, etc, and understand how the optimal system changes with these variations.



http://www.homerenergy.com/HOMER_pro.html


Thank you.

Appendix 2: Counterpart List

Counterpart List

No.	Mr./Ms.	Name	Title	Organization	Telephone	E-Mail
1	Mr.	Mitsuhisa NISHIKAWA	Team Leader/Power System Planning	yec		
	Mr.	Kione J. Isechal	CEO	PPUC		
2	Mr.	Masaki KOBAYASHI	Deputy Team Leader / Renewable Energy / System Stabilization Method	KEPCO		
	Mr.	Kennard Sugiyama	Renewable Energy Division Manager	PPUC		
3	Mr.	Tomoyuki INOUE	Power Demand Forecast	yec		
	Mr.	Tito Cabunagan	Power Generation Division Manager	PPUC		
4	Mr.	Nobuyuki KINOSHITA	Power System Analysis (1)	yec		
	Mr.	Kazuaki KONDO	Power System Analysis (2)	yec		
	Mr.	Tito Cabunagan	Power Generation Division Manager	PPUC		
5	Mr.	Tatsuhiro TAMURA	Power Transmission & Distribution System	KEPCO		
	Mr.	Takashi GENJI	Operation & Maintenance of Power Transmission & distribution System	KEPCO		
	Mr.	James Mengeolt	System Control Division Manager	PPUC		
	Mr.	Hilton Hideos	Power Distribution Division Manager	PPUC		
6	Mr.	Makoto ABE	Substation System	yec		
	Mr.	Takaya FUYUKI	Operation & Maintenance of Substation System	KEPCO		
	Mr.	James Mengeolt	System Control Division Manager	PPUC		
	Mr.	Hilton Hideos	Power Distribution Division Manager	PPUC		
7	Mr.	Yoshiyuki CHOSO	Economic & Financial Analysis	yec		
	Ms.	Hashinta Idechong	Chief Financial Officer	PPUC		
8	Mr.	Masaya SUGITA	Environment & Social Consideration	yec		
	Mr.	Anthony Rudimch	Project Planning and Implementation Department Manager	PPUC		
9	Mr.	Naoya KISHI	Project Coordinator/Assistant of Power System Planning	yec		

Note: Red color for PPUC and Black color for JICA Team

PPUC Members attended to Explanation of Inception Report

No.	Mr./Ms.	Name	Title	Organization	Telephone	E-Mail
1	Mr.	Kione J. Isechal	CEO	PPUC		
2	Mr.	Samy Masang	Board of Director / Chairman	PPUC		
3	Mr.	Ted T. Mereb	Board of Director	PPUC		
4	Mr.	Greg Decherong	Board of Director	PPUC		
5	Mr.	Anthony Rudimch	Project Planning and Implementation Department Manager	PPUC		
6	Mr.	James Mengeolt	System Control Division Manager	PPUC		
7	Mr.	Hilton Hideos	Power Distribution Division Manager	PPUC		
8	Mr.	Tito Cabunagan	Power Generation Division Manager	PPUC		
9	Mr.	Kennard Sugiyama	Renewable Energy Division Manager	PPUC		
10	Ms.	Dee Lola Reklai	Project Planning & Implementation Dep.	PPUC		
11	Ms.	Lucia Santos	Executive Secretory	PPUC		
12	Ms.	Turung Rengiil	WIA	PPUC		
13	Mr.	Yuzo Yasui	Senior JICA Volunteer (RED)	JICA (PPUC)		

