TIME TABLE FOR
JOINT COORDINATION COMMITTEE
ON THE PROJECT FOR
STUDY ON UPGRADING AND MAINTENANCE IMPROVEMENT OF NATIONAL POWER GRID
IN THE REPUBLIC OF PALAU

PLACE AND VENUE: PALASIA HOTEL, KOROR, PALAU
DATE: 13TH APRIL, 2018.

Time	Event/ Activity	Action by
09:10-09:15	Opening Remarks	Representative from PPUC
09:15-09:20	Introduction of Members of JICA Study Team	Mr. Mitsuhisa Nishikawa
09:20-09:30	Power Demand Forecast	Mr. Tomoyuki Inoue
09:30-09:55	Renewable Energy Roadmap	Mr. Masaki Kobayashi
09:55-10:10	Network Planning and Analysis	Mr. Nobuyuki Kinoshita
10:10-10:25	Power Transmission and Distribution line	Mr. Tatsuhiro Tamura
10:25-10:40	Substation Planning & Summary of Facility Planning	Mr. Makoto Abe
10:40-10:50	Questions and Answers	All
10:50-11:10	Coffee break	All
11:10-11:20	Environmental and social considerations	Mr. Masaya Sugita
11:20-11:30	Economic Analysis	Mr. Yoshiyuki Choso
11:30-11:40	Target of Pre-feasibility Study	Mr. Makoto Abe
11:40-11:50	Questions and Answers	All
11:50-11:55	Closing Remarks	Representative from JICA

Members of JICA Study Team

Assignment	Name	Belonging to
Team Leader / Power System Planning	Mitsuhisa NISHIKAWA	Yachiyo Engineering Co., Ltd.
Deputy Team Leader / Renewable Energy / System Stabilization Method	Masaki KOBAYASHI	Kansai Electric Power Company, Inc.
Power Demand Forecast	Tomoyuki INOUE	Yachiyo Engineering Co., Ltd.
Power System Analysis (1)	Nobuyuki KINOSHITA	Yachiyo Engineering Co., Ltd.
Power System Analysis (2)	Kazuaki KONDO	Yachiyo Engineering Co., Ltd.
Power Transmission & Distribution System	Tatsuhiro TAMURA	Kansai Electric Power Company, Inc.
Operation & Maintenance of Power Transmission & distribution System	Takamu GENJI	Kansai Electric Power Company, Inc.
Substation System	Makoto ABE	Yachiyo Engineering Co., Ltd.
Operation & Maintenance of Substation System	Kazuki KONISHI	Kansai Electric Power Company, Inc.
Economic & Financial Analysis	Yoshiyuki CYOSO	Yachiyo Engineering Co., Ltd.
Environment & Social Consideration	Masaya SUGITA	Yachiyo Engineering Co., Ltd.
Project Coordinator / Assistant of Power System Planning	Naoya KISHI	Yachiyo Engineering Co., Ltd.

Power Demand Forecasts and Evaluation

Contents

1. Collection of the data Survey (page 2)
2. Preconditions for Model Building (page 4)
3. Results of PPUC Power Demand (page 10)
4. Evaluation of Power Demands (page 13)

April 2018

1. Collection of the data

(1) Information and data from Palau's authorities

No.	Data and Information	Device	From following organization
1	Population estimation up to 2030	EXCEL	MOF
2	Employment and wage estimation up to 2030	EXCEL	MOF
3	GDP outlook up to 2030	EXCEL	MOF
4	Economic Review 2016 by OCI	Document	MOF
5	Palau Energy Policy 2010	PDF	Energy Administration
6	Palau Energy Road map - Draft for discussion	Word	Energy Administration, IRENA
7	Power peak and generation data	EXCEL	PPUC - Generation
8	Power demand data by sector and state	EXCEL	PPUC - Generation
9	PV System Connected to Grid	EXCEL	PPUC - RE
10	Intended Nationally Determined Contribution	PDF	PPUC - RE
11	Power sales by sector	EXCEL	PPUC - Finance
12	Power tariff by sector	EXCEL	PPUC - Finance
13	Number of Customers by sector	EXCEL	PPUC - Finance
14	WWO Power consumptions & payment	EXCEL	PPUC - WWO
15	Foreign Investment List	PDF	Foreign Investment Board
16	Public Infrastructure Plan	Hearing	Capital Improvement Program
17	State Investment plans	Hearing	Ngarchelong, Melekeok, Ngchesar, Airai, Koror

(2) Related power and Energy documents from Int. organizations 3

Organization	Reference documents	Published
DOI	Economic Review 2016, Republic of Palau	February 2017
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	World/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 and 2017	2016, 2017 version
IRENA	Palau Energy Roadmap 2017 (Draft)	2017 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
Donors	Donor list for Palau energy sector projects	Past years

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
IRENA: International Renewable Energy Agency

2. Preconditions for the model building 4

(1) Number of Population by state

Unit: person

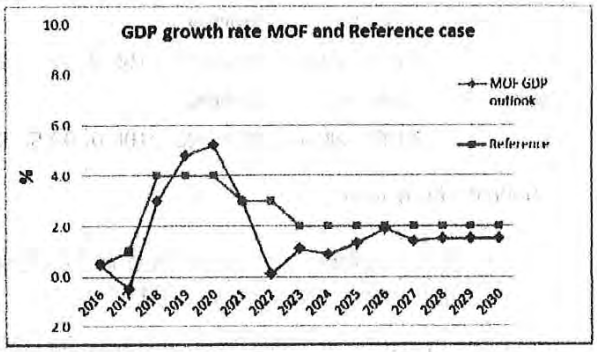
	2005	2010	2015	2020	2025	2030	2035	2040
Aimeliik (アイメリーク)	270	275	334	337	341	344	348	351
Airai(アイライ)	2,723	2,463	2,455	2,528	2,602	2,681	2,761	2,844
Koror (コロール)	12,776	12,081	11,754	11,907	12,057	12,201	12,345	12,489
Melekeok(メレケオク)	391	396	277	281	287	294	303	312
Ngaraard(ガラルド)	581	499	413	419	426	434	442	449
Ngardmau(ガラスマオ)	166	165	185	187	189	191	193	195
Ngaremlengui(アルモノグイ)	317	300	350	353	357	361	364	368
Ngatpang(ガスパン)	464	302	282	285	288	291	294	297
Ngchesar (チェサール)	254	266	291	295	302	309	318	328
Ngarchelong(アルコロン)	488	435	316	321	326	332	338	344
Ngiwal(オギワール)	223	234	282	285	288	291	294	297
Koror+Babeldaob(バベルダオブ)	18,653	17,396	16,939	17,198	17,461	17,727	17,998	18,273
Others	1,175	892	722	729	736	744	752	759
Total	19,828	18,289	17,661	17,927	18,197	18,471	18,750	19,033

- The state population are forecasted under considering regional investment schedules.
- Future country population is estimated by MOF. The increase rate is 0.3 % per year.
- The state population are forecasted by elasticity to the increase rate of the country population

(2) GDP growth rate as Reference case

< GDP growth rate forecasted by MOF and Study team>

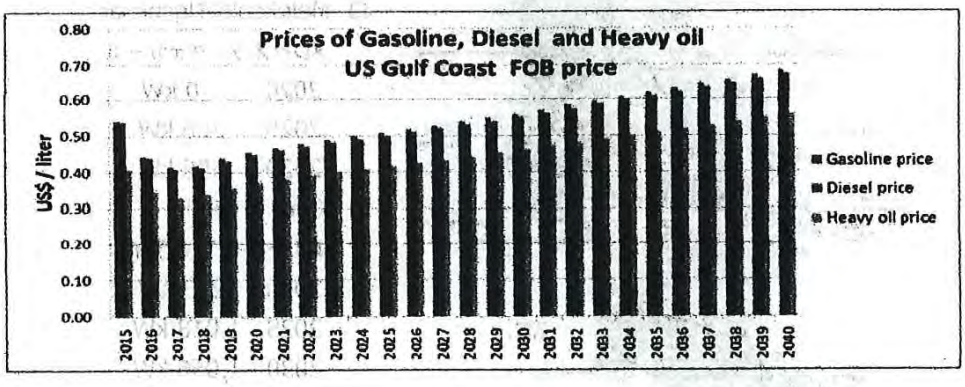
Unit %	MOF outlook	Study team outlook
2016	0.5	0.5
2017	-0.5	1.0
2018	3.0	4.0
2019	4.8	4.0
2020	5.2	4.0
2021	3.0	3.0
2022	0.1	2.0
2023	1.1	2.0
2024	0.9	2.0
2025	1.3	2.0
2026	1.9	2.0
2027	1.4	2.0
2028	1.5	2.0
2029	1.5	2.0
2030	1.5	2.0
2035/30		2.0
2040/35		2.0



(3) Crude oil and Fuel prices for estimating power tariffs

	Unit	2017	2020	2030	2040
WTI	US$ / bbl	50	61	75	91

Source: Study team after referring IEA and IEEJ outlook.



(4) Energy efficiency & Conservation factors

7

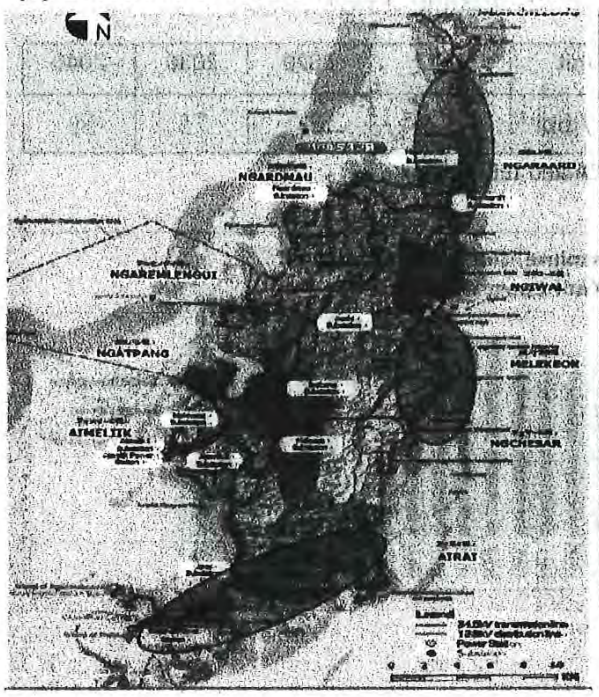
Sector	Items	Unit	2017	2018	2019	2020	2025	2030	2035	2040
Commercial	EE&C rate	Saving%	0.0	0.5	0.5	0.5	1.0	1.0	1.0	1.0
	EE&C Indicator	2017=100	100.0	99.5	99.0	98.5	96.1	91.4	86.9	82.6
Gov & Public	EE&C rate	Saving%	0.0	0.5	0.5	0.5	1.0	1.0	1.0	1.0
	EE&C Indicator	2017=100	100.0	99.5	99.0	98.5	96.1	91.4	86.9	82.6
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: Study team

- EE&C activities are described in "Intended Nationally Determined Contribution, November 2015"
- The targets of EE&C are reduced to 35% by energy intensity ,energy conversion and energy efficiency to 2015 by 2025.
- EE&C rate with 0.5% in the table is world average from 2013 to 2040 by IEA report in 2016.

(5) Locations of future additional demands

8



- Ngaraard+ Ngarchelong
  ガラルド＋アルコロン
  - 2020 0 kW
  - 2025 236 kW
  - 2030 397 kW
- Melekeok+Ngchesar
  メレケオク＋チェサール
  - 2020 0 kW
  - 2025 206 kW
  - 2030 396 kW
- Koror + Airai
  コロール＋アイライ
  - 2020 273 kW
  - 2025 1,018 kW
  - 2030 1,056 kW

Source: The forecasted future demand are based on FIB, CIP and State government plans.

(6) Investment plans for future additional demands

9

◆ Koror + Airai

Unit: kW

	2020	2021	2022	2023	2024	2025	2030	2035
a) New hotel for 2000 rooms	245	343	490	637	784	980	1,005	1,034
b) Public facility in Airai						10	23	34
c) Prison	28	28	28	28	28	28	28	28
Total	273	371	518	665	812	1,018	1,056	1,095

◆ Melekeok+Ngchesar

Unit: kW

	2020	2021	2022	2023	2024	2025	2030	2035
a) Government office				24	40	56	88	108
b) Embassy						17	112	112
c) Big hotel				70	70	84	98	98
d) Small hotels				29	39	49	98	98
Total				123	149	206	396	416

◆ Ngaraard+ Ngarchelong

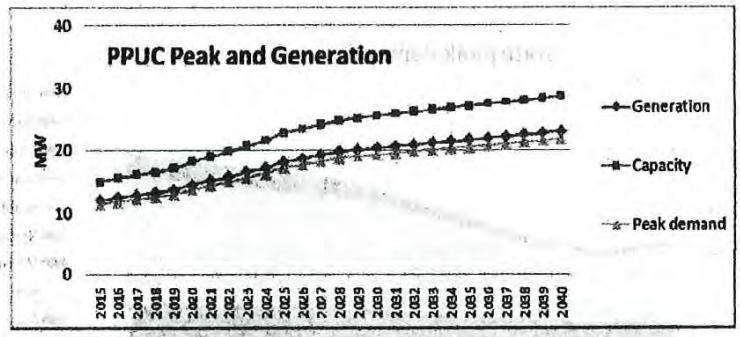
Unit: kW

	2020	2021	2022	2023	2024	2025	2030	2035
a) Big hotel with 150rooms						53	74	74
b) Big hotel with 300 rooms						105	147	147
c)10 Small hotel				39	59	78	176	196
Total				39	59	236	397	417

3. Results of PPUC Power Demand

10

(1) Peak demand of PPUC



Source: Study team

PPUC Peak and Generation

MW

	2016	2017	2019	2020	2025	2030	2035	2040
Peak demand	11.8	12.2	13.0	13.8	17.2	19.3	20.5	21.8
Generation	12.5	12.9	13.7	14.6	18.2	20.3	21.6	23.0
Capacity	15.6	16.1	17.1	18.2	22.7	25.4	27.0	28.7

(2) Annual power and peak demands

11

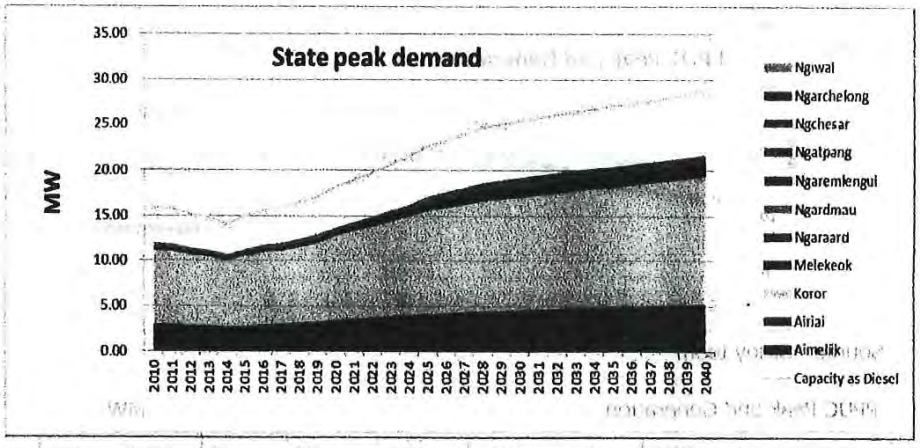
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Gross generation	MWh	83,430	84,870	88,020	91,290	96,880	100,210	102,920	106,920	110,040	115,110
Load factor	%	76.3	76.0	76.0	76.0	76.0	75.2	74.5	73.7	73.0	72.3
Reserve margin	%	20	20	20	20	20	20	20	20	20	20
Required capacity	kW	15,610	16,130	16,530	17,140	18,190	19,000	19,720	20,690	21,510	22,730
Net demand(Energy)	MWh	79,310	80,460	83,450	86,540	91,840	95,000	97,560	101,360	104,310	109,120
Net peak demand	kW	11,840	12,230	12,530	13,000	13,790	14,410	14,950	15,690	16,310	17,240
Own use	MWh	4,350	4,413	4,577	4,747	5,038	5,211	5,352	5,560	5,722	5,986
Own use rate	%	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2

		2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Gross generation	MWh	116,850	119,140	121,270	123,230	124,960	126,550	128,170	129,730	131,280	132,850
Load factor	%	71.6	70.8	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1
Reserve margin	%	20	20	20	20	20	20	20	20	20	20
Required capacity	kW	23,300	24,000	24,680	25,070	25,430	25,750	26,080	26,400	26,710	27,030
Net demand(Energy)	MWh	110,770	112,950	114,970	116,820	118,460	119,970	121,500	122,980	124,450	125,940
Net peak demand	kW	17,670	18,200	18,710	19,020	19,280	19,530	19,780	20,020	20,260	20,500
Own use	MWh	6,076	6,196	6,306	6,408	6,498	6,581	6,665	6,746	6,827	6,908
Own use rate	kW	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2

Source: Study team

(3) State wise power demand and capacity

12

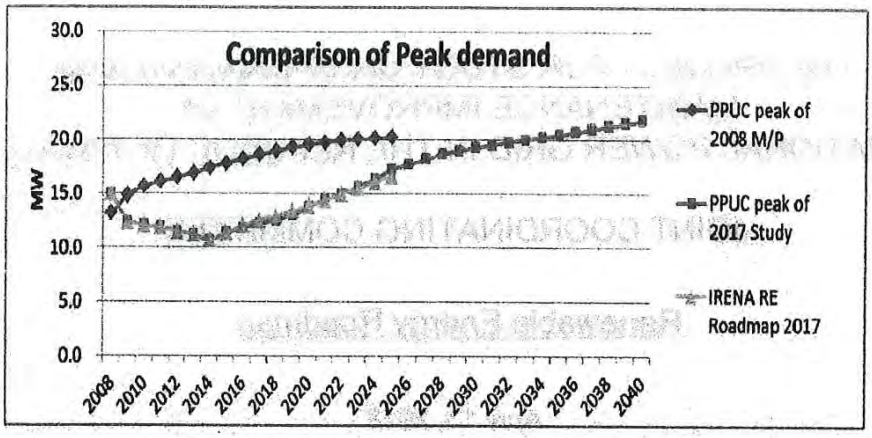


Source: Study team

4. Evaluation of power Demands

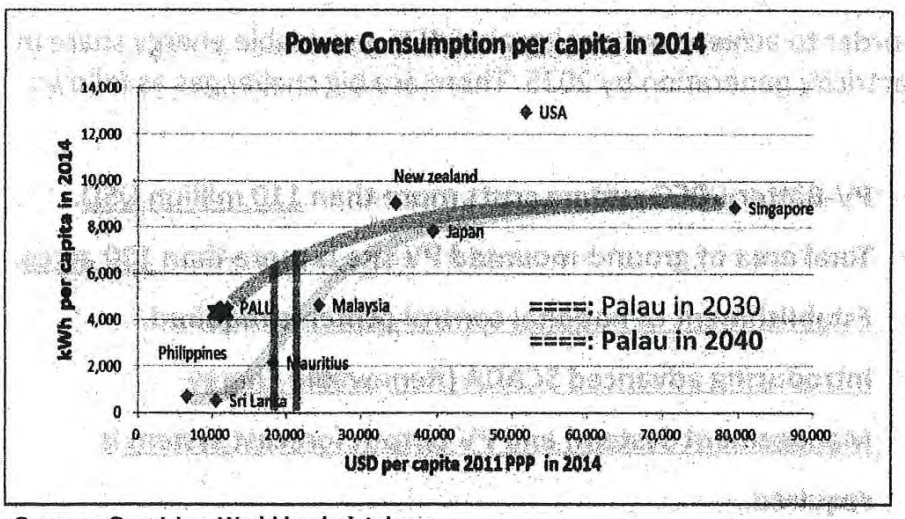
13

(1) Comparison of IRENA 2017, M/P 2008 and Study team 2017



14

(2) Comparison of power consumption per capita



Source: Countries: World bank database
Palau: Study team

Japan International Cooperation Agency

YACHIYO ENGINEERING CO.,LTD.
Consulting Engineers & Architects

Kansai Electric Power

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

JOINT COORDINATING COMMITTEE

Renewable Energy Roadmap

April 13, 2018

Executive Summary

In order to achieve national goal of 45% renewable energy share in electricity generation by 2025. There are big challenges as follows.