Appendix 3: List of Authorities/Offices visited and Data/Information collected

No.	Name of Data/Information	Authorities/Offices visited	Preparer	Date
1	Palau Energy Policy 2010	Palau Energy Administration	Palau Energy Office	2017/7/13
2	Palau Energy Roadmap – Draft for discussion	Palau Energy Administration	IRENA	2017/7/13
3	PALAU INTERNATIONAL AIRPORT GRID CONNECTED SOLAR SYSTEM	PPUC Renewable Energy Division	PPUC	2017/7/13
4	Palau Intended Nationally Determined Contribution November 2015	PPUC Project Planning & Implementation Dep.ion	PPUC	2017/7/14
5	KB YEARLY LOAD GRAPH FOR 2016	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/17
6	KB YEARLY LOAD GRAPH FOR 2017	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/17
7	PGD GROSS GENERATION	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/17
8	TEST REPORT FOR ON-LOAD TAP-CHANGING TRANSFORMER	PPUC Renewable Energy Division	PPUC Accounting & Finance	2017/7/17
9	Electric Power Operation (EPO) Generation, transmission, and Distribution Cost,	PPUC Renewable Energy Division	PPUC Accounting & Finance	2017/7/17
10	PPUC EPO History-Fuel cost and KwH Sold	PPUC Renewable Energy Division	PPUC Accounting & Finance	2017/7/17
11	EXISTING ONE LINE DIAGRAM AUG 16, 2016	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
12	PPUC TECHNICAL DATA	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
13	FINAL REPORT ISSYSTEMS	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
14	Power Generation Table of Organization	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
15	A SUMMARY OCTOBER 2015 – SEPT 2016	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
16	A SUMMARY OCTOBER 2016 – SEPT 2017	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
17	OKAY final PDD report 2017 sen hearing	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
18	PDD ORG CHART	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
19	SUMMARY OCT 2013 TO SEPT 2014	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
20	SUMMARY OCT 2014 – SEPT 2015	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18
21	TREE MANAGEMENT PLAN	PPUC Power Generation Division	PPUC Power Generation Division	2017/7/18

Appendix 3: List of Authorities/Offices visited and Data/Information collected

No.	Name of Data/Information	Authorities/Offices visited	Preparer	Date
22	EQPB Regulations: CHAPTER 2401-01 EARTHMOVING REGULATIONS CHAPTER 2401-11 MARINE AND FRESH WATER QUALITY REGULATIONS CHAPTER 2401-13 TOILET FACILITIES AND WASTEWATER DISPOSAL SYSTEMS REQUIREMENTS CHAPTER 2401-31 SOLID WASTE MANAGEMENT REGULATIONS CHAPTER 2401-33 PESTICIDE REGULATIONS CHAPTER 2401-51 PUBLIC WATER SUPPLY SYSTEM REGULATIONS CHAPTER 2401-61 ENVIRONMENTAL IMPACT STATEMENT REGULATIONS CHAPTER 2401-71 AIR POLLUTION CONTROL REGULATIONS CHAPTER 2401-81 OZONE LAYER	PPUC-Project Planning and Implementation Department	EQPB	2017/7/19
23	EQPB Permit Process rev 08-03	PPUC-Project Planning and Implementation Department	EQPB	2017/7/19
24	Lab Testing w fees	PPUC-Project Planning and Implementation Department	EQPB	2017/7/19
25	General Application Modified Dec2015	PPUC-Project Planning and Implementation Department	EQPB	2017/7/19
26	Earthmoving Application Modified Dec2015	PPUC-Project Planning and Implementation Department	EQPB	2017/7/19
27	Org Chart RED	PPUC Renewable Energy Division	PPUC Renewable Energy Division	2017/7/19
28	Economic Review Fiscal Year 2015	Ministry of Finance	U.S. Department of the Interior	2017/7/19
29	Palau Climate Change Policy 2015	Ministry of Finance	Government of Palau	2017/7/19
30	Population Projection to 2030	Ministry of Finance	Ministry of Finance	2017/7/19
31	GDP and Tourism Numbers Projection to 2030	Ministry of Finance	Ministry of Finance	2017/7/19
32	Palau's Public Projects	Ministry of Finance	Ministry of Finance	2017/7/19

Memorandum
between
Palau Public Utilities Corporation (PPUC)
and
The JICA Study Team
for
The Project for Study on Upgrading and Maintenance Improvement
of
National Power Grid in the Republic of Palau
(2nd Field Survey)

The JICA Study Team (hereinafter referred to as "the Team") consists of Yachiyo Engineering Co., Ltd. Tokyo, Japan (hereinafter referred to as "YEC") and Kansai Electric Power Co., INC. Osaka, Japan (hereinafter referred to as "KEPCO") visited the Republic of Palau (hereinafter referred to as "Palau") from 12th September, to 1st October, 2017 for **the Project for Study on Upgrading and Maintenance Improvement of National Power Grid in the Republic of Palau** (hereinafter referred to as "the Project") as 2nd field survey.

During its stay in Palau, the Team had a series of discussions and exchanged mutual opinions with Palau Public Utilities Corporation (hereinafter referred to as "PPUC") and other concerned authorities of the Government of Palau (hereinafter referred to as "the Palauan side") through the explanation of the Planned Activities during the 2nd field survey, conducting the field survey and the collection of necessary data and information for the successful implementation of the Project, and this survey will continue up to 25th October,2017.

As a result of discussions, both sides recognized the matters referred to in the document attached hereto.

Koror, Palau, 29th September, 2017

Mr. Mitsuhisa NISHIKAWA
Team Leader
JICA Project Team,
Japan International Cooperation Agency (JICA)

Mr. Kione J. Isechal, P.E.
Chief Executive Officer
Palau Public Utilities Corporation (PPUC)
The Republic of Palau

ATTACHMENT

1 Explanation of the planned activities during 2nd field survey.

The Team distributed the explanation sheets to the Palauan side, and explained their contents. Main contents of explanations are as follows:

(1) Power Demand forecast (Explain to and discuss with PPUC counterparts)
1) Main preconditions for model building
2) Results of PPUC Power Demand
3) Results of State Power Demand
4) Comparison of Power Demands
5) Schedule of Power Demand Evaluation

(2) Power Flow Analysis (Explain to and discuss with PPUC counterparts)
1) Power Flow Analysis under the present conditions (year 2016-2017)
2) Collection of data necessary for Power Flow Analysis (continued)
3) Building of main preconditions for Power Flow Analysis
4) Stability analysis under the present conditions (Preliminary)

(3) Power Transmission and Distribution (T/D) System
1) Conducting detailed site survey with PPUC counterparts and Grasping the present situations
2) Collecting Transmission and Distribution drawings & specifications
3) Confirmation of present operation & maintenance system of PPUC
4) Preparation of alternatives for Pre-F/S Projects (Preliminaries)
5) Explain to and discuss with PPUC counterparts regarding Pre-F/S Projects
6) Meeting with IS Systems Pty Limited (Austria Electric Engineering Company) for the causes of power outage of Nekken transmission lines, in case they come to Palau by PPUC request. If they did not come to Palau, the Team would contact them by e-mail as necessary.

(4) Substation system
1) Confirmation of present operation & maintenance system of PPUC(continued)
2) Conducting detailed site survey with PPUC counterparts and Grasping the present situations of substations (Continued)
3) Collection of specifications & drawings of substation's equipment and systems (continued).
4) Preparation of alternatives for Pre-F/S Projects (Preliminaries)
5) Explain to and discuss with PPUC counterparts regarding Pre-F/S Projects

(5) Economic and Financial Analysis
1) Collection of basic data with PPUC counterparts for Economic & financial analysis
2) Building of main preconditions for Economic analysis, and explain to PPUC counterparts about economic valuation criteria and models.

(6) Environment and Social Consideration
1) Collection of data and information necessary for Environment and Social consideration and SEA (Strategic Environment Assessment) (continued)
2) Confirmation of Pre-F/S Project sites for T/D and Substation
3) Conducting 1st stakeholder meeting, as EQPB (Environment Quality Protection Board) accepted during 1st field survey.

2 Technology transfer commenced.

The Team has conducted the lecture for "the Evaluation of Renewable Energy Integration capacity" 25th to 26th September, 2017 and "Smart Meter System" 27th September, 2017 at PPUC meeting room at Malakal Power Plant.

(1) Lecture of "the Evaluation of Renewable Energy Integration capacity"
Two(2) days Lecture were conducted with view point that the System stabilization measures when introducing renewable energy in large quantities mainly comprise the following three items:
1) Evaluation methodology of Renewable Energy Integration Capacity.
2) Reduction of the renewable energy fluctuation rate with batteries
3) Curtailment of renewable energy output
Since the Study targets the transmission and distribution system, feasibility will be assessed concerning 2) and 3). Concerning 3), it is common to control renewable energy output through control of the power conditioners (PCS) composing PV systems.

(2) Lecture of "Smart Meter System"
This Lecture was conducted with view point that Introduction of Current situation of Smart Meter System in KANSAI. After this lecture, the team and students had discussion about installation possibility of Smart Meter in Palau.

(3) Occasional students of the Lecture were persons from Energy Administration and the young technicians from PPUC. Total numbers of attendance were around 10 persons.

3 Target of introduction of renewable energy capacity against total generating capacity by year 2025

(1) The Team confirmed that Palau's NDC put the nation on a trajectory to generating 45% of its energy from renewable sources by 2025.

(2) PPUC strongly hope that one (1) 5MW diesel generator out of three (3) 5MW diesel generators which are operating at present, replace to renewable energy (RE) source.

(3) The Team will make the following study and show the results in the Master Plan report.
1) Influences and issues in the case that the 45% power demand covered by renewable resources, including compositions of auxiliaries, rough cost estimation and O & M cost.
2) A proposal that most reasonable compositions (ratio of renewable energy against total generation capacity), with viewpoints of equipment, O & M cost, cost estimation, etc.