- **PV-Battery-DEG system costs more than 110 million USD.**
- **Total area of ground-mounted PV site is more than 100 acres.**
- **Establishment of national control center is required.**
- **Introducing advanced SCADA (Renewable Energy Management System) and PV output forecast system is required.**

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Presentation Outline

- RE roadmap objective
- RE roadmap analysis methodology
- RE system configuration
- RE 45% roadmap
- Recommendation

RE Roadmap Objective

To provide RE development plan in order to achieve national goal of 45% renewable energy share in electricity generation by 2025 under maximum consideration of securing the electric power supply quality and PPUC's O&M capacity.

RE Roadmap analysis methodology

	Influence and Issues	Countermeasures
1	Frequency Fluctuation (Short-term constraint)	• LFC/AFC • Generator Improvement • Batteries
2	Surplus Electricity (Long-term constraint)	• Demand creation • Generator Improvement • RE output curtailment • RE output forecast • Batteries
	Take into consideration in RE roadmap analysis	
3	Voltage Rise in Distribution System	• Demand creation • Voltage control equipment
4	Lack of Transmission / Distribution Facilities	• New transmission/distribution facilities
	Take into consideration in power system planning	

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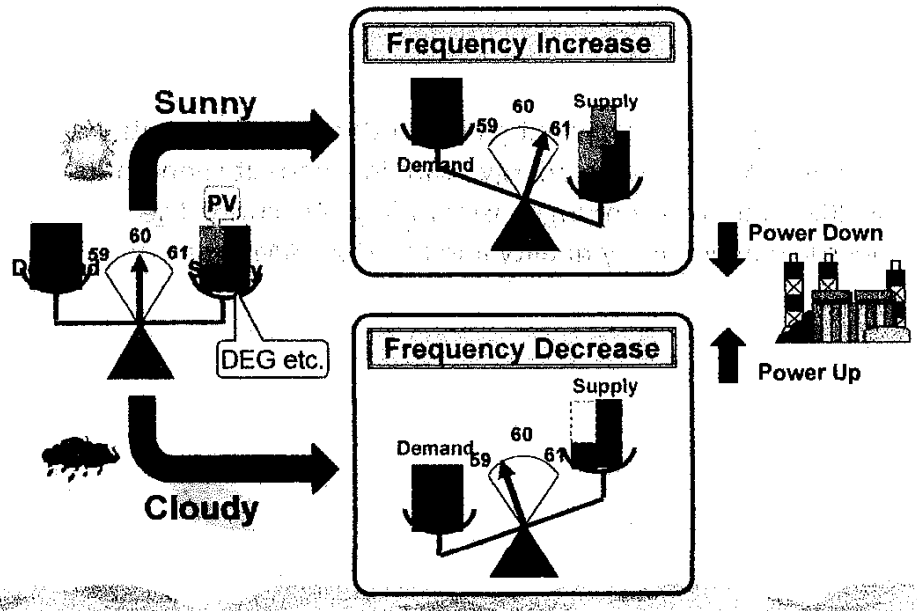
Frequency Fluctuation (Short-term constraint)



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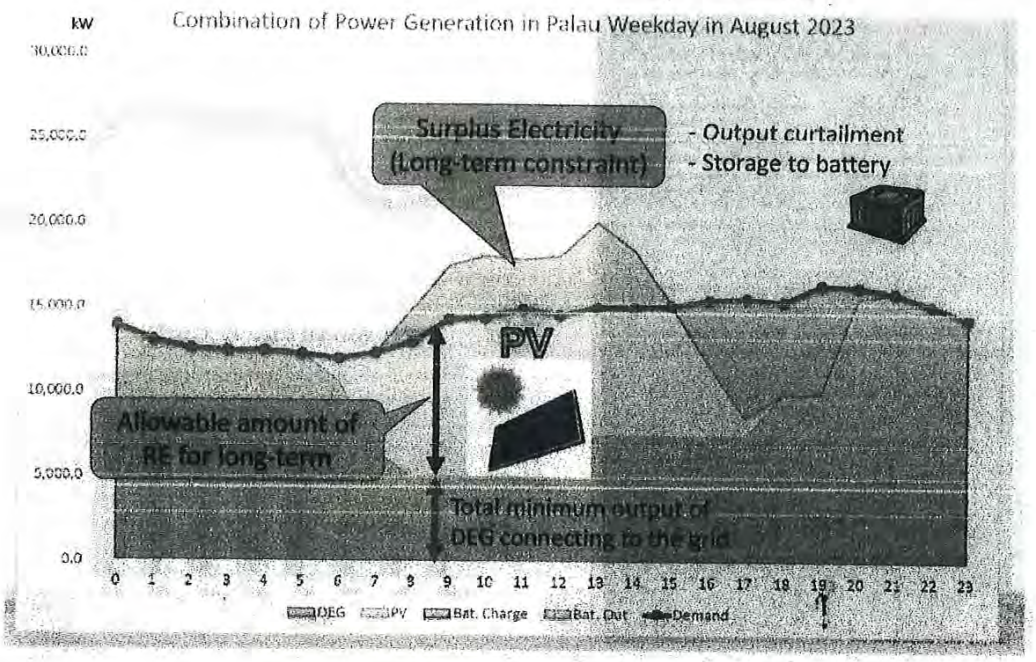
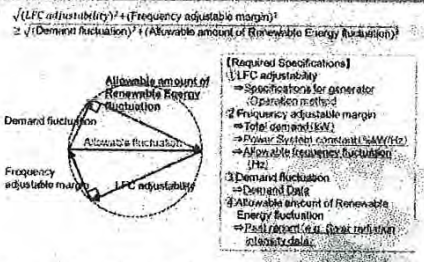
Surplus Electricity (Long-term constraint)

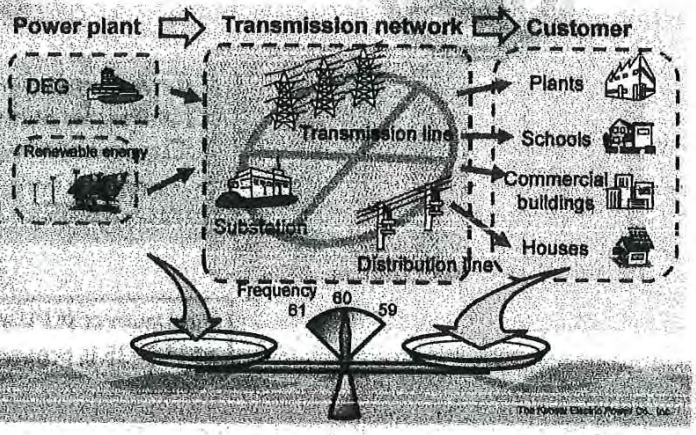


RE Roadmap analysis methodology

Short-term constraint
⇒ Algebraic method



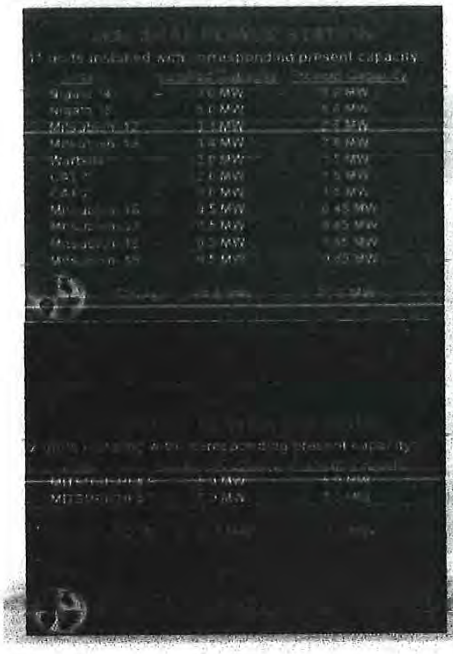
Long-term constraint
⇒ Demand-supply balance simulation

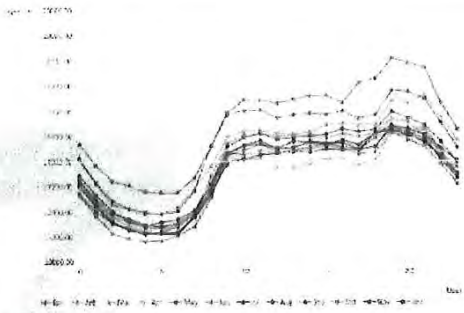


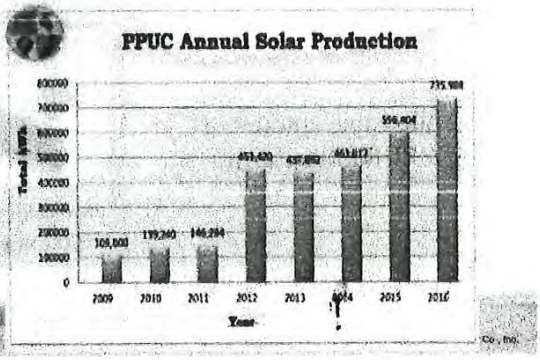
RE Roadmap analysis methodology

8

Baseline: 2016 power system







RE Roadmap analysis methodology

9

<Renewable energy source>

- Average of wind speed is little low
- Regular maintenance is required
- Low capacity factor in other island country
- Hard supply of spare parts

Minimum cost PV +WT system configuration as of 2025 is presented for reference.

RE Roadmap analysis methodology

Generator use	Make	Model	Name	Year installed	Capacity (kW)
Active generation	Nigata	16V28HLX	Unit 14	2011	5,000
	Nigata	16V28HLX	Unit 15	2011	5,000
	Mitsubishi	18KU30A	Unit 6	2013	5,000
	Mitsubishi	18KU30A	Unit 7	2013	5,000
Total active generation capacity					20,000

Minimum Output : 50 %

Generator use	Make	Model	Name	Year installed	Capacity (kW)
Back up	Caterpillar	3516B	Unit 1	2007	2,000
	Caterpillar	3516B	Unit 2	2007	2,000
	Wartsila	SACM 12V200	Wartsila 1	1996	1,200
	Mitsubishi	S6R - PTA	Unit 1	2013	500
	Mitsubishi	S6R - PTA	Unit 2	2013	500
	Mitsubishi	S6R - PTA	Unit 3	2013	500
	Mitsubishi	S6R - PTA	Unit 4	2013	500
Total backup capacity					7,200

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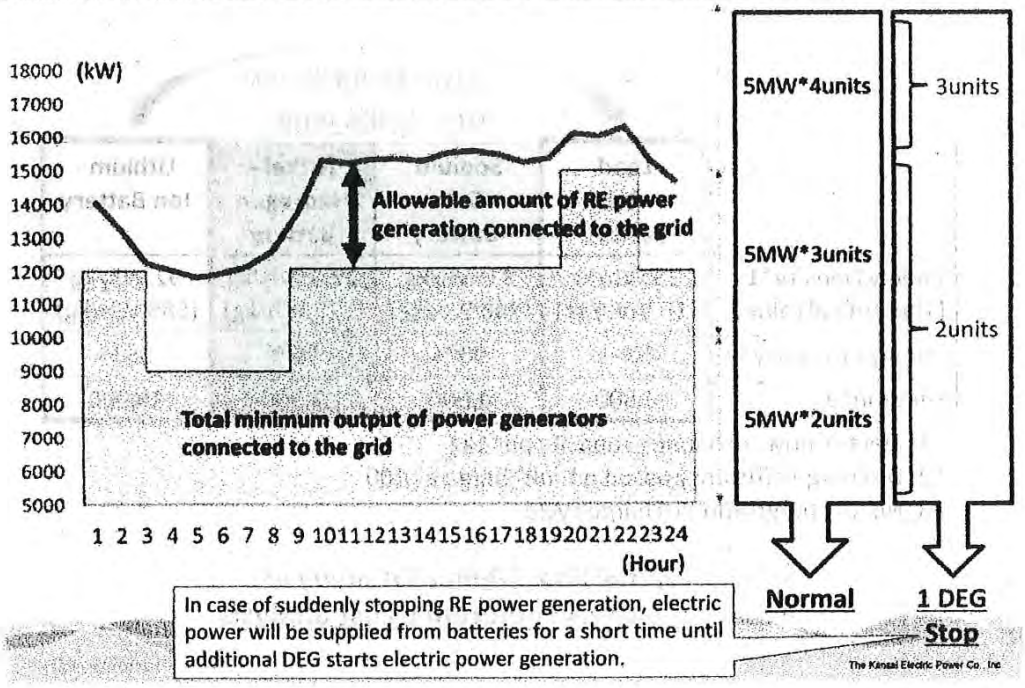
RE Roadmap analysis methodology



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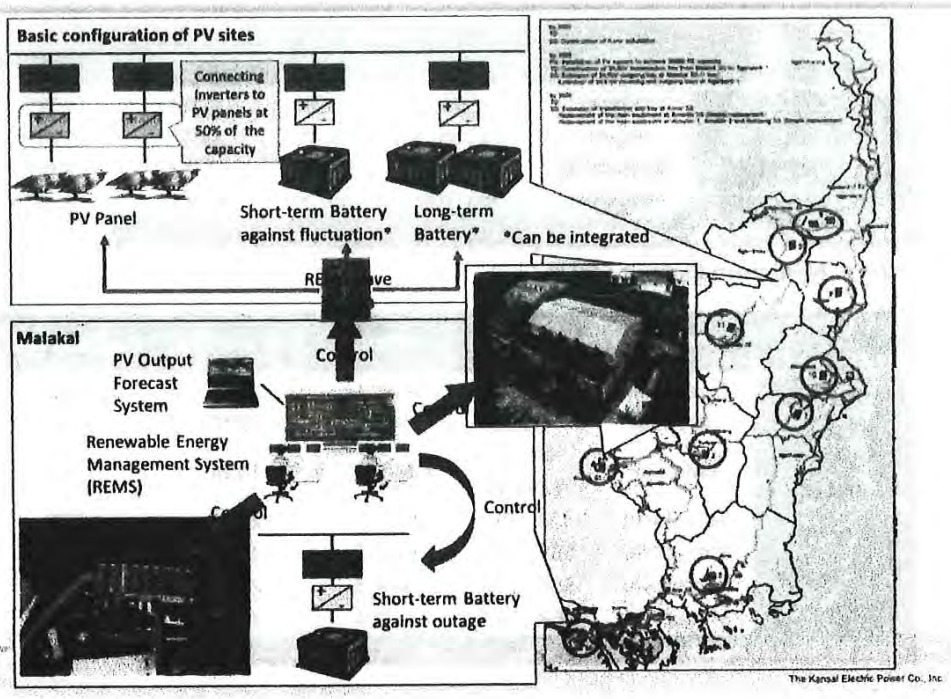
RE System Configuration

12



RE System Configuration

13

Cost: 35-65 % low
Size: 150% large

	Lead - Acid Battery	Sodium - Sulfur Battery	[illegible] Battery	Lithium - Ion Battery
Energy Density*1 (Theoretical value)	25 Wh/kg (167 Wh/kg)	87 Wh/kg (786 Wh/kg)	[illegible]	92 Wh/kg (585 Wh/kg)
Energy Efficiency*2	85 %	90 %	[illegible]	95 %
Lifetime*3	4,500	4,500	[illegible]	15,000

*1: Electric power charging capacity per 1kg
*2: Discharge efficiency based on full charge as 100
*3: No. of charge and discharge cycle

Lithium-Ion Battery: Main cost analysis
Lead-Acid Battery: Reference cost analysis

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RE 45% Roadmap

		Phase1			Phase2			Phase3	
PV panel (kW)*	Panel (kW)	6,000	10,000	16,000	16,000	22,000	30,000	40,000	44,000
	Inverter (kW)	3,000	5,000	8,000	8,000	11,000	15,000	20,000	22,000
Short-Term Battery against fluctuation	Battery (kW)	400	2,400	5,400	5,400	8,400	12,400	17,400	21,400
	Battery (kWh)	200	1,200	2,700	2,700	4,200	6,200	8,700	10,700
	Inverter (kW)	400	2,400	5,400	5,400	8,400	12,400	17,400	21,400
Short-Term Battery against power outage	Battery (kW)	0	0	5,000	5,000	5,000	5,000	5,000	5,000
	Battery (kWh)	0	0	2,000	2,000	2,000	2,000	2,000	2,000
	Inverter (kW)	0	0	5,000	5,000	5,000	5,000	5,000	5,000
Long-Term Battery	Battery (kW)	0	0	0	0	0	9,000	17,000	22,000
	Battery (kWh)	0	0	0	0	0	37,800	71,400	92,400
	Inverter (kW)	0	0	0	0	0	9,000	17,000	22,000
Peak Demand (kW)		12,530	13,000	13,790	14,410	14,950	15,690	16,310	17,240
RE Share of Gross Generation (%)		–	–	19	–	–	–	–	45
Gross Generation (kWh)		88,020,000	91,290,000	96,880,000	100,210,000	102,920,000	106,920,000	110,040,000	115,110,000
Rooftop PV (kW)		2,400	2,700	3,000	3,400	3,700	4,000	4,500	5,000