(4) The Team submitted and explained to PPUC an attached report (Appendix-1) of "Influence and Issues Brought by High Penetration of PV or Wind" and PPUC side basically understood it.

(5) Energy Administration shows the Team the expected locations (candidate sites) for the high penetration of PV system as preliminary (not fix yet) as Appendix-2.

4 Meeting with IS Systems Pty Limited (Austria Electric Engineering Company)

For the causes of power outage of Nekken transmission lines, the Team requested to arrange a meeting with IS systems. However, the contract between IS systems and PPUC was completed, and IS system has no idea to visit Palau in near future. Therefore, the Team will contact IS system by e-mail if the Team find questions in their final report.

candidate projects were discussed.

(1) Expanding 34.5kV transmission lines from Kokusai S/S～Melekeok～Airai or New Koror S/S～Malakal S/S. (Airai or New Koror S/S should be constructed by year 2023)
This Project plans to improve power supply reliability by double circuits between Malakal～Melekeok～Aimeliik～Malakal.

(2) Re-location of Nekken 34.5kV transmission and 13.8kV distribution lines which are presently installed far from Compact road and difficult to accesses for maintenance, to alongside of Compact road (target year; as early as possible).

(3) Rehabilitation of Malakal S/S and Aimeliik S/S by year 2030.

(4) Rehabilitation of small substations, specially switching system, metering system, communication system as necessary.(At least, the key lock system shall immediately be installed)

6 Next field survey

The Team will visit Palau from 18th November to 17th December, 2017 as third field survey. (See Appendix – 3)

Appendix List

Appendix 1: Influence and Issues Brought by High Penetration of PV or Wind
Appendix 2: Expected PV installation Location
Appendix 3: Dispatching schedule of the team members (preliminary)
Appendix4: Preliminary Location Map of Transmission lines, Distribution lines and Substations (After year 2030)

Japan International Cooperation Agency

YACHIYO ENGINEERING CO.,LTD.
Consulting Engineers & Architects

Kansai Electric Power

Influence and Issues Brought by High Penetration of PV or Wind

September, 2017

Influence and Issues Brought by High Penetration of PV and Wind

	Influence and Issues	Countermeasures
1	Frequency Fluctuation (Short-term)	• LFC/AFC function improvement • Batteries
2	Surplus Electricity (Long-term)	• Demand creation at peak time • Generator Improvement • RE output curtailment • RE output forecast • Batteries
3	Voltage Rise in Distribution System	• Demand creation in the distribution line. • Voltage control equipment
4	Lack of Transmission/Distribution Facilities	• New transmission/distribution facilities

Underlined Items need lots of cost

Influence and Issues Brought by High Penetration of PV

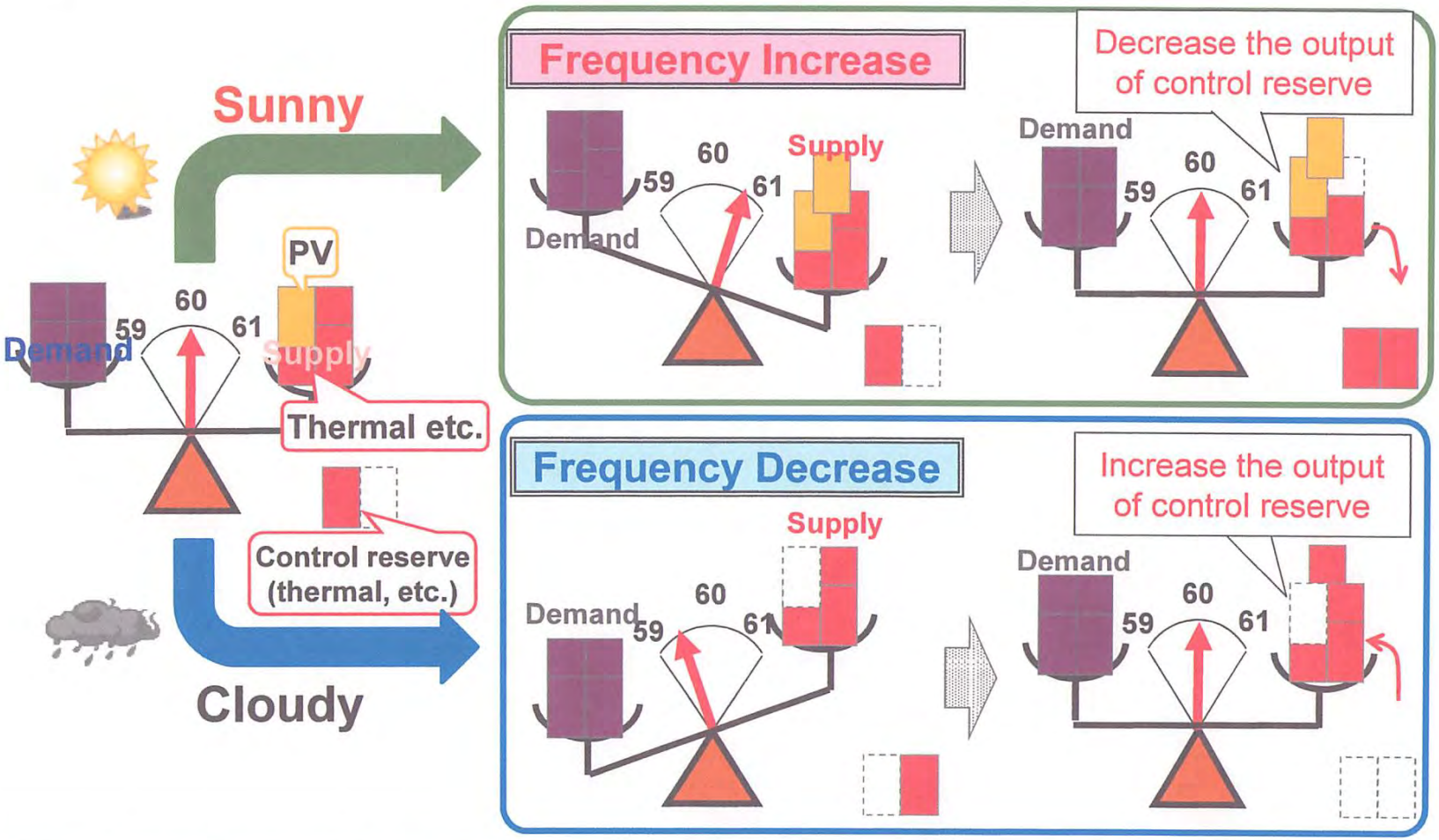
	Influence and Issues	Measures
1	Frequency Fluctuation (Short-term)	• LFC/AFC function improvement • Batteries
2	Surplus Electricity (Long-term)	• Demand creation at peak time • Gene • RE ou • RE ou • Batte
3	Voltage Rise in Distribution System	• Demand creation in the distribution line.
4	Lack of Transmission/Distribution Facilities	