DEG normal operation ⟷ 1 DEG stop operation

National control center
(with REMS and RE forecast system)

RE 45% Roadmap

No.	Location	Capacity	Owner	Distance	Area (Acre)
1	Aimeliik (Next to power plant) This is already planned with PPUC.	5 MWp +1MWp	PPUC	0.2 km from the nearest transmission line	15 acres +α
2	Ngatpang (Koiusai)	2-3 MWp +1MWp	PPUC	0.1 km from Koiusai SS	8 acres +α
3	Ngardmau (Terraces of hill)	2-3 MWp +1MWp	PPUC	0.28 km from the nearest transmission line	7 acres +α
4	Airai Airport side by road	3 MWp +3MWp	PPUC	0.8 km from Airport	8 acres +α
5	Ngchesar	3 MWp +1MWp	PPUC	2.2 km	8 acres +α
6	Ngiwal	3 MWp +1MWp	PPUC	7.7 km	9 acres +α
7	Ngardmau	5 MWp +1MWp	PPUC	.08 km	15 acres +α
8	Melekeok	3 MWp +1MWp	PPUC	.76 km	9 acres +α
9	Ngaremlengui	5 MWp +1MWp	PPUC	.55 km	18 acres +α
Total		33MWp +11MWp			

Area required for 1MW PV is 2.47 acres ⟹ 44MW PV is 108 acres

RE 45% Roadmap

< RE system introduction cost by phase (Li-ion Battery) >

USD

		Phase1 (2018-2020)	Phase2 (2021-2023)	Phase3 (2024-2025)	Total	Unit Price
PV	Module, Inverter, etc. (kW)	24,000,000	21,000,000	21,000,000	66,000,000	1,500
Short-term	Battery against fluct. (kWh)	945,000	1,225,000	1,575,000	3,745,000	350
	Inverter against fluct. (kW)	810,000	1,050,000	1,350,000	3,210,000	150
	Battery against outage. (kWh)	700,000	0	0	700,000	350
	Inverter against outage (kW)	750,000	0	0	750,000	150
Long-term	Battery (kWh)	0	13,230,000	19,110,000	32,340,000	350
	Inverter (kW)	0	1,350,000	1,950,000	3,300,000	150
Total		27,205,000	37,855,000	44,985,000	110,045,000	

< RE management system and RE forecast system introduction cost by phase >

USD

		Phase1 (2018-2020)	Phase2 (2021-2023)	Phase3 (2024-2025)	Total	
RE Management System	Meter system	270,000	270,000	270,000	810,000	Install:270kUSD Slave Addition:90kUSD/Unit
	Slave system	450,000	450,000	450,000	1,350,000	Install:150USD/Unit
	Optical Fiber	90,000	90,000	90,000	270,000	4500USD/km
	Subtotal	810,000	810,000	810,000	2,430,000	
RE Forecast	System	160,000	0	0	160,000	
	O&M (Data maintenance, etc.)	45,000	135,000	90,000	270,000	45kUSD/Year
	Subtotal	205,000	135,000	90,000	430,000	
Total		1,015,000	945,000	900,000	2,860,000	

(Unit prices are based on the retail prices at 2017)

RE 45% Roadmap

< For Reference: Lead-acid Battery (50% lower cost of LI-ion battery) >

USD

		Phase1 (2018-2020)	Phase2 (2021-2023)	Phase3 (2024-2025)	Total	Unit Price
PV	Module, Inverter, etc. (kW)	24,000,000	21,000,000	21,000,000	66,000,000	1,500
Short-term	Battery against fluct. (kWh)	472,500	612,500	787,500	1,872,500	175
	Inverter against fluct. (kW)	810,000	1,050,000	1,350,000	3,210,000	150
	Battery against outage. (kWh)	350,000	0	0	350,000	175
	Inverter against outage (kW)	750,000	0	0	750,000	150
Long-term	Battery (kWh)	0	6,615,000	9,555,000	16,170,000	175
	Inverter (kW)	0	1,350,000	1,950,000	3,300,000	150
Total		26,382,500	30,627,500	34,642,500	91,652,500	

(Reference) PV-WT System Configuration

PV	Module (kW)	36,000
	Inverter (kW)	18,000
WT	Turbine(kW)	8,250
	Inverter (kW)	5,775
Short-Term Battery against fluctuation	Battery (kW)	36,000
	Battery (kWh)	18,000
	Inverter (kW)	36,000
Short-Term Battery against power outage	Battery (kW)	5,000
	Battery (kWh)	2,000
	Inverter (kW)	5,000
Long-Term Battery	Battery (kW)	36,000
	Battery (kWh)	100,000
	Inverter (kW)	36,000

Not require to WTs

Not require to WTs

< RE system introduction cost (Li-ion Battery) >

USD

		Total	Unit Price	
PV	Module, Inverter, etc...(kW)	54,000,000	1,500	
WT	Tubine, Inverter, etc...(kW)	22,497,750	2,727	750kUSD/Unit
Short-term	Battery against fluct. (kWh)	6,300,000	350	
	Inverter against fluct. (kW)	5,400,000	150	
	Battery against outage. (kWh)	700,000	350	
	Inverter against outage (kW)	750,000	150	
Long-term	Battery (kWh)	35,000,000	350	
	Inverter (kW)	5,400,000	150	
Total		130,047,750		

1.18 times higher than only PV system

Recommendation

Item		Recommendation
Battery Capacity Reduction	Short-term	Taking high- speed DEG into normal operation
		Improvement of DEG governor function
		Introduction of new high- speed DEG which can operate at low load continuously.
	Long-term	DEG operation planning agree perfectly with the demand
		Demand shifting / creation
Battery Introduction Cost Reduction		Concentration of long-term battery

Recommendation

<Capacity reduction of Short-term battery>

High-speed DEG

1	Total Demand	10.7	MW
2	System Constant	10	%/Hz
3	Allowable Frequency Fluctuation Range	2	Hz
4	Adjustable Frequency Margin	2.14	MW
5	LFC Adjustability	0	MW
6	Allowable Fluctuation	2.14	MW
7	Demand Change Rate	0.2354	MW
8	Total Fluctuation of PV+Wind	2.13	MW
9	PV Output Fluctuation	2.13	MW
11	PV Change Rate	0.338	–
10	Allowable Amount of PV	6.29	MW

1	Total Demand	10.7	MW
2	System Constant	11	%/Hz
3	Allowable Frequency Fluctuation Range	2	Hz
4	Adjustable Frequency Margin	2.354	MW
5	LFC Adjustability	0	MW
6	Allowable Fluctuation	2.354	MW
7	Demand Change Rate	0.2354	MW
8	Total Fluctuation of PV+Wind	2.34	MW
9	PV Output Fluctuation	2.34	MW
11	PV Change Rate	0.338	–
10	Allowable Amount of PV	6.93	MW

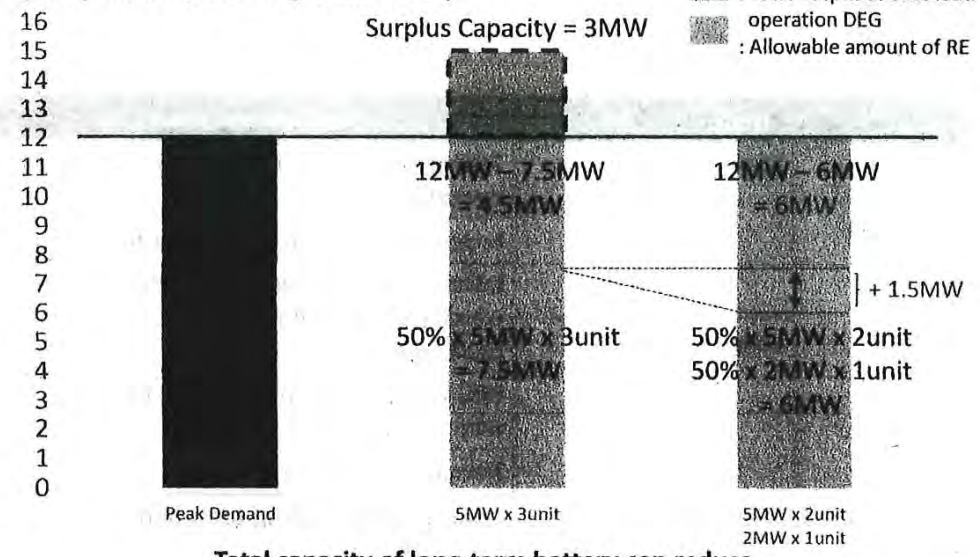
+ 0.6MW

Total capacity of short-term battery can reduce

To improve governor function of DEGs will contribute reducing total capacity of short-term battery as well.

Recommendation

<Capacity reduction of Long-term battery>



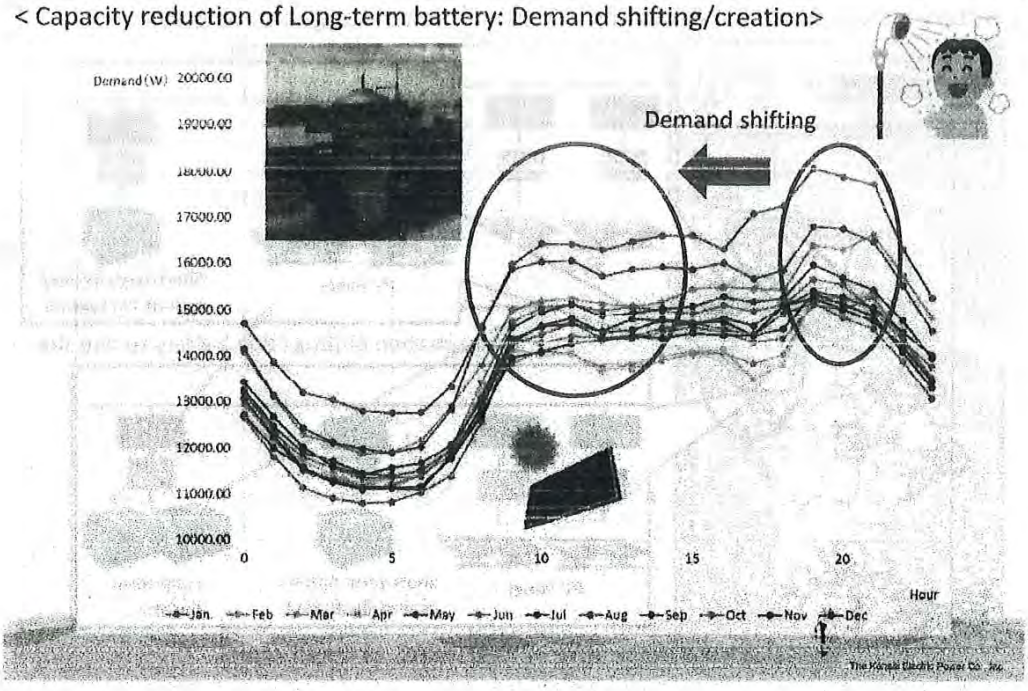
Total capacity of long-term battery can reduce

Introduction of new DEG which can continuously operate at low load contribute to drastically reduce total capacity of long-term battery as well.

Recommendation

22

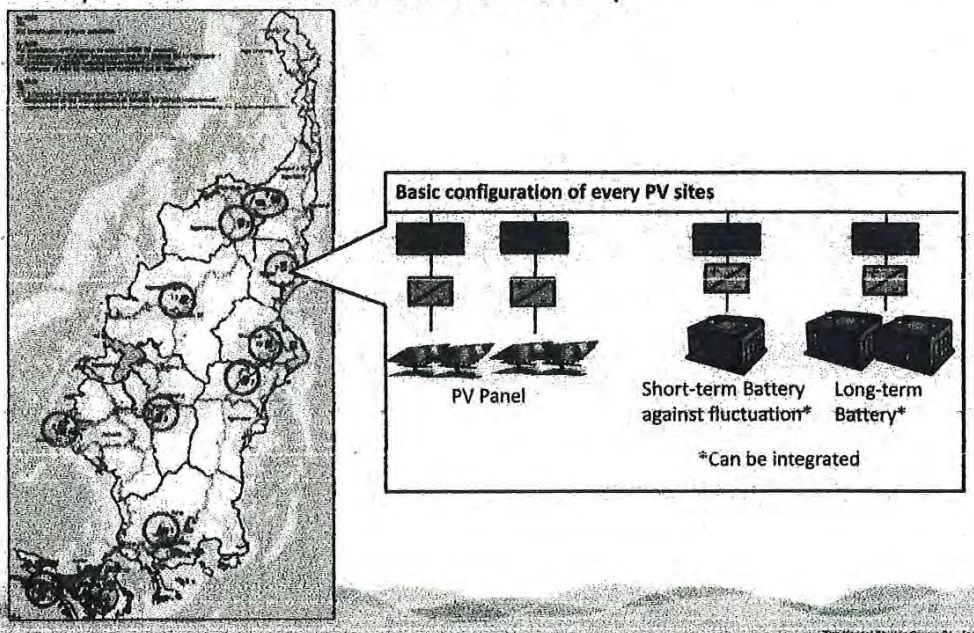
< Capacity reduction of Long-term battery: Demand shifting/creation>



Recommendation

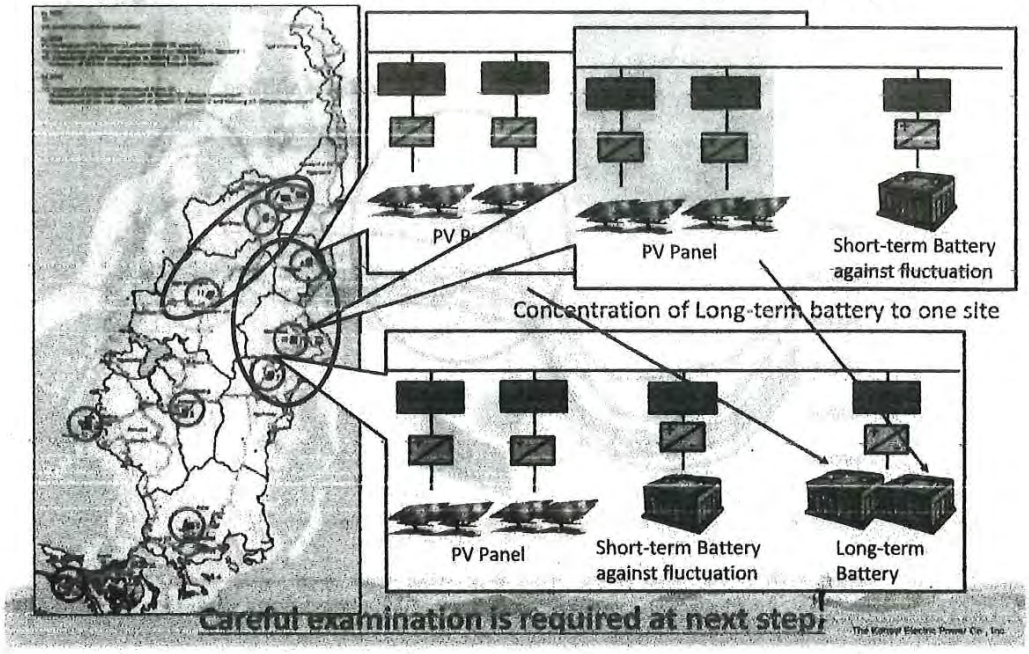
23

< Battery Introduction Cost Reduction : In this Roadmap >



Recommendation

< Battery Introduction Cost Reduction : Concentration of Long-term battery>



Network Planning and Analysis

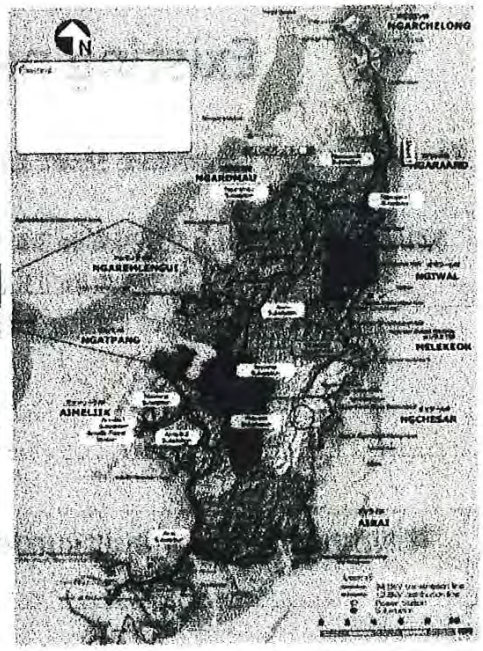
JICA Project Team

Nobuyuki KINOSHITA

Existing network system

Present status of Koror-Babeldaob network

Item	Quantity	Remarks
Peak demand	12.29MW	13th Aug. 2016
Power plant output	36.45MW	Malakal, Aimeliik
Transmission line	79.7km	34.5kV
Substation	59.95MVA	12 stations

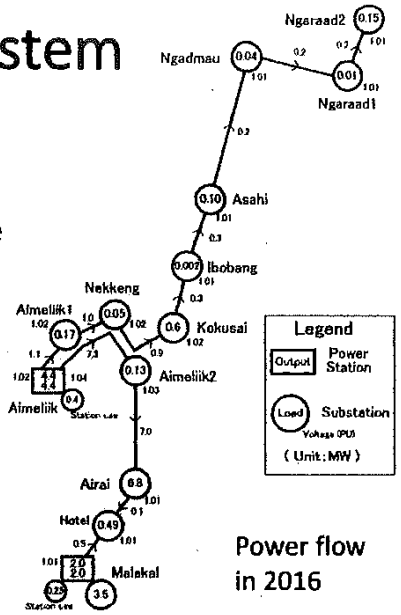


Existing network system

Power flow and voltage

- Max power flow: 7.3MW in Aimeliik-Aimeliik2 line (transmitting capacity 21.5MW)
- Voltage : 101-104% (desired range 95-105%)