These issues may cause fluctuation of …

- Frequency
- Voltage

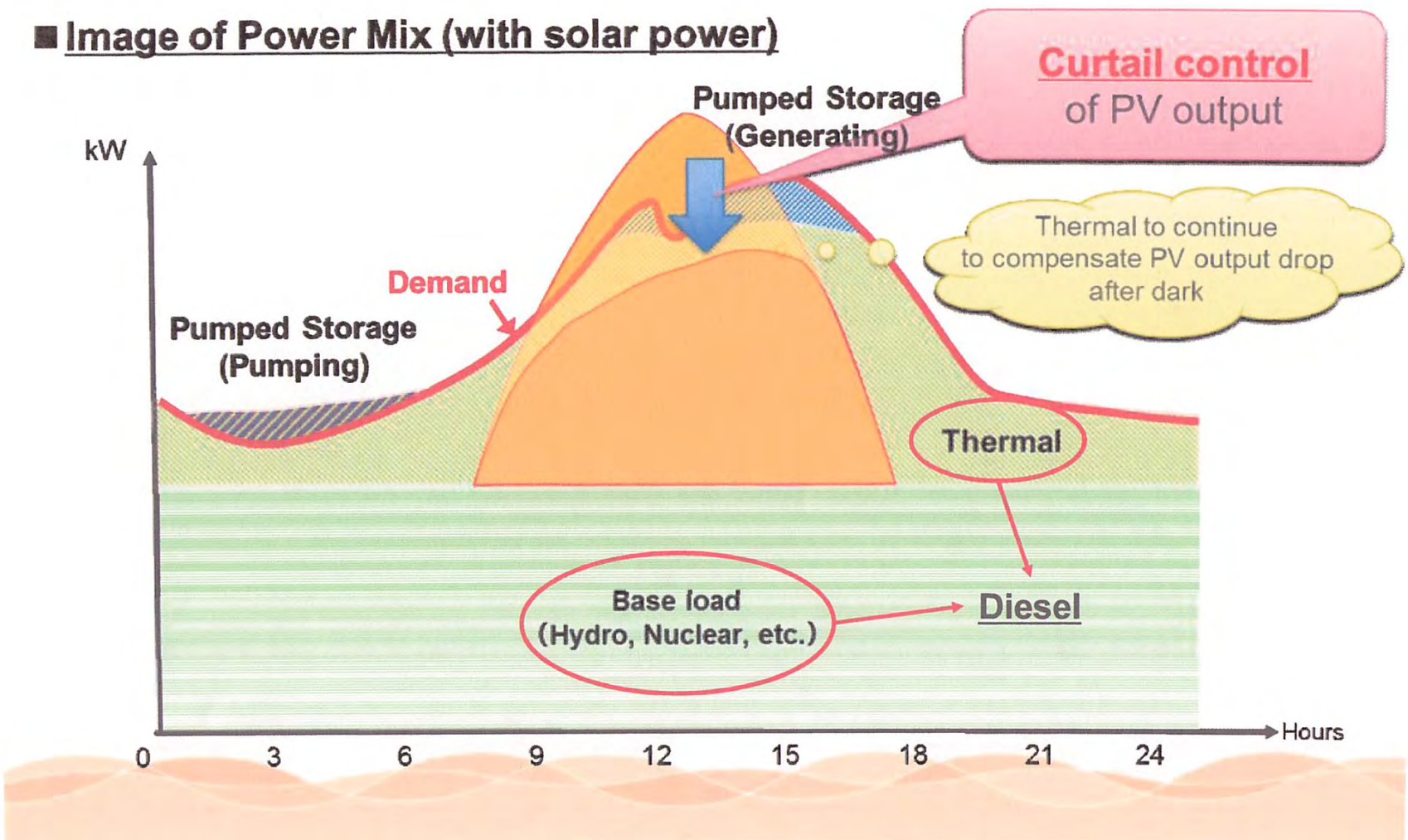
✓ Blackout
✓ Appliance breakdown

One of issues of Short term Fluctuation



As output fluctuation of PV power generation, in addition to demand change, is covered by increasing or decreasing the output of control reserve, required capacity for frequency control (thermal or pumped storage) increases.

One of issues of long term Fluctuation

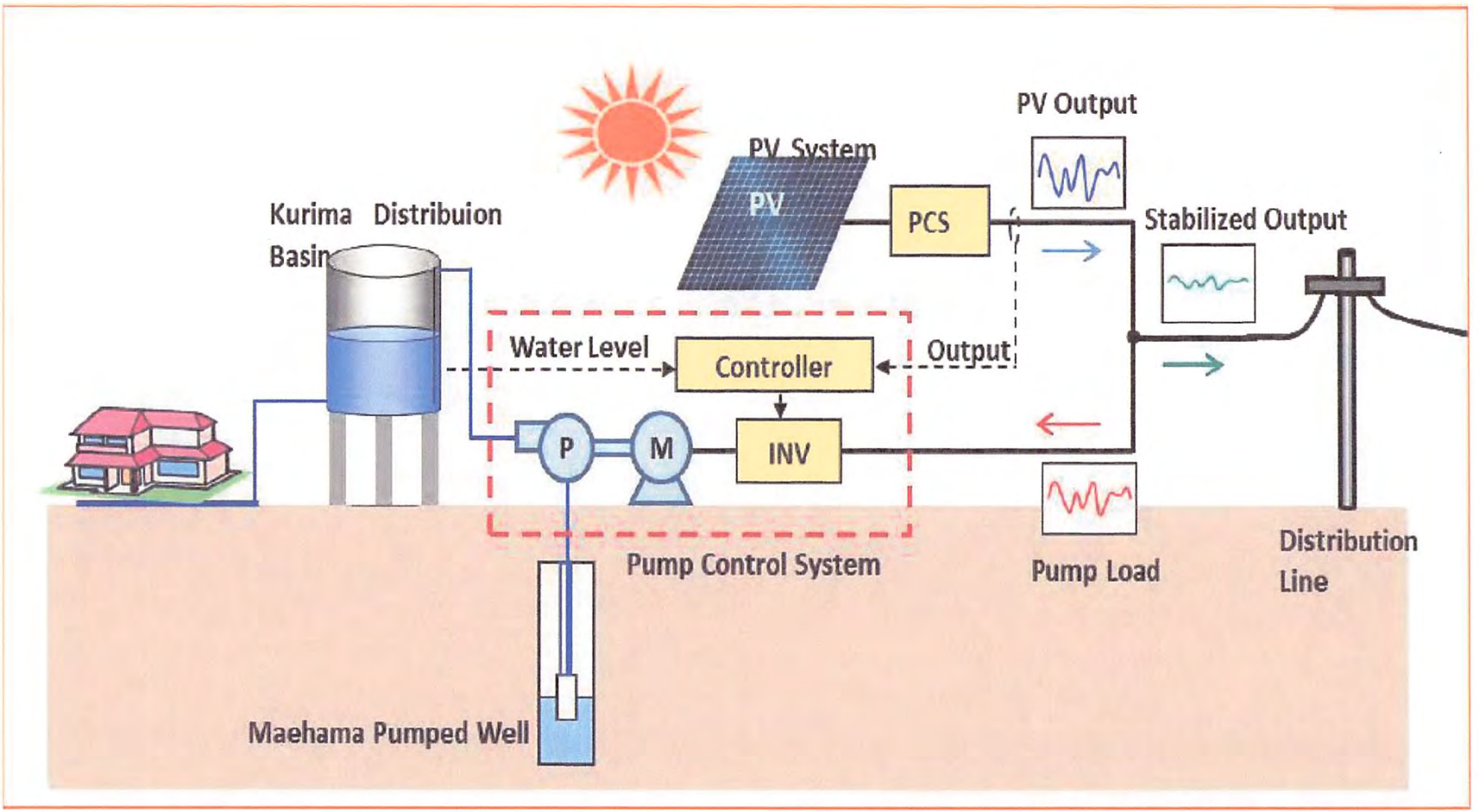


Influence and Issues Brought by High Penetration of PV

	Technical Challenges	Measures
1	Frequency Fluctuation (Short-term)	• LFC/AFC funct • Batteries
2	Surplus Electricity (Long-term)	• Demand creation at peak time • Generator Improvement • RE output curtailment • RE output forecast • Batteries
3	Voltage Rise in Distribution System	• Demand creation in the distribution line. • Voltage control equipment
4	Lack of Transmission/Distribution Facilities	• New transmission/distribution facilities

Pumping for Water Tank?
Ice making machine?

Expanding PV integration by utilizing the water supply facilities



Ref: JICA report by Okinawa Enetec

Long term fluctuation

POWERHOUSE

New powerhouse built by STELCO for its existing diesel generators and the new PV system equipment.

HYBRID SYSTEM

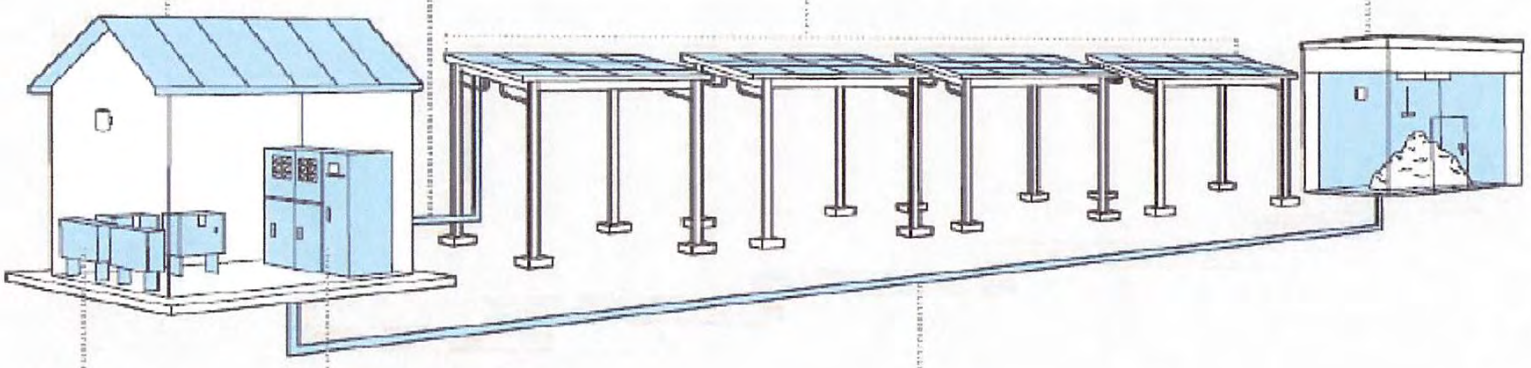
40 kW PV system is connected to Dhiffushi's power grid and works in conjunction with the existing diesel generators.