■ No problem on power flow nor voltage



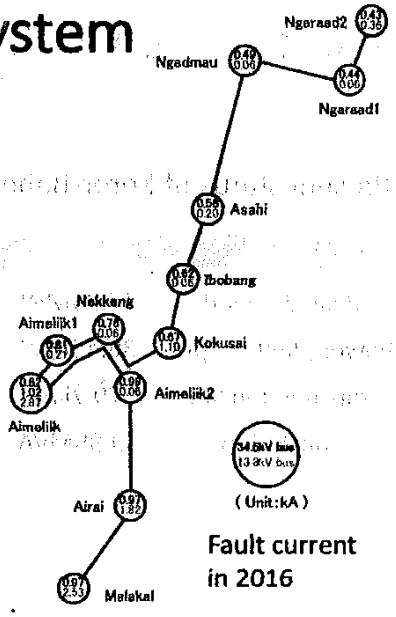
Power flow in 2016

Existing network system

Fault current (3 phase shirt circuit)

- Max fault current : 1.02kA in 34.5kV at Aimeliik
  2.87kA in 13.8kV at Aimeliik
  (circuit breaker rating 12.5kA)

■ No problem on fault current

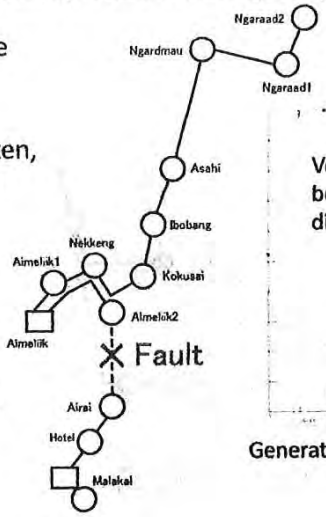


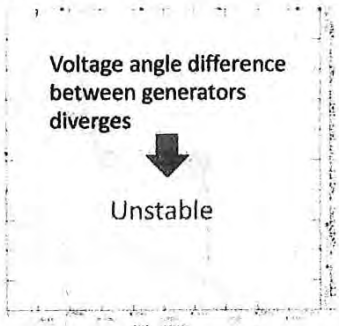
Fault current in 2016

Existing network system

Stability : after fault occurrence and fault cleared, network must be in operation without blackout

- In case of fault occurrence on 34.5kV line between Aimeliik and Malakal power station and opening faulted line, since interconnection of both PSs is broken, network stability can not be maintained and large scale blackout causes





Generator voltage angle fluctuation

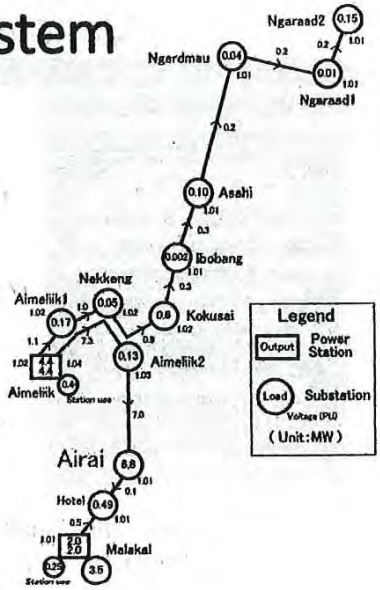
- 2 routes of transmission line connecting Malakal and Aimeliik Power station are necessary

Existing network system

Aging Airai substation

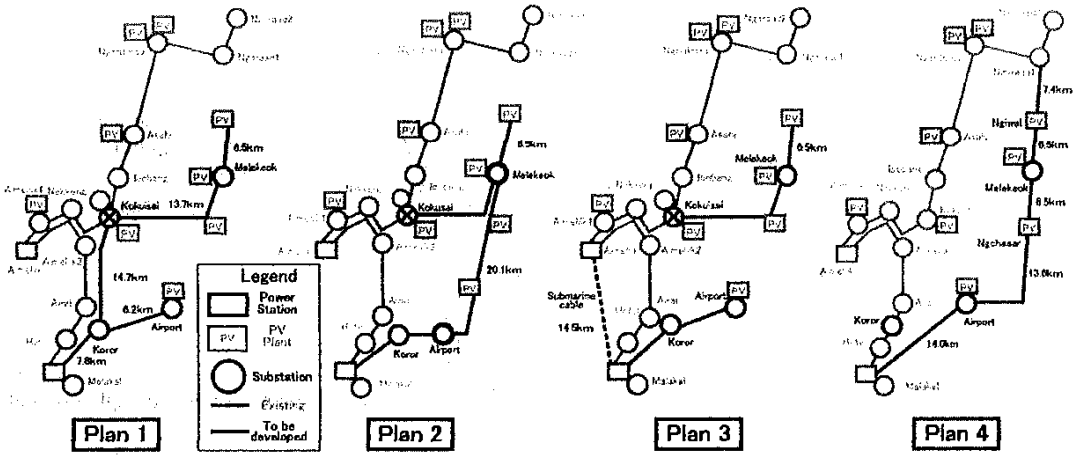
- 34.5/13.8kV Airai Substation most important to supply power to Koror area is aged (constructed in 1985)

- Construction of new substation in Koror Island is necessary



Countermeasures against instability and aging substation

- Taking account of 9 sites of PV, 4 plans of countermeasures can be considered

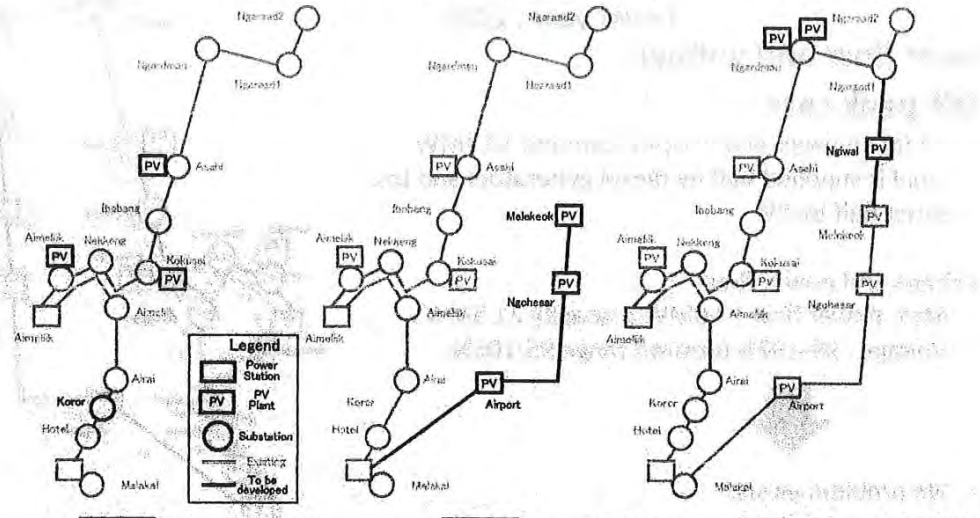


Comparison of countermeasures

	Plan 1	Plan 2	Plan 3	Plan 4
Volume of new overhead line	48.9 km	54.3 km	34.2 km	48.0 km
Submarine cable	-	-	14.5 km	-
Construction cost (US$)	14.7 million	16.3 million	26.4 million	14.4 million
Power supply reliability (Substations which undergo power outage due to transmission line fault)	Low (7 substations)	Medium (5 substations)	Low (11 substations)	High (1 substation)
Environmental impact	Low	Low	High Excavation to coral reefs	Low
Overall evaluation rank	3	2	4	1

- Plan 4, which shall form one round of 34.5 kV transmission line throughout Babeldaob Island is superior to other plans.

Network developing step



Step 1 Around 2020 Step 2 Around 2023 Step 3 Around 2025

Result of power system analysis

Target year : 2025

Power flow and voltage

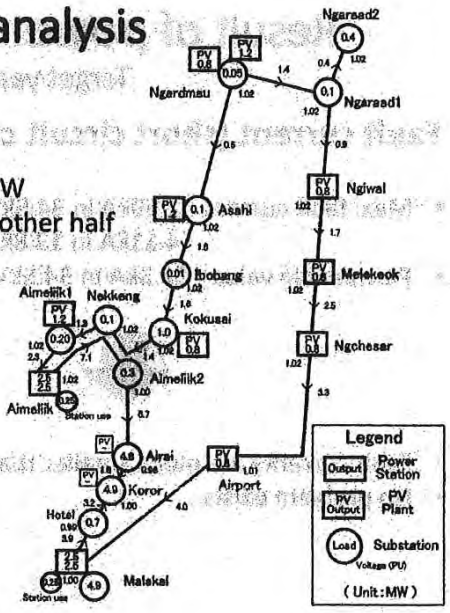
Peak case

- 19:00 on week day in August, max demand 18.1MW
- Load is supplied half by diesel generators and the other half by batteries charged by PV in daytime.

Voltage and power flow

- Max. power flow : 7.1MW (capacity 21.5MW)
- Voltage : 98-103% (desired range 95-105%)

- Through the completion of 34.5kV loop network, the balance of power flows at the east route and the west route will be sustained.
- No problem exists.



Result of power system analysis

Target year : 2025

Power flow and voltage

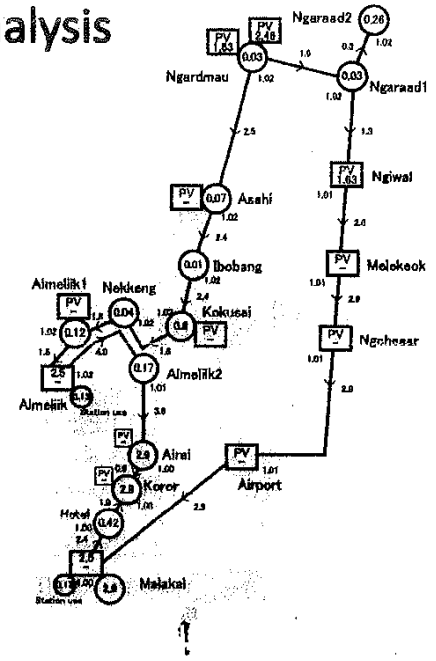
Off-peak case

- 14:00 on week-end in April, demand 10.7MW
- Load is supplied half by diesel generators and the other half by PV.

Voltage and power flow

- Max. power flow : 4.0MW (capacity 21.5MW)
- Voltage : 99-102% (desired range 95-105%)

- No problem exists.



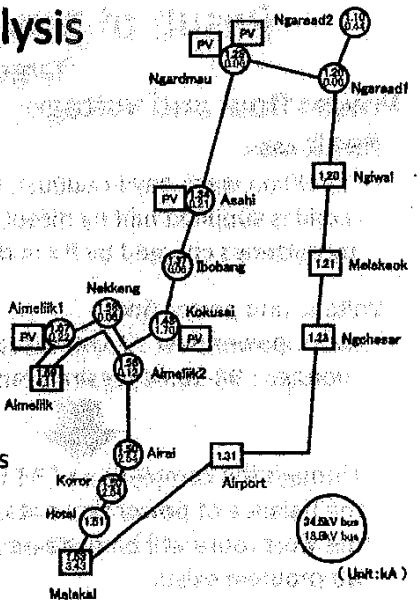
Result of power system analysis

Target year : 2025

Fault current (short circuit current)

- Max. fault current : 1.69kA in 34.5kV network
  4.11kA in 13.8kV network
- Permissible value : 12.5kA in 34.5kV and 13.8kV

- Fault currents are much smaller than permissible values
- No problem exists



Result of power system analysis

Target year : 2025

Stability

- By completion of loop system of 34.5kV transmission line, fluctuation of generator caused by fault shall be damped in the both cases of peak and off-peak conditions. Even if the severe fault happens, the system is maintained to be stable.

Peak case

Off-peak case

Conclusion

- No problem about voltage and power flow will exist by looped 34.5kV transmission network.
- Regardless of location of transmission line fault, the interconnection of Aimeliik Power Station and Malakal Power Station will be maintained and the stable operation will be maintained even under single contingency condition.
- In addition, almost all of substations shall have the two routes of transmission lines, the power supply to substations will be realized during the transmission line faults and thus the reliability of power supply will be improved remarkably.
- Fault currents are much smaller than permissible values

JICA Project Team recommends to configure loop network around Babeldaob Island

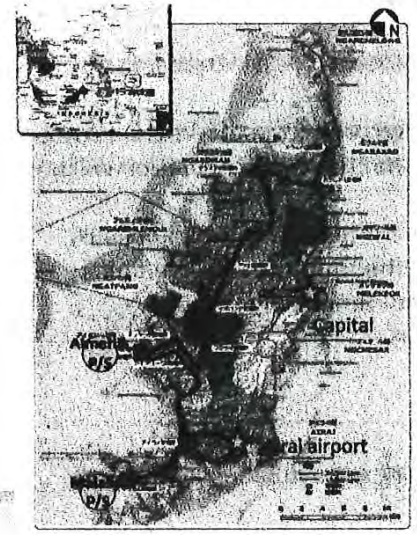
1

Power Transmission and Distribution line

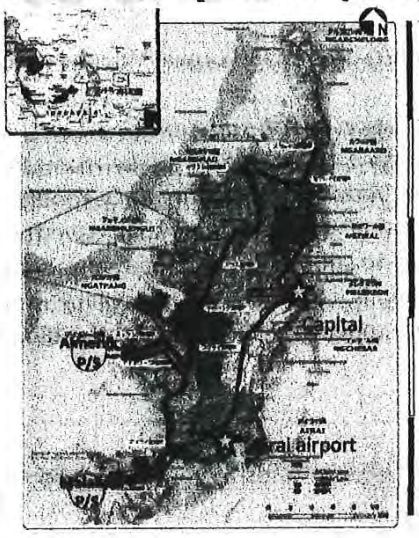
Outline form of the T/L and D/L in PPUC

2

Existing form



Final form(Master plan)



Power Equipment planning

3

(1) Transmission line

- Construction of the T/L to form the network in the system master plan. (The network can transmit the forecasted power demand and assumed RE power source.)

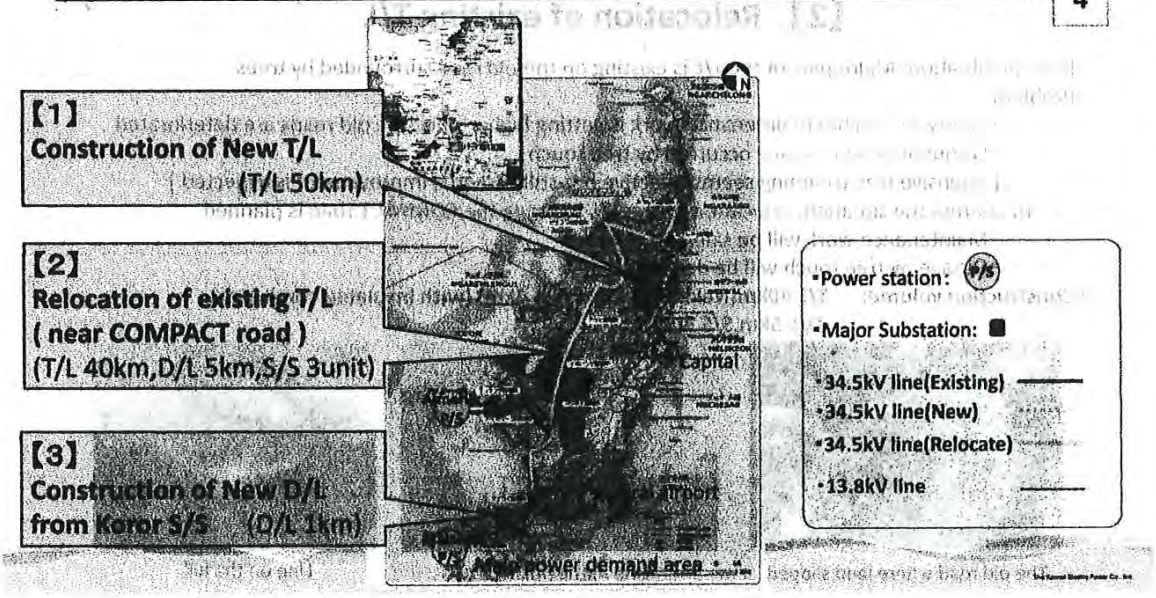
- Option : Measures for the improvement of existing T/L on the old road along the COMPACT.

(2) Distribution line

- Construction of the D/L to meet the forecasted power demand.

Power equipment planning(Outline of the result)

4



【1】 Construction of new T/L

5

The network in the master plan can meet the following points.

1.Assureance of the power transmission capacity for the future demand
2.Power transmission from new RE power source
3.Upgrade of the supply reliability(making double route of network)

→ to realize the network form, construction of new T/L is planned **(total length=50km)**

- Route Malakal P/S - Melekeok - Ngarraard1 S/S

Koror Island

KB bridge

COMPACT road

【2】 Relocation of existing T/L

6

- Present Situation: Major part of the T/L is existing on the old road surrounded by trees
- Problem :
  - Safety risk on the maintenance work is getting higher since the old roads are deteriorated
  - Frequent power outage occurred by tree touch

  (Intensive tree trimming seems effective but still essential improvement is expected)

→ to address the situation, relocation of the T/L to along the COMPACT road is planned

- Maintenance work will be safe and effective
- Outage by tree touch will be decreased

- **Construction volume:** **T/L 40km(Nekken36 km + A-A 4km) (with insulated conductor), D/L 5km,S/S 3units**

The old road where land slipped

Line in the bush

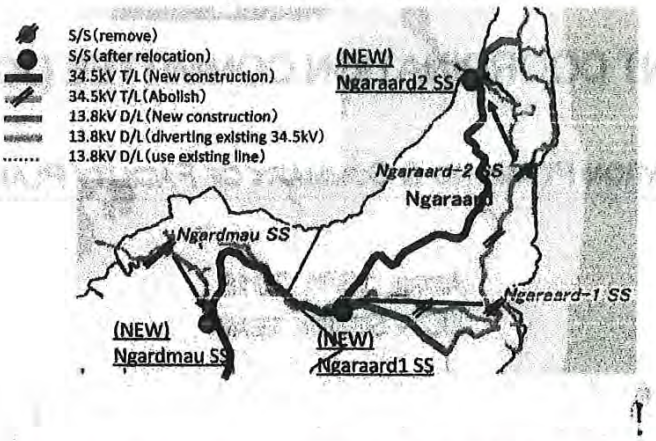
Line on the hill

【2】 Relocation of T/L

7

Accompanied with the relocation of transmission line, existing three substation needs to be replaced to near along the COMPACT road

Nekken T/L (North area)



【3】 Construction of New D/L from Koror S/S

8

Necessity of Construction of new feeder to address the estimated future power demand was examined.
As a result,

1) For **Koror substation**

- Construction of One new D/L feeder is planned to secure the capacity for back up supply when one of two distribution feeders for Koror downtown area is broken. The planned construction year is in 2020.
- **Construction length: D/L 1km**

2) For other substations

No need to add feeders since the existing lines have enough capacity to meet the estimated future power demand.

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

JOINT COORDINATION COMMITTEE (JCC)

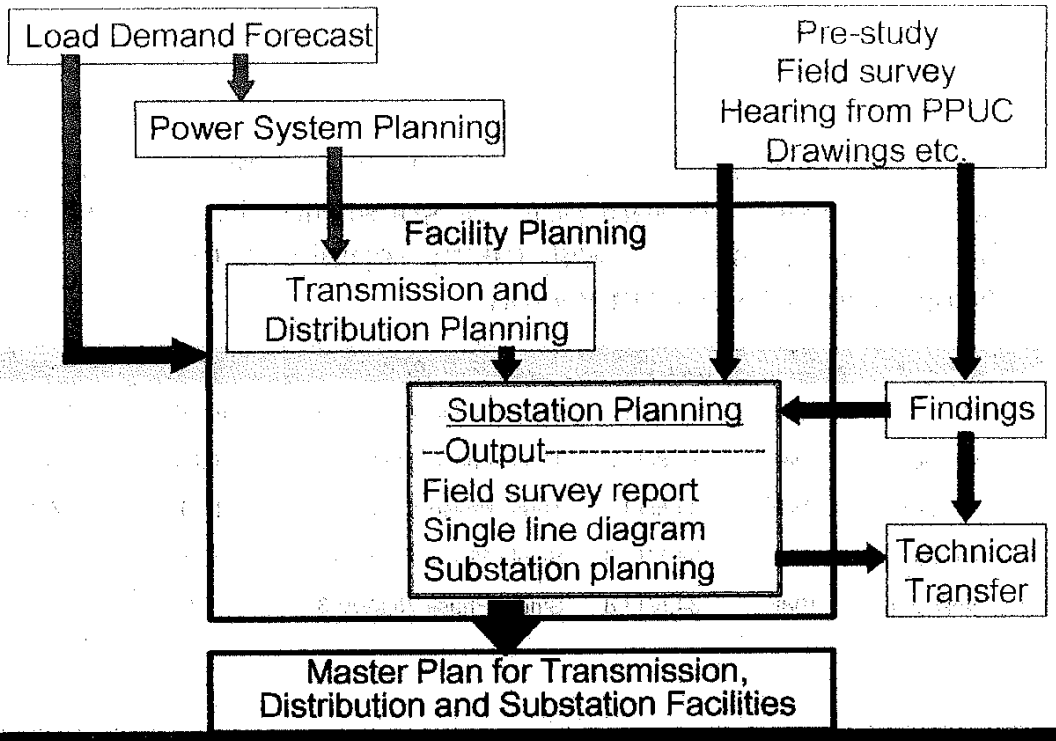
SUBSTATION PLANNING & SUMMARY OF FACILITY PLANNING

APRIL 13TH, 2018
JICA STUDY TEAM

Contents

1. Review of the Work Flow
2. Concept for Substation Facility Planning
3. Countermeasures (Aging Substation Facilities)
4. Countermeasures (Improvement of Power Supply Reliability)
5. Considerations (Improvement of Power Supply Reliability)
6. Considerations (Detailed)
7. Candidates site (Koror Substation)
8. Master Plan of T&D and Substation Facility (Stepping)
9. Master Plan of T&D and Substation Facility (Step1)
10. Master Plan of T&D and Substation Facility (Step2)
11. Master Plan of T&D and Substation Facility (Step3)
12. Master Plan of T&D and Substation Facility (Step4)
13. Summary of Facility Plan and Tentative Rough Cost Estimation

1. Review of the Work Flow



2. Concept for Substation Facility Planning

- Result of Load Demand Forecast
  - Not necessary of countermeasures for Load Demand in the period of Master Plan
- Main Objectives for Substation Facility Planning
  - Improvement of Power Supply Reliability
  - Improvement of Maintenance Manageability
  - Countermeasures for Aging Substation Facilities
  - Countermeasures for Grid connected PV System
  - Countermeasures for Future Load Demand

3. Countermeasures (Aging Substation Facilities)

- Result of Field Survey (Refer to the Field Survey Report for more details of the condition of substation facilities)

➢ Since old substations which had built in 1986 are aging severely, improvement plan for substation facilities shown below are considered with taking replacement of equipment into consideration.

1	Airai	1986	34.5/13.8	Three-Phase 10 MVA×1	10,000	Y-Y-Δ
2	Aimeliik	1986	13.8/34.5	Three-Phase 10 MVA×2	20,000	Δ-Y
3	Aimeliik-1	1986	34.5/13.8	Three-Phase 1000 kVA×1	1,000	Δ-Y
4	Aimeliik-2	1986	34.5/13.8	Single-Phase 75 kVA×3	225	Δ-Y
5	Nekkeng	1986	34.5/13.8	Single-Phase 75 kVA×3	225	Δ-Y

4. Countermeasures (Improvement of Power Supply Reliability)

- Focus

➢ In addition to the countermeasures against aging Airai substation facilities, three ideas are considered to determine more reliable power supply for the load center (Koror state).

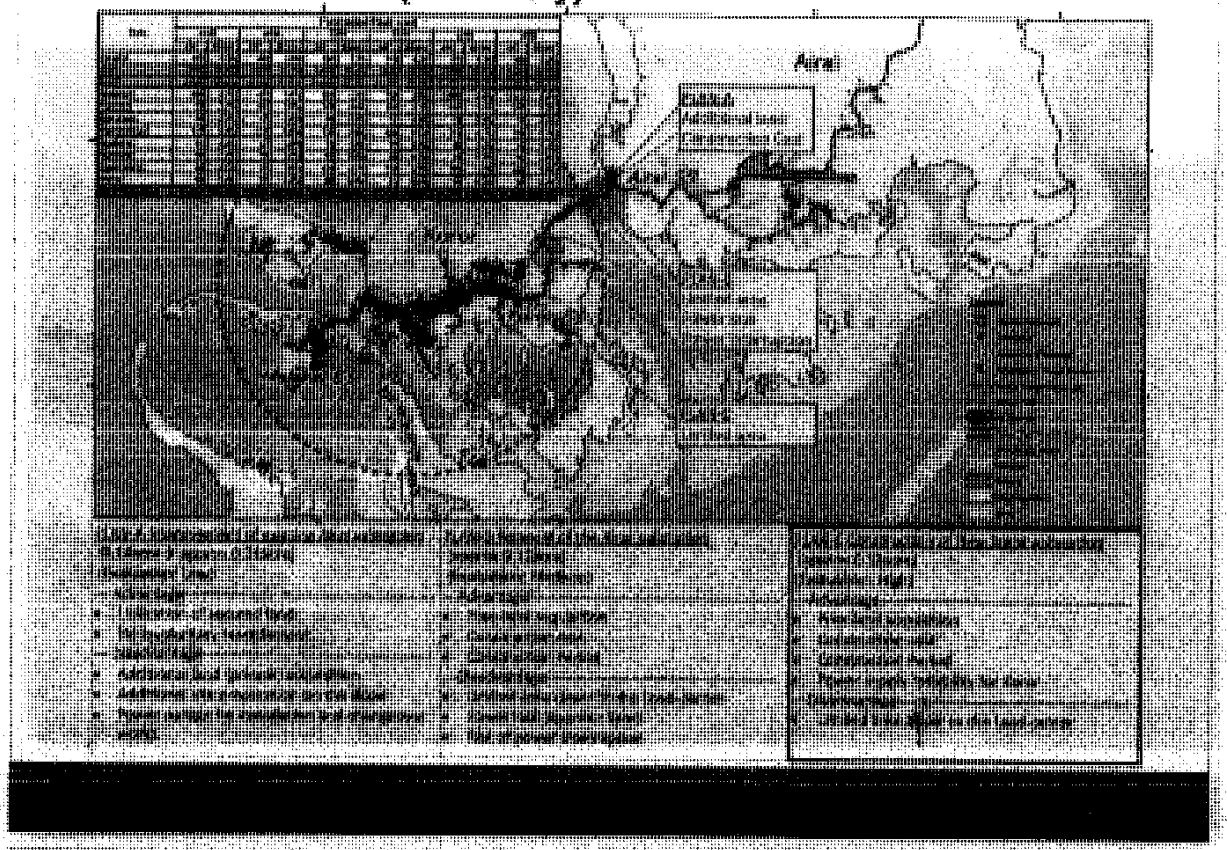
- Ideas (See Considerations (Summary))

➢ PLAN-A Improvement of existing Airai substation

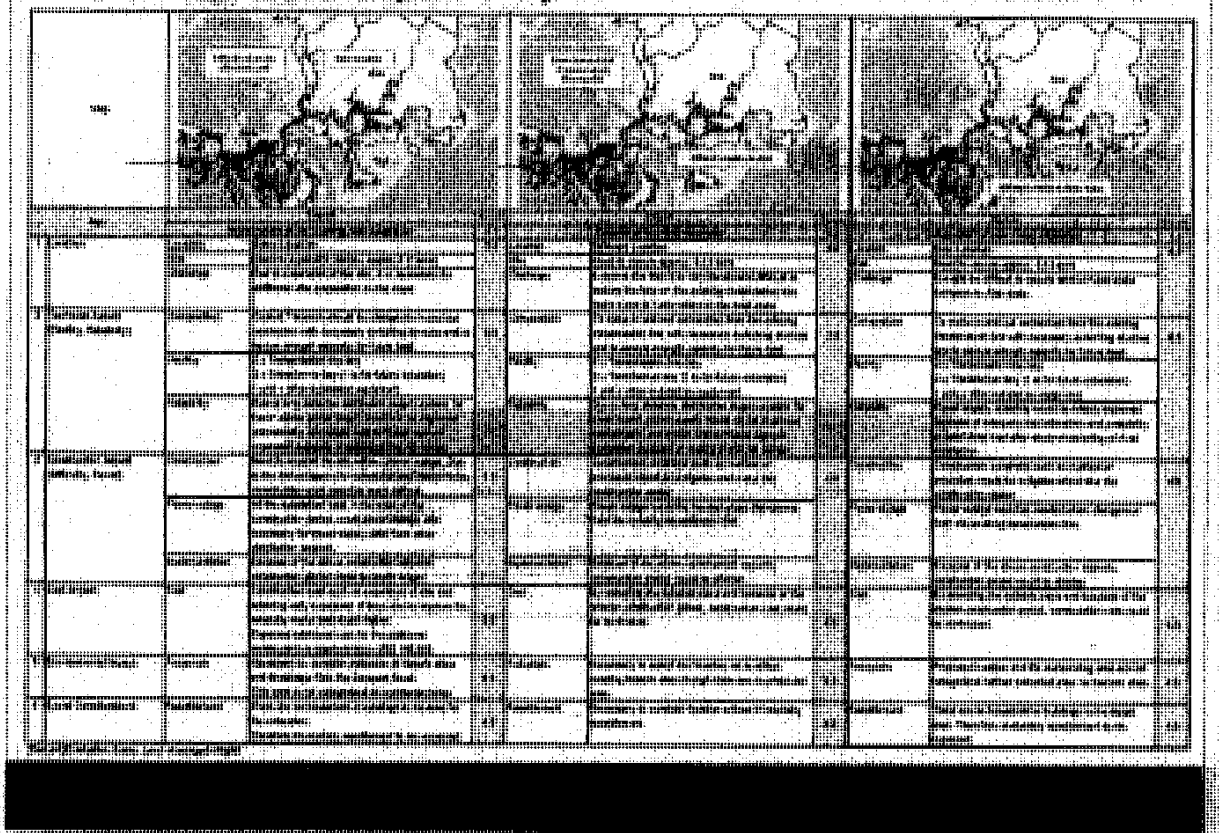
➢ PLAN-B Renewal of the Airai substation

➢ PLAN-C Construction of New Koror substation

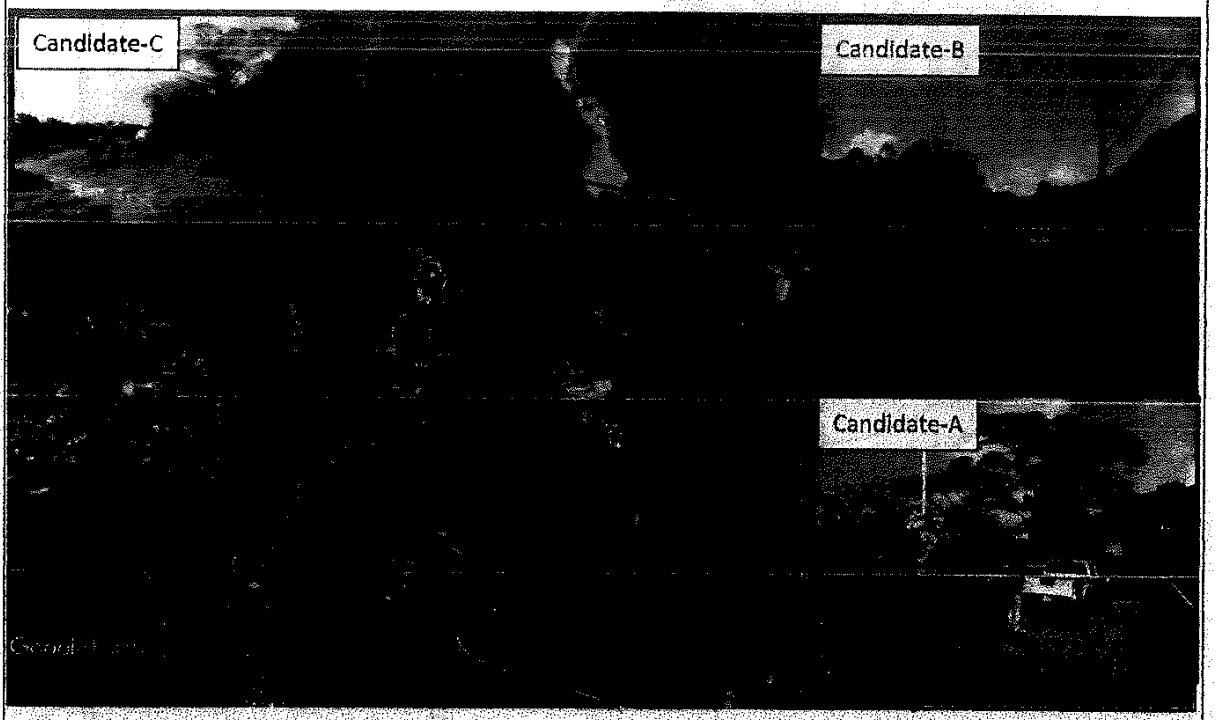
5. Considerations (Summary)



6. Considerations (Detailed)



7. Candidates site (Koror Substation)



8. Master Plan of T&D and Substation Facility (Stepping)

- Target Year
  - Master Plan: 2030
  - Keep in Step with RE roadmap

1	by 2020	Phase1
2	From 2021 to 2023	Phase2
3	From 2024 to 2025	Phase3
4	by 2030	-

9. Master Plan of T&D and Substation Facility (Step1)

■ Step1 Target Year (by 2020) (Refer to the Location Map)

1-1	2020	T&D	Improvement of Maintenance Manageability	■ Relocation of existing 34.5kV Transmission Line ・ Airai – Ngaraard 2
1-2	2020	SS	Improvement of Maintenance Manageability	■ Relocation of existing substations ・ Ngardmau ・ Ngaraard 1 ・ Ngaraard 2
1-3	2020	SS	Improvement of power supply reliability	■ Construction of Koror substation ・ 34.5/13.8kV 1 bank x 10MVA
1-4	2020	D	Improvement of power supply reliability	■ Construction of 13.8kV distribution line ・ 1 feeder x 13.8kV distribution line
1-5	Within the period	SS	For grid protection and maintenance	■ Installation of circuit breaker panel ・ Grid connected PV system (Aimeliik) ・ Grid connected PV system (Ngatpang (Kokusai)) ・ Grid connected PV system (Ngaremlengui)

Remarks: T&D: Transmission and Distribution facilities, T: Transmission facilities, D: Distribution facilities, SS: Substation facilities

10. Master Plan of T&D and Substation Facility (Step2)

■ Step2 Target Year (2021-2023) (Refer to the Location Map)

2-1	2023	T	For grid connected PV system and improvement of power supply reliability	■ Construction of 34.5kV transmission line ・ Malakal – Melekeok PV site
2-2	2023	SS	Improvement of Maintenance Manageability	■ Expansion of Malakal substation ・ Expansion of Malakal outgoing feeder bay ・ 34.5/13.8kV 1 bank x 10MVA (Option)
2-3	Within the period	SS	For grid protection and maintenance	■ Installation of circuit breaker panel ・ Grid connected PV system (Airai Airport) ・ Grid connected PV system (Ngchesar) ・ Grid connected PV system (Melekeok)

Remarks: T&D: Transmission and Distribution facilities, T: Transmission facilities, D: Distribution facilities, SS: Substation facilities

11. Master Plan of T&D and Substation Facility (Step3)

■ Step3 Target Year (2024-2025) (Refer to the Location Map)

3-1	2025	T&D	For grid connected PV system and improvement of power supply reliability	■ Construction of 34.5kV transmission line ・ Melekeok PV site - Ngaraard 1 ・ Expansion of outgoing feeder at Ngaraard 1
3-2	Within the period	SS	For grid protection and maintenance	■ Installation of circuit breaker panel ・ Grid connected PV system (Ngiwal) ・ Grid connected PV system(Ngardmau(Terraces of Hill)) ・ Grid connected PV system (Ngardmau)

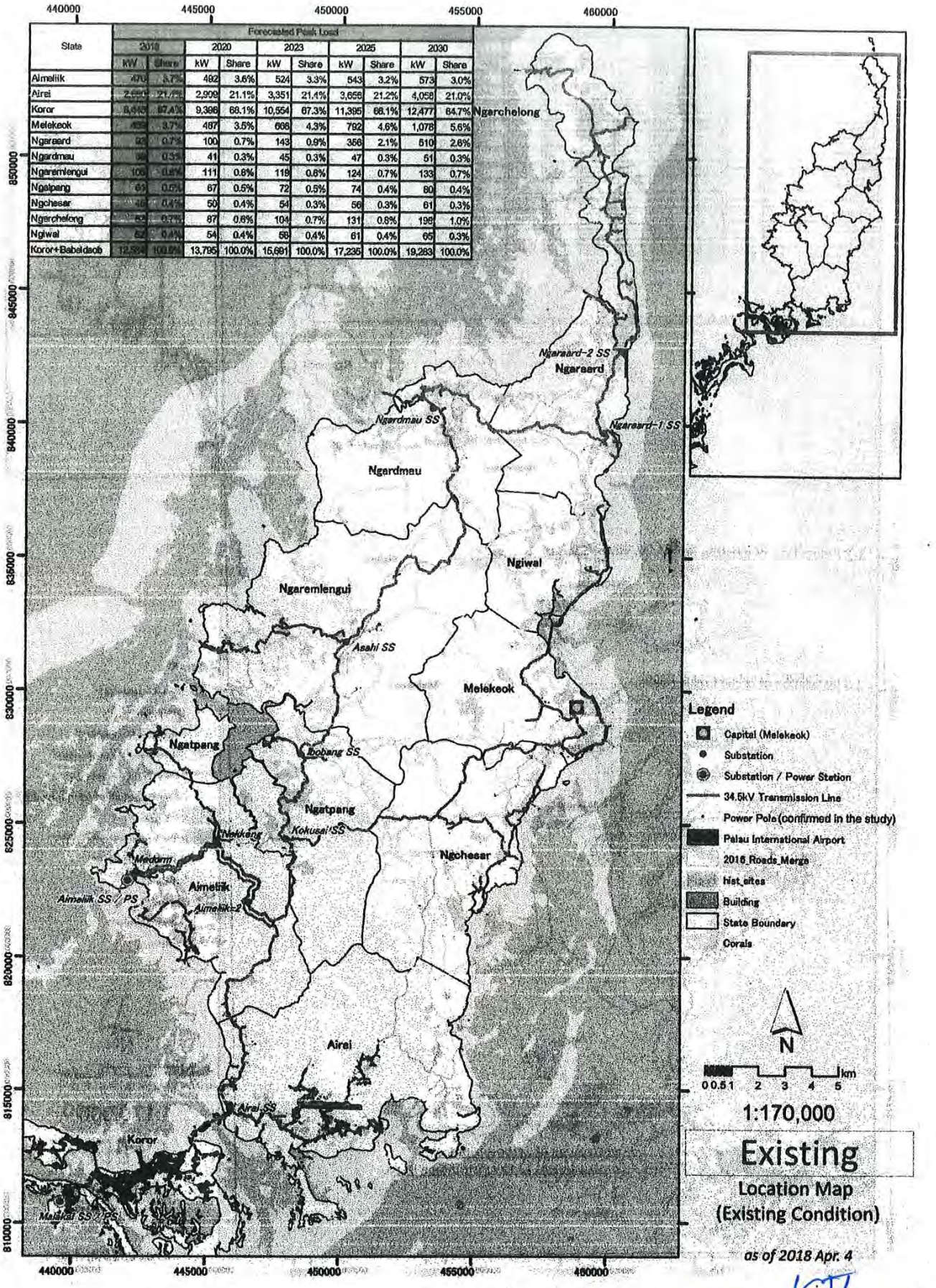
Remarks: T&D: Transmission and Distribution facilities, T: Transmission facilities, D: Distribution facilities, SS: Substation facilities

12. Master Plan of T&D and Substation Facility (Step4)

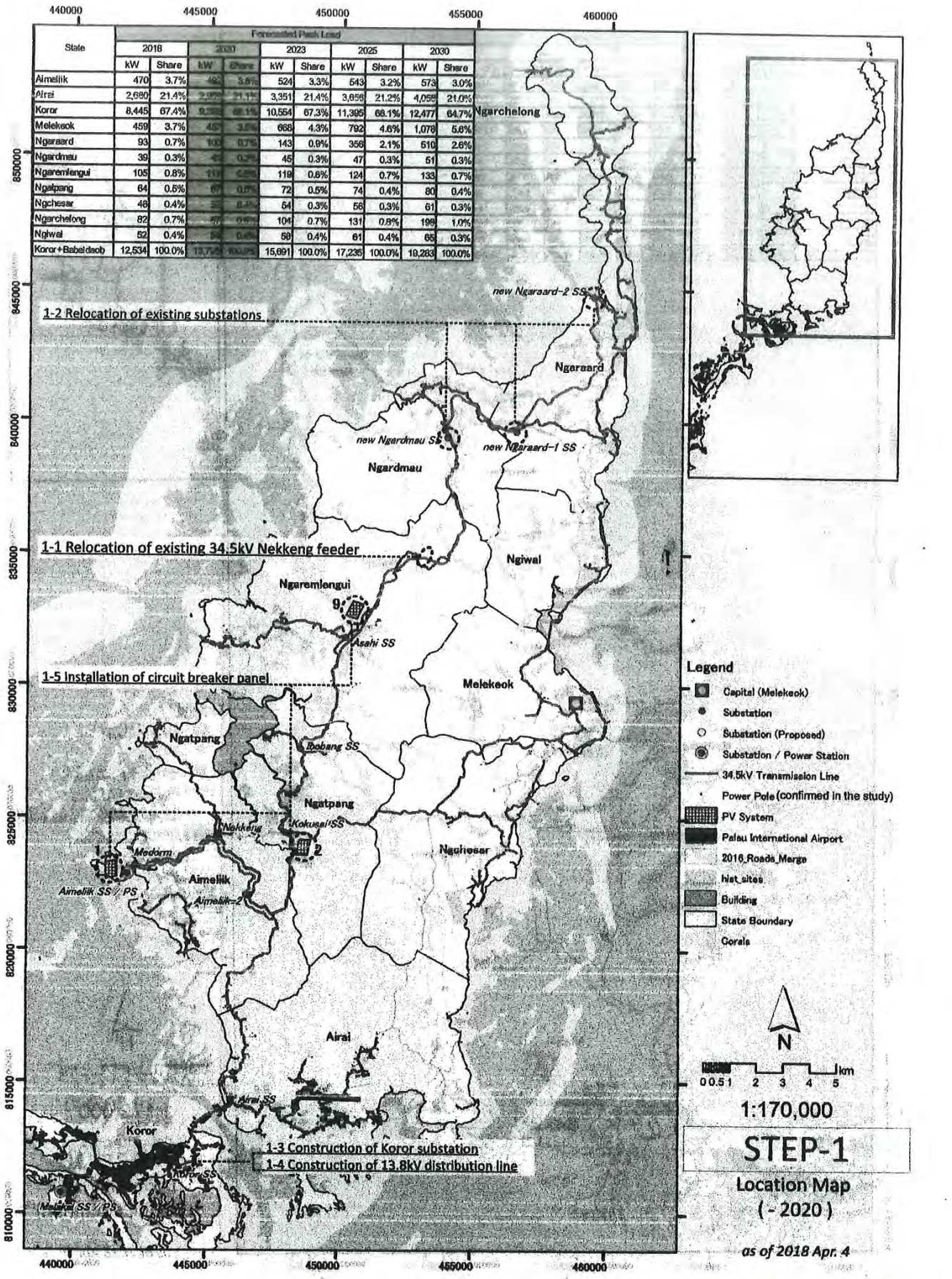
■ Step4 Target Year (2025-2030) (Refer to the Location Map)

4-1	2026	SS	Countermeasure for aged equipment	■ Simple replacement work for existing substation ・ Airai S/S ・ Airai S/S 1 ・ Koror ・ Koror 2
4-2	2026	SS	Countermeasure for future load and improvement of Maintenance Manageability	■ Expansion of Koror substation ・ 34.5/13.8kV 1 bank x 10MVA

Remarks: T&D: Transmission and Distribution facilities, T: Transmission facilities, D: Distribution facilities, SS: Substation facilities



State	Forecasted Peak Load									
	2018		2020		2023		2025		2030	
	kW	Share	kW	Share	kW	Share	kW	Share	kW	Share
Aimeliik	470	3.7%	492	3.6%	524	3.3%	543	3.2%	573	3.0%
Airai	2,690	21.1%	2,909	21.1%	3,351	21.4%	3,656	21.2%	4,058	21.0%
Koror	8,445	67.4%	9,386	68.1%	10,554	67.3%	11,395	66.1%	12,477	64.7%
Melekeok	468	3.7%	487	3.5%	666	4.3%	792	4.6%	1,078	5.6%
Ngaraard	93	0.7%	100	0.7%	143	0.9%	356	2.1%	510	2.6%
Ngardmau	38	0.3%	41	0.3%	45	0.3%	47	0.3%	51	0.3%
Ngaremlengui	103	0.8%	111	0.8%	119	0.8%	124	0.7%	133	0.7%
Ngatpang	63	0.5%	67	0.5%	72	0.5%	74	0.4%	80	0.4%
Ngchesar	46	0.4%	50	0.4%	54	0.3%	56	0.3%	61	0.3%
Ngarchelong	82	0.7%	87	0.6%	104	0.7%	131	0.8%	196	1.0%
Ngiwal	52	0.4%	54	0.4%	58	0.4%	61	0.4%	65	0.3%
Koror+Babeldaob	12,534	100.0%	13,795	100.0%	15,691	100.0%	17,235	100.0%	19,283	100.0%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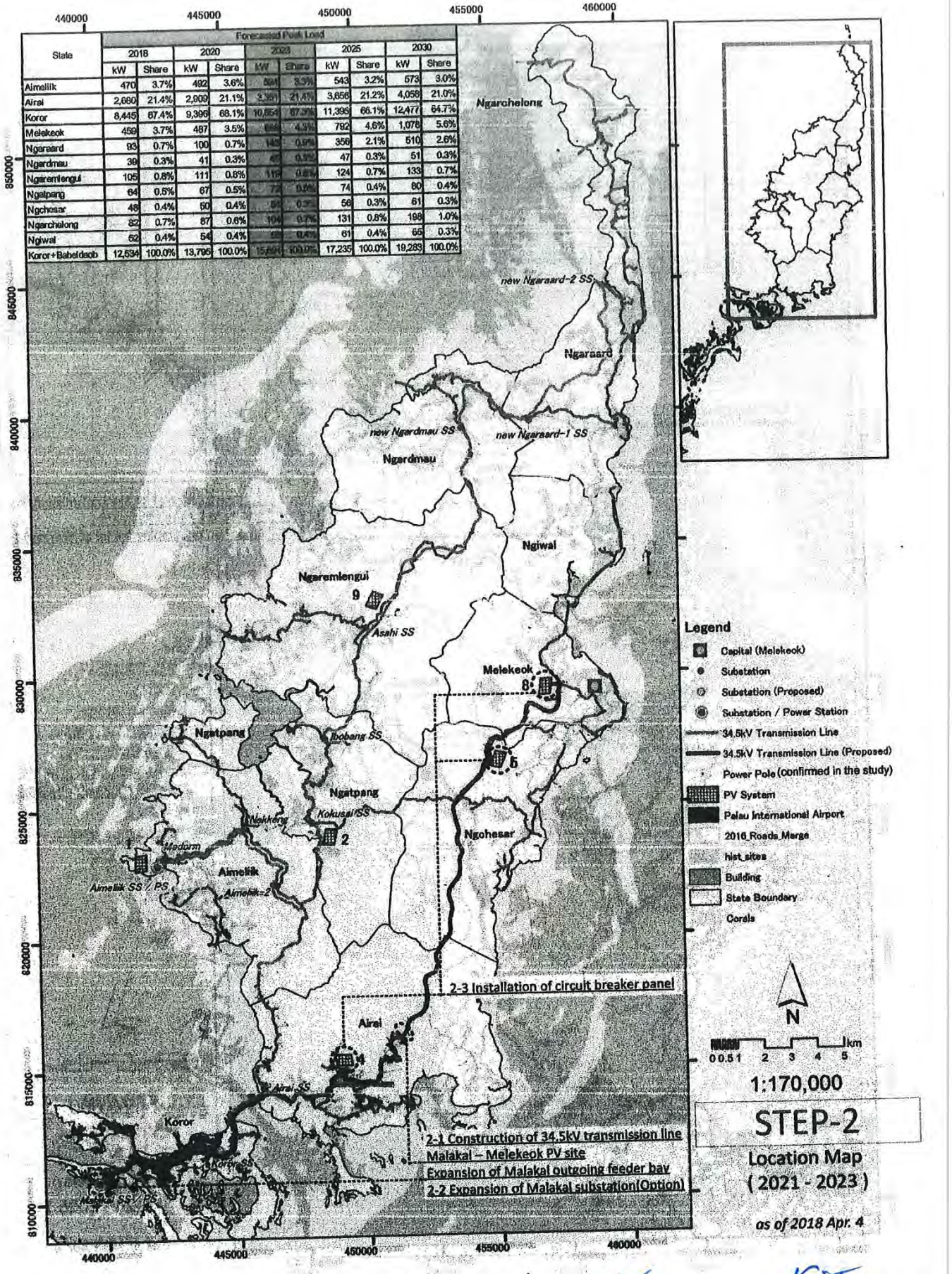
Forecasted Peak Load
State
2018
2020
2023
2025
2030
kW
Share
Aimeliik 470 3.7% 524 3.3% 543 3.2% 573 3.0%
Airai 2,680 21.4% 3,351 21.4% 3,656 21.2% 4,059 21.0%
Koror 8,445 67.4% 10,554 67.3% 11,395 66.1% 12,477 64.7%
Melekeok 459 3.7% 668 4.3% 792 4.6% 1,078 5.6%
Ngaraard 93 0.7% 143 0.9% 356 2.1% 510 2.6%
Ngardmau 39 0.3% 45 0.3% 47 0.3% 51 0.3%
Ngaremlengui 105 0.8% 119 0.8% 124 0.7% 133 0.7%
Ngatpang 64 0.5% 72 0.5% 74 0.4% 80 0.4%
Ngchesar 46 0.4% 54 0.3% 56 0.3% 61 0.3%
Ngarchelong 82 0.7% 104 0.7% 131 0.8% 199 1.0%
Ngiwal 52 0.4% 58 0.4% 61 0.4% 65 0.3%
Koror+Babeldaob 12,534 100.0% 15,691 100.0% 17,235 100.0% 19,283 100.0%
Ngarchelong
new Ngaraard-2 SS
Ngaraard
new Ngardmau SS
new Ngaraard-1 SS
Ngardmau
1-2 Relocation of existing substations
1-1 Relocation of existing 34.5kV Nekkeng feeder
Ngiwal
Ngaremlengui
Asahi SS
1-5 Installation of circuit breaker panel
Melekeok
Ngatpang
Ibobang SS
Ngatpang
Nekkeng
Kokusai SS
Ngchesar
Medorm
Aimeliik
Aimeliik SS / PS
Aimeliik-2
Airai
Airai SS
Koror
1-3 Construction of Koror substation
1-4 Construction of 13.8kV distribution line
Malakal SS / PS
Legend
Capital (Melekeok)
Substation
Substation (Proposed)
Substation / Power Station
34.5kV Transmission Line
Power Pole (confirmed in the study)
PV System
Palau International Airport
2016_Roads_Merge
hist_sites
Building
State Boundary
Corals
N
0 0.5 1 2 3 4 5 km
1:170,000
STEP-1
Location Map
(- 2020)
as of 2018 Apr. 4



State	Forecasted Peak Load									
	2018		2020		2023		2025		2030	
	kW	Share	kW	Share	kW	Share	kW	Share	kW	Share
Aimeliik	470	3.7%	492	3.6%	524	3.5%	543	3.2%	573	3.0%
Airai	2,660	21.4%	2,909	21.1%	3,351	21.4%	3,656	21.2%	4,058	21.0%
Koror	8,445	67.4%	9,396	68.1%	10,854	67.3%	11,395	66.1%	12,477	64.7%
Melekeok	459	3.7%	487	3.5%	686	4.3%	792	4.6%	1,078	5.6%
Ngaraard	93	0.7%	100	0.7%	143	0.9%	356	2.1%	510	2.6%
Ngardmau	39	0.3%	41	0.3%	42	0.3%	47	0.3%	51	0.3%
Ngaremlengui	105	0.8%	111	0.8%	119	0.8%	124	0.7%	133	0.7%
Ngatpang	64	0.5%	67	0.5%	72	0.5%	74	0.4%	80	0.4%
Ngchesar	48	0.4%	50	0.4%	54	0.3%	56	0.3%	61	0.3%
Ngarchelong	82	0.7%	87	0.6%	104	0.7%	131	0.8%	198	1.0%
Ngiwal	52	0.4%	54	0.4%	58	0.4%	61	0.4%	65	0.3%
Koror+Babeldaob	12,634	100.0%	13,796	100.0%	15,904	100.0%	17,235	100.0%	19,289	100.0%

State	Forecasted Peak Load									
	2018		2020		2023		2025		2030	
	kW	Share	kW	Share	kW	Share	kW	Share	kW	Share
Airmelik	470	3.7%	492	3.6%	524	3.3%	548	3.2%	573	3.0%
Airai	2,680	21.4%	2,909	21.1%	3,351	21.4%	3,654	21.2%	4,056	21.0%
Koror	8,446	67.4%	9,366	68.1%	10,554	67.3%	11,705	68.1%	12,477	64.7%
Melekeok	459	3.7%	487	3.5%	668	4.3%	764	4.4%	1,078	5.6%
Ngaraard	93	0.7%	100	0.7%	143	0.9%	386	2.2%	510	2.6%
Ngardmau	39	0.3%	41	0.3%	45	0.3%	47	0.3%	51	0.3%
Ngaremlengui	105	0.8%	111	0.8%	119	0.8%	184	0.7%	133	0.7%
Ngatpang	64	0.5%	67	0.5%	72	0.5%	75	0.4%	80	0.4%
Ngchesar	48	0.4%	50	0.4%	54	0.3%	56	0.3%	61	0.3%
Ngarchelong	82	0.7%	87	0.8%	104	0.7%	153	0.8%	198	1.0%
Ngiwal	52	0.4%	54	0.4%	58	0.4%	61	0.3%	65	0.3%
Koror+Babeldaob	12,534	100.0%	13,795	100.0%	15,691	100.0%	17,203	100.0%	19,283	100.0%

3-2 Installation of circuit breaker panel

3-1 Construction of 34.5kV transmission line
Melekeok PV site - Ngaraard 1
Expansion of outgoing feeder at Ngaraard 1

Legend
- Capital (Melekeok)
- Substation
- Substation (Proposed)
- Substation / Power Station
- 34.5kV Transmission Line
- 34.5kV Transmission Line (Proposed)
- Power Pole (confirmed in the study)
- PV System
- Palau International Airport
- 2018_Roads_Merge
- hist_sites
- Building
- State Boundary
- Corals

N

0 0.5 1 2 3 4 5 km

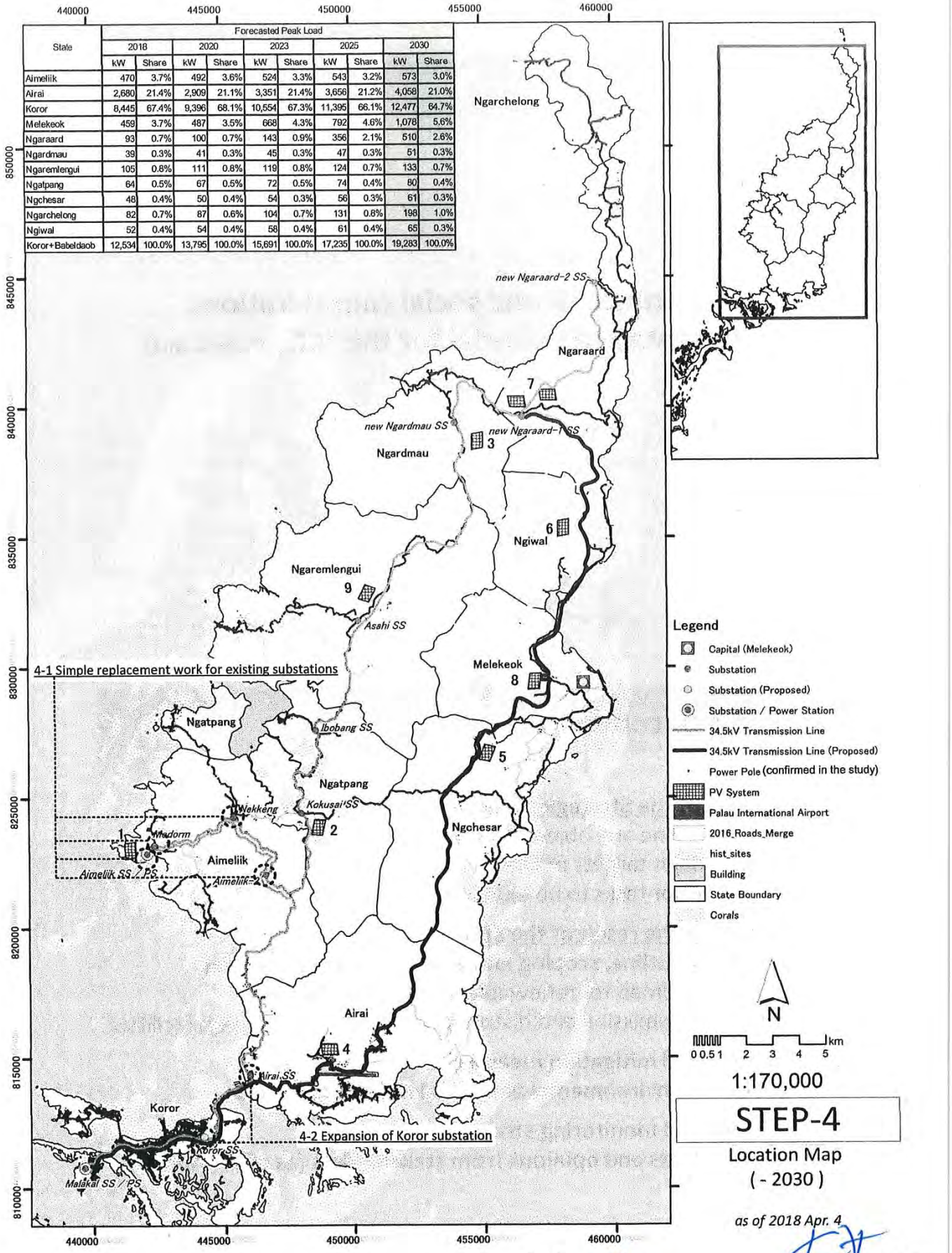
1:170,000

STEP-3

Location Map
(2024 - 2025)

as of 2018 Apr. 4

State	Forecasted Peak Load									
	2018		2020		2023		2025		2030	
	kW	Share	kW	Share	kW	Share	kW	Share	kW	Share
Aimeliik	470	3.7%	492	3.6%	524	3.3%	543	3.2%	573	3.0%
Airai	2,680	21.4%	2,909	21.1%	3,351	21.4%	3,656	21.2%	4,058	21.0%
Koror	8,445	67.4%	9,396	68.1%	10,554	67.3%	11,395	66.1%	12,477	64.7%
Melekeok	459	3.7%	487	3.5%	668	4.3%	792	4.6%	1,078	5.6%
Ngaraard	93	0.7%	100	0.7%	143	0.9%	356	2.1%	510	2.6%
Ngardmau	39	0.3%	41	0.3%	45	0.3%	47	0.3%	51	0.3%
Ngaremlengui	105	0.8%	111	0.8%	119	0.8%	124	0.7%	133	0.7%
Ngatpang	64	0.5%	67	0.5%	72	0.5%	74	0.4%	80	0.4%
Ngchesar	48	0.4%	50	0.4%	54	0.3%	56	0.3%	61	0.3%
Ngarchelong	82	0.7%	87	0.6%	104	0.7%	131	0.8%	198	1.0%
Ngiwal	52	0.4%	54	0.4%	58	0.4%	61	0.4%	65	0.3%
Koror+Babeldaob	12,534	100.0%	13,795	100.0%	15,691	100.0%	17,235	100.0%	19,283	100.0%



Environmental and social considerations
Presentation material for the JCC (13th April, 2018)

Table of contents

Outline of the Strategic Environmental Assessment (SEA)

(1) Outline and objective of the SEA
(2) Major targets of the SEA
(3) Major tasks to be executed in the SEA

Report of the result of the SEA

1. Project outline, scoping and evaluation of alternatives

(1) Roadmap for renewable energy introduction
(2) Transmission and distribution network /substation facilities

2. Proposed mitigation measures against environmental and social negative impacts

3. Proposed monitoring structure

4. Comments and opinions from stakeholders (as of 11th April)

Outline of the Strategic Environmental Assessment (SEA)

1 (1) Outline and objective of the SEA

What is the Strategic Environmental Assessment (SEA)?

" Analytical and participatory approach that aims to integrate environmental considerations into policies, plans and programs and evaluate inter linkages with economic and social considerations. " (OECD/DAC (2006))

Objective

To elaborate master plan (MP) ensuring a full integration of relevant biophysical, economic, and social aspects considering stakeholders' opinions and concerns by involving the stakeholders at the early stage of MP examination.

4

1 (2) Major targets of the SEA

Phase	Targets to be examined
1. Policy	-Setting the goal of the National Power Grid MP -Long-term energy balance and composition of power generation system including renewable energy -Alternatives to achieve the goal etc.
2. Plan	-Long-term development plan (up to 2030) on T&D lines, substations and related facilities -Alternatives of the development plan etc.
3. Program and Project	-Alternatives of priority project to be proposed in the National Power Grid MP etc.

5

1 (3) Major tasks to be executed in the SEA

(1) Examination of development alternatives

- Comparative analysis of development alternatives for the assessment of possible environmental and social impacts

(2) Consultation with stakeholders

- Collecting the opinions of public and private stakeholders

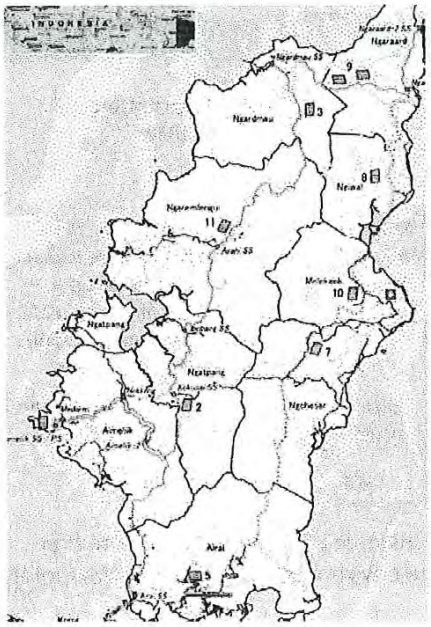
(3) Reflecting stakeholders' opinions to the MP

- Elaborating the MP considering stakeholders' opinions and concerns addressed in stakeholder's meetings.

6

Report of the result of the SEA

1. Project outline, scoping and evaluation of alternatives
(1) Roadmap for renewable energy 1) Outline



Site	Output	Area
Aimeliik (Next to power plant)	5 MWp+1MWp	15 acres+α
Ngatpang (Koksrsai)	2-3 MWp+1MWp	8 acres+α
Ngardmau (Terrace of Hill)	2-3 MWp+1MWp	7 acres+α
Airai Airport side by road	3 MWp+3MWp	8 acres+α
Ngchesar	3 MWp+1MWp	8 acres+α
Ngiwal	3 MWp+1MWp	9 acres+α
Ngardmau	5 MWp+1MWp	15 acres+α
Melekeok	3 MWp+1MWp	9 acres+α
Ngaremlengui	5 MWp+1MWp	18 acres+α
Total	33MWp+11MWp	

Candidate site for
PV installation proposed by PPUC

<Note> Other technical details are mentioned in the Progress Report 2.

8

1 (1) 2) Scoping (renewable energy)

	Scoping items	Construction phase			Operation phase		
		PV Panel	Wind Turbine	Battery	PV Panel	Wind Turbine	Battery
Environmental	Air pollution	B-	B-	B-	D	D	D
	Soil pollution	B-	B-	B-	D	D	D
	Water pollution	C-	C-	C-	D	D	D
	Noise and vibration	B-	B-	B-	D	B-	C-
	Flora and fauna	A-	B-	B-	C-	C-	C-
	Preserved area	C-	C-	C-	C-	C-	C-
	Biodiversity	C-	C-	C-	C-	C-	C-
Social	Land acquisition/ involuntary resettlement	A-	B-	B-	D	D	D
	Influence on local economy	C-	C-	C-	Positive	Positive	Positive
	Human health hazard	B-	B-	B-	C-	C-	C-
	Risk of accident	B-	B-	B-	C-	B-	C-

A-: Significant negative impact is expected. B-: Negative impact is expected.
C-: Extent of negative impact is unknown. D: No impact is expected.

9

social aspects (renewable energy)

	Case 1	Case 2	Case 3	Case 4
Outline	-PV panel -Short-term battery -Long-term battery	-PV panel -Short-term battery -Long-term battery -Wind turbine	-PV panel -Short-term battery	-PV panel -Short-term battery -Wind turbine
Environmental aspect	Negative impact on flora and fauna	Negative impact on flora and fauna, negative impact due to construction of access road of wind turbine and new transmission line, noise during operation	Negative impact on flora and fauna	Negative impact on flora and fauna, negative impact due to construction of access road of wind turbine and new transmission line, noise during operation
Social aspect	Larger site required	Accident risk during wind turbine maintenance	Larger site required	Accident risk during wind turbine maintenance
Evaluation	++	+	++	+

Considering the negative impacts derived from the installation wind turbines, the first and third cases are relatively advantageous from the environmental and social viewpoint.

10

1 (1) 4) Distribution of protected areas and historic sites in candidate sites for solar power generation

Site	Output	Area	Location	
			Preservation area	Historic site
Aimeliik (Next to power plant)	5 MWp+1MWp	15 acres+α	-	Near
Ngatpang (Kokusai)	2-3 MWp+1MWp	8 acres+α	-	-
Ngardmau (Terrace of Hill)	2-3 MWp+1MWp	7 acres+α	-	Included
Airai Airport side by road	3 MWp+3MWp	8 acres+α	-	-
Ngchesar	3 MWp+1MWp	8 acres+α	-	-
Ngiwal	3 MWp+1MWp	9 acres+α	-	Near
Ngardmau	5 MWp+1MWp	15 acres+α	Near	Near
Melekeok	3 MWp+1MWp	9 acres+α	Included	-
Ngaremlengui	5 MWp+1MWp	18 acres+α	-	-
Total	33MWp+11MWp			

Protected areas and historic sites are included or are in proximity in some candidate sites. It is necessary to give due consideration to the impact on the protected areas and historic sites at the phase of feasibility study and basic design in the future.

11

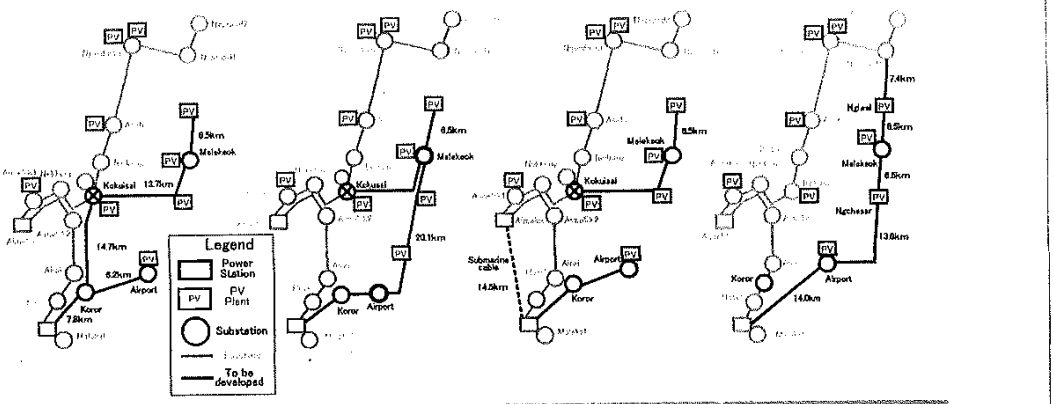
1. Project outline, scoping and evaluation of alternatives (2) T&D network and substation 1) Outline

Year	Item	Outline
2020	Improvement of 34.5kV Nekken feeder	Relocation of 34.5kV Transmission Line (Aimeliik – Ngaraard 2)
	Relocation of the Existing Substation facilities	Asahi substation Ngardmau substation Ngaraard 1substation Ngaraard 2substation
	Construction of Koror substation	34.5/13.8kV 1bank 10MVA
2023	Construction of 34.5kV Transmission Line	34.5kV Transmission Line (Malakal substation – Melekeok PV site) Expansion of 34.5kV outgoing bay at Malakal substation
2025	Construction of 34.5kV Transmission Line	34.5kV Transmission Line (Melekeok PV site – Ngaraard 1) Expansion of 34.5kV outgoing bay at Ngaraard 1 substation
2026	Replacement of the existing Substation equipment	Aimeliik substation Aimeliik 1 substation Nekkeng substation Aimeliik 2 substation

<Note> Other technical details are mentioned in the Progress Report 2.

12

1 (2) 2) Alternatives of T&D network development



Case 1	Case 2	Case 3	Case 4
New transmission line along existing transmission line (Malakal power plant – Kokusai substation)	Construction of a network that half-rounds the southern part of Babeldaob Island	Linkage by submarine cable (Malakal power plant - Aimelik power station)	Construction of a network that circles Babeldaob Island

<Note> Other technical details are mentioned in the Progress Report 2.

1 (2) 3) Scoping (T&D network)

	Scoping items	Construction phase			Operation phase		
		Expansion	Relocation	Rehabilitation	Expansion	Relocation	Rehabilitation
Environmental	Air pollution	B-	B-	B-	D	D	D
	Soil pollution	B-	B-	B-	D	D	D
	Water pollution	C-	C-	C-	D	D	D
	Noise and vibration	B-	B-	B-	D	D	D
	Flora and fauna	B-	B-	C-	C-	C-	C-
	Preserved area	C-	B-	D	D	D	D
	Biodiversity	C-	B-	D	C-	C-	C-
Social	Land acquisition/ involuntary resettlement	C-	B-	D	D	D	D
	Influence on local economy	C-	C-	C-	Positive	Positive	Positive
	Human health hazard	B-	B-	B-	C-	C-	C-
	Risk of accident	B-	B-	B-	C-	C-	C-

A-: Significant negative impact is expected. B-: Negative impact is expected.
C-: Extent of negative impact is unknown. D: No impact is expected.

1 (2) 4) Comparative evaluation of environmental and social aspects (T&D network)

	Case 1	Case 2	Case 3	Case 4
Outline	New transmission line along existing transmission line (Malakal power plant – Kokusai substation)	Construction of a network that half-rounds the southern part of Babeldaob Island	Linkage by submarine cable (Malakal power plant - Aimelik power station)	Construction of a network that circles Babeldaob Island
Environmental aspect	Temporary negative impact at the construction phase	Temporary negative impact at the construction phase	Temporary negative impact at the construction phase, irreversible negative impact on coral reefs at the seafloor	Temporary negative impact at the construction phase
Social aspect	Noticeable negative impact is not assumed because the construction will be basically on public land.			
Evaluation	++	++	+	++

The newly installed power distribution lines are supposed to be constructed at public places along the compact road; land acquisition and involuntary resettlement are not assumed. In the third case, irreversible negative impact on coral reefs is assumed.

1 (2) 5) Scoping (substation)

	Scoping items	Construction phase: Relocation/ New construction	Construction phase: Rehabilitation/ Replacement	Operation phase: All
Environmental	Air pollution	B-	B-	D
	Soil pollution	B-	B-	D
	Water pollution	C-	C-	D
	Noise and vibration	B-	B-	C-
	Flora and fauna	B-	C-	C-
	Preserved area	B-	D	D
	Biodiversity	B-	D	C-
Social	Land acquisition/ involuntary resettlement	B-	D	D
	Influence on local economy	C-	C-	Positive
	Human health hazard	B-	B-	C-
	Risk of accident	B-	B-	C-

A-: Significant negative impact is expected. B-: Negative impact is expected.
C-: Extent of negative impact is unknown. D: No impact is expected.

1 (2) 6) Comparative evaluation of environmental and social aspects (substation)

Target of the evaluation is the examination of the new construction of Koror substation which is urgently needed by 2020.

	Case 1	Case 2	Case 3
Outline	Rehabilitation of Airai substation (same location)	Renewal of Airai substation (different location)	New construction of Koror substation
Environmental aspect	Historic site is adjacent to the slope to be constructed at the site. Protected areas are not adjacent.	Necessary to find the location that do not affect the historic sites in Airai.	No historic sites and protected areas are around the site.
Social aspect	No dwellings and buildings in the target area; involuntary resettlement is not expected.	Since the site is uncertain, it is necessary to acquire a site that does not require as much as possible involuntary resettlement.	No dwellings and buildings in the target site; involuntary resettlement is not expected.
Evaluation	++	+	++

Compared to the second case where the site is not fixed, the first and third plans are evaluated relatively high because the location has already been identified and the uncertain factors are also limited.

2. Proposed mitigation measures

Item	Mitigation Measures
Air pollution	- Appropriate operation and management of construction activity
Soil pollution	- Installation of countermeasures against noise and vibration at construction site (e.g. soundproof sheet, etc.)
Noise and vibration	
Flora and fauna	- Careful consideration on the location of development site and basic designs to avoid/mitigate environmental and social impacts as far as possible
Preserved area	- Examination of optimal plan considering opinion of stakeholders to minimize environmental and social impacts that cannot be avoided
Biodiversity	- Recovery of natural environment by backfilling, afforestation, etc.
Involuntary resettlement and land acquisition	
Human health hazard	- Careful consideration on health condition of workers at construction site
Risk of accident	- Implementation of safety control measures, preparation and training for accident (e.g. evacuation, firefighting, etc.)

3. Proposed monitoring structure

Proposed responsible organization for monitoring

[Planning phase]

Project Planning & Implementation Department, PPUC

[Implementation phase]

During construction: Contractor

During operation: Operator (PPUC)

- EQPB shall supervise the above-mentioned organizations in both planning and implementation phase.
- PPUC as a project proponent shall report the status of the monitoring to EQPB and shall share the status among stakeholders as necessary.

19

4. Major comments and opinions from stakeholders

(comments collected by 11th April 2018)

<EQPB>

- It is **necessary to carefully consider environmental negative impacts in and around environmentally vulnerable area** such as water source and area along the coast.
- It is **better to consult with relevant State Government at an early stage** to obtain State Authorization and to proceed the examination of environmental permit smoothly.
- It is **recommended to hold quarterly meetings with stakeholders during construction phase,** which is the same as water supply project.

Comments from other stakeholders (Historic Preservation Office, Palau Conservation Society, etc.) are under collection.

20

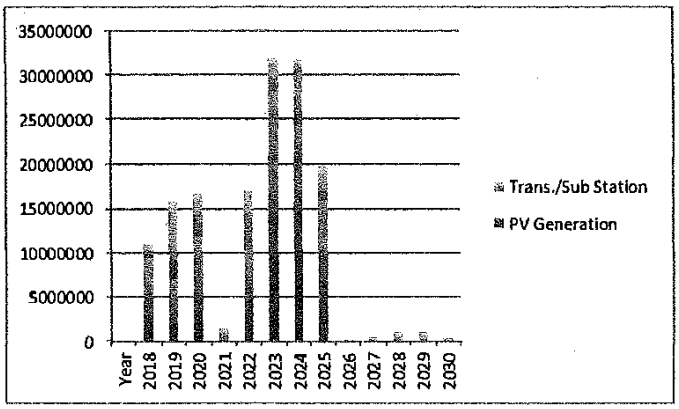
ECONOMIC ANALYSIS OF MASTER PLAN

April 2018

By Yoshiyuki Choso (JICA Study Team)

Money for Master Plan (1)

- US$112.9 million Investment for PV Generation
- US$35.3 million for Transmission and Sub Station
- Total US$ 148.2 million



Money for Master Plan (2)

Year	Capital Expenditure		
	PV Generation	Trans./Sub Station	Annual Capital Expenditure
2018	9,468,333	1,520,000	10,988,333
2019	6,988,333	8,816,000	15,804,333
2020	11,763,333	4,864,000	16,627,333
2021	315,000	1,160,000	1,475,000
2022	10,290,000	6,728,000	17,018,000
2023	28,195,000	3,712,000	31,907,000
2024	30,035,000	1,705,000	31,740,000
2025	15,850,000	3,795,000	19,645,000
2026	0	120,000	120,000
2027	0	450,000	450,000
2028	0	1,020,000	1,020,000
2029	0	1,080,000	1,080,000
2030	0	330,000	330,000
Sub Total	112,905,000	35,300,000	
	Total Capital Cost		148,205,000

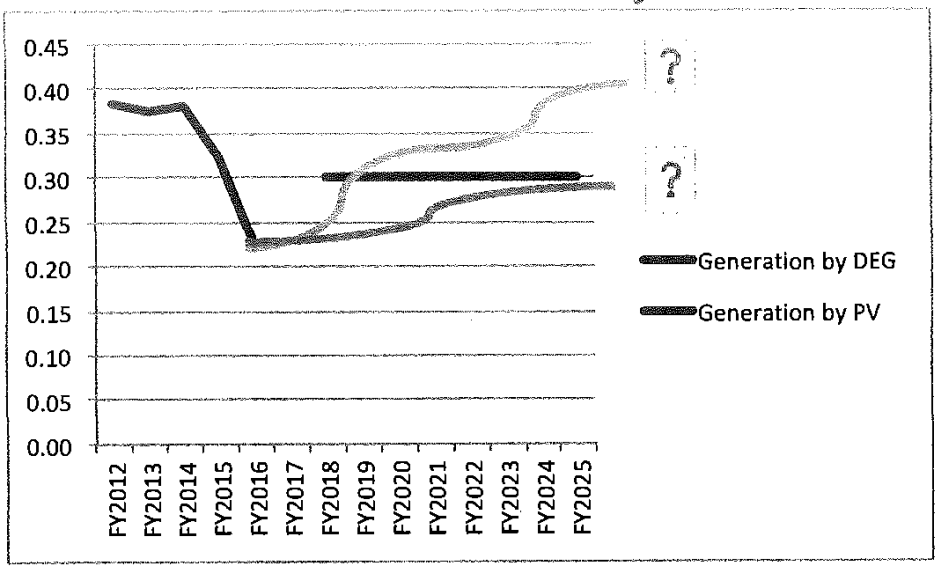
Cost of Generation

- US$0.30/kWh by PV
- US$0.38～0.22/kWh by DEG(Table below)

	FY2012	*FY2013*	*FY2014*	*FY2015*	*FY2016*
Cost of Generation (kWh)	0.38	0.38	0.38	0.33	0.22
Cost of Electricity (kWh)	0.41	0.40	0.40	0.35	0.26
Average revenue of Electricity (kWh)	0.40	0.41	0.41	0.32	0.29

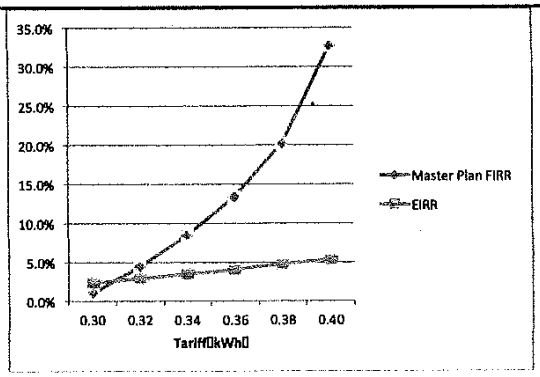
Source: Study Team based of PPUC data

Stable Generation Cost by PV
Uncertain Generation Cost by DEG



Investment Return for Master Plan

Tariff	Tariff ($/kWh)				
	0.30	0.32	0.34	0.36	0.38
Master Plan FIRR	1.0%	4.4%	8.4%	13.3%	20.2%
EIRR	2.3%	2.9%	3.5%	4.1%	4.7%



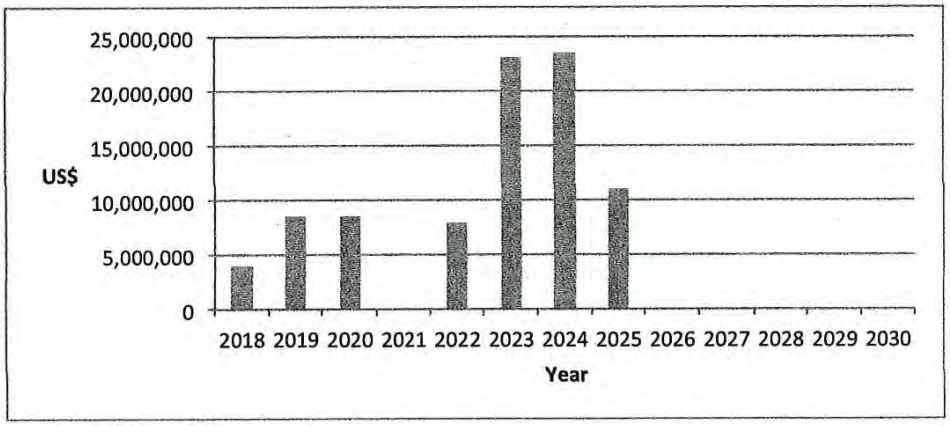
Financing Plan (1)

US$0.34kwh, Debt Ratio 30%, Interest 3.0%

Financing Projection for Master Plan											
Year		Out Flow (US$, million)				In Flow (US$, million)					Net Cash (USD, million)
		Expendiiure and O&M Cost	Loan		Total Out Flow	Electric Power Revenue	Finance			Total Inflow	
			Repayment	Interest			Equity	Debt	Total		
1	2018	29,288,109	0	36,663	29,324,773	25,251,087	2,851,580	1,222,106	4,073,686	29,324,773	0
2	2019	34,575,995	0	113,181	34,689,176	26,187,190	5,951,390	2,550,596	8,501,986	34,689,176	0
3	2020	36,167,401	0	190,287	36,357,688	27,790,345	5,997,140	2,570,203	8,567,342	36,357,688	0
4	2021	21,404,692	0	190,287	21,594,979	28,745,988	0	0	0	28,745,988	7,151,009
5	2022	37,154,247	0	261,319	37,415,566	29,523,155	5,524,688	2,367,723	7,892,411	37,415,566	0
6	2023	53,300,810	0	469,209	53,770,019	30,671,090	16,169,250	6,929,679	23,098,929	53,770,019	0
7	2024	54,342,565	0	680,327	55,022,892	31,565,400	16,420,244	7,037,247	23,457,491	55,022,892	0
8	2025	43,361,871	0	780,428	44,142,299	33,019,936	7,785,654	3,336,709	11,122,363	44,142,299	0
9	2026	24,025,119	5,202,852	624,342	29,852,314	33,520,436	0	0	0	33,520,436	3,668,122
10	2027	24,602,611	5,202,852	468,257	30,273,720	34,178,448	0	0	0	34,178,448	3,904,727
11	2028	25,402,429	5,202,852	312,171	30,917,453	34,789,470	0	0	0	34,789,470	3,872,018
12	2029	25,673,336	5,202,852	156,086	31,032,274	35,350,213	0	0	0	35,350,213	4,317,939
13	2030	25,109,893	5,202,852	0	30,312,746	35,846,217	0	0	0	35,846,217	5,533,471

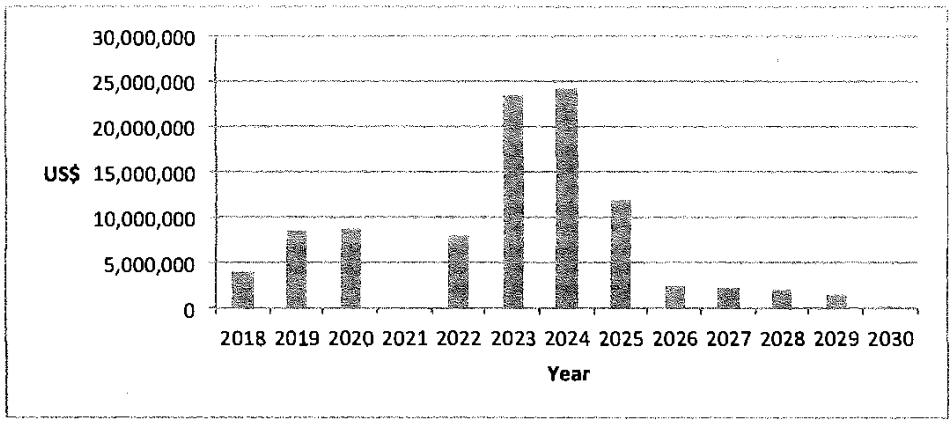
Financing Plan (1)

US$0.34kwh, Debt Ratio 30%, Interest 3.0%



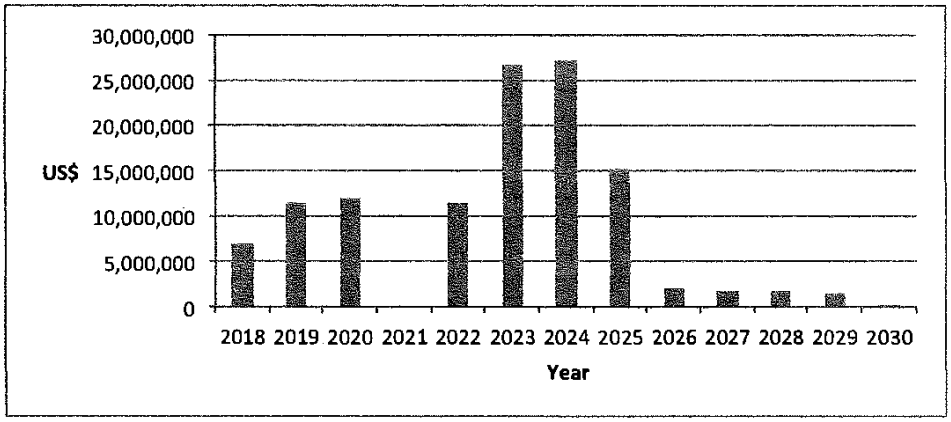
Financing Plan (2)

US$0.34kwh, Debt Ratio 60%, Interest 3.0%



Financing Plan (3)

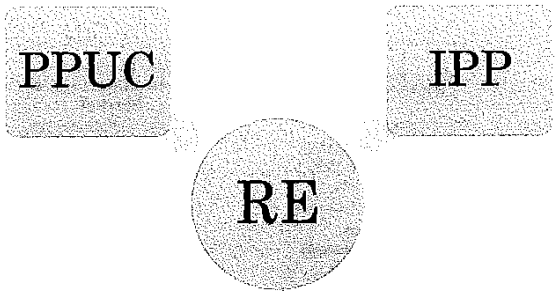
US$0.30kwh, Debt Ratio 30%, Interest 3.0%



If IPPs enter in PV (1)

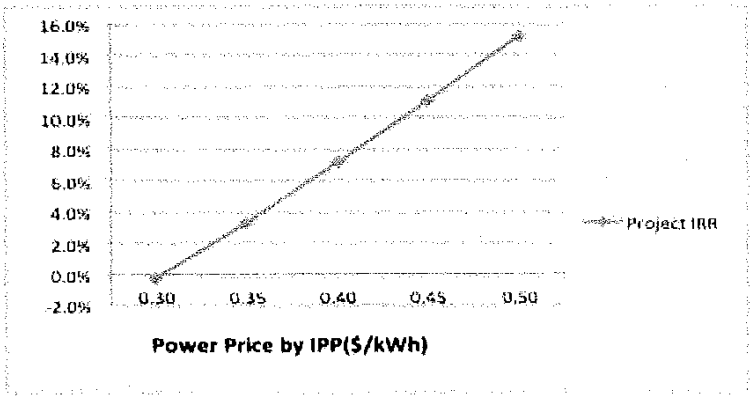
RE Development will be shared between PPUC and IPP.

- IPP will wholesale PV power to PPUC



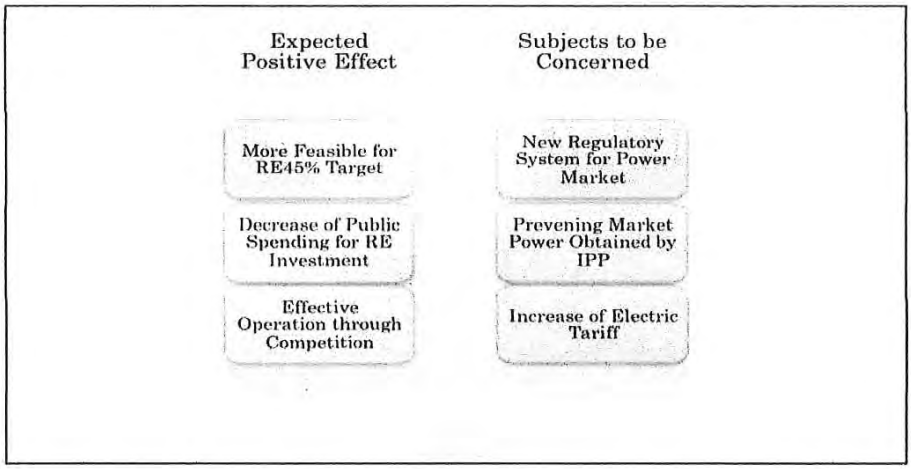
If IPPs enter in PV (2)

- Wholesale price will be over $0.44/kWh if Target Return for investment is 10%.



If IPPs enter in PV (3)

- Fair Market System for RE market
- Public Consent for Tariff rise



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

JOINT COORDINATION COMMITTEE (JCC)

TARGET OF PRE-FEASIBILITY STUDY

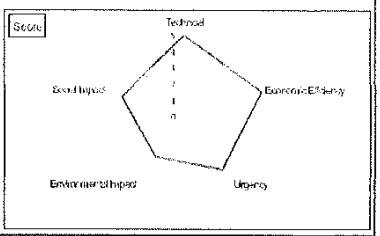
APRIL 13TH, 2018
JICA STUDY TEAM

Contents

1. Methodology to select the target project (Step)
2. Nomination of components for projects
3. Set up Criteria for Evaluation
4. Evaluation for Prioritization-Project No.1
5. Evaluation for Prioritization-Project No.2
6. Evaluation for Prioritization-Project No.3
7. Evaluation for Prioritization-Project No.4
8. Selection of target project for Pre-feasibility study

5. Evaluation for Prioritization-Project No.2

Project No.: 2
Target Year: 2020
Project: Construction of Koror Substation and 34.5kV Transmission Line
Component: 34.5/13.8kV 1 bank 10MVA
Construction of 13.8kV distribution line (1 feeder)
Construction of 34.5kV Transmission Line (Malakal – Ngaraard 1)
Expansion of 34.5kV outgoing bay at Malakal Substation
Expansion of 34.5kV feeders at Ngaraard 1 Substation
Main Objective: Improvement of Power Supply Reliability
Remarks: Recommended to consider space for the second bank at Koror substation in order to improve the power supply reliability and to satisfy N-1 criterion
Cost related to RE roadmap is not included in the estimation



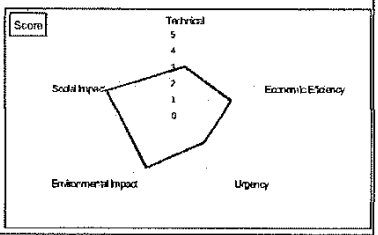
No.	Criteria	Contributing Factor	Specific Information	Score	Weight of Criteria	Evaluation Score
1	Technical	N-1 criterion	By satisfying N-1 criterion