MULTI-FUNCTIONAL FRAME STRUCTURE

3 metre high frame structure holds four separate 10 kW PV panel arrays inclined at 5 degrees, limiting the extent of damage in case of a tsunami and providing good shade for residents.

ICE HOUSE

Industrial ice machine installed in new ice house on the pier effectively functions as the supply-demand controller for the grid-connected PV system.



POWER CONDITIONERS

Four power conditioners and a system controller are installed inside the powerhouse.

FLEXIBLE CONTROL SYSTEM

The control system is operated in both automatic and manual mode. This flexibility helps maximize PV power generation and improve its stability, making maintenance and troubleshooting easier.

CABLING

The PV system and ice making machine are connected to the powerhouse through underground cables.

Appendix-2

Expected PV System Installation Location

As of 24th September

No.	Location	Capacity	Owner/Present situation
1	**Aimeliik (Next to power plant)**	**5 MW**	**PPUC** This is already planned by PPUC but Energy administration do not have the details. Please ask Ken Sugiyama for confirmation
2	**Ngatpang (Kokusai)**	**2-3 MW**	Owners of both sites are not confirmed yet for both #2 Ngatpang and #3 Ngardmau. The capacity are also not confirmed yet,
3	**Ngardmau (Terraces of Hill)**	**2-3 MW**	
4	**Koror & Airai (Roof top)**	**2-5 kw / roof**	**House owner** Energy Administration will send the detail number of systems and capacity to PPUC
5	**Commercial roof top by Joint Crediting Mechanism**	**Total 5 MW**	Surangle, WCTC PIDC & PMA
6.	**Airai airport (side by road)**	**3 MW**	**PPUC**
7.	**Ocean Thermal Energy Conversion in 15 – 20 years later**	**3 MW**	**PPUC**
Total		**18 ～23 MW**	

Notes

(1) Above data received from Energy Administration, but not authorized yet (as of the end of September, 2017)

(2) Capacity of No. 6 & 7 are only expectation, but we, Energy Administration will make more details after our plans become more detailed.

The Project for Upgrading and Maintenance of the National Electrical Power Grid in the Republic of Palau

Tentative Team Members Dispatching Schedule to Palau

Assignment	Name	Belong to	Fisical Year 2017											Fisical Year 2018								
			6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Team Leader/Power System Planning	Mitsuhisa NISHIKAWA	YEC		(16) 8 23		(16) 16 1		(16) 18 3			(16)									(12)		
Depty Team Leader / Renewable Energy / System Stabilization Method	Masaki KOBAYASHI	KEPCO		(21) 9 29			(16) 12 27				(21)			(14)			(14)			(14)		
Power Demand Forecast	Tomoyuki INOUE	YEC		(16) 8 23		(16) 16 1					(16)											
Power System Analysis (1)	Nobuyuki KINOSHITA	YEC		(23) 8 30		(23) 16 8		(23) 18 10			(16)											
Power System Analysis (2)	Kazuaki KONDO	YEC		(23) 18 9		(23) 16 8		(23) 18 10			(23)											
Power Transmission & Distribution System	Tatsuhiro TAMURA	KEPCO					(18) 11 28	(21) 19 9			(21)			(14)	(16)		(14)			(14)		
Operation & Maintenance of Power Transmission & distribution System	Takashi GENJI	KEPCO					(18) 11 28	(23) 18 10			(21)			(14)			(14)			(14)		
Substation System	Makoto ABE	YEC		(16) 8 23		(30) 16 15		(23) 25 17			(23)				(16)			(12)		(12)		
Operation & Maintenance of Substation System	Takaya FUYUKI	KEPCO					(18) 11 28	(21) 28 16			(21)				(14)			(12)		(14)		
Economic & Financial Analysis	Yoshiyuki CYOSO	YEC				(19) 16 4		(19) 29 17			(23)											
Evironment & Social Consideration	Masaya SUGITA	YEC		(16) 18 2			(16) 3 18	(16) 25 10			(16)											
Project Coordinator/Assistant of Power System Planning	Naoya KISHI	YEC		(23) 8 30		(30) 16 15		(30) 18 17			(30)			(16)				(12)		(12)		
YEC: Yachiyo Engineering Co., LTD. KEPCO: The Kansai Electrlic Power Co., Inc.				▲ Inception Report				▲ Progress Report (1)			▲ Progress Report (2)									▲ Draft Final Report	▲ Final Report	

(As of 12 June 2017)

Appendix-4: Preliminary Location Map of Transmission Lines, Distribution Lines and Substations (After Year 2030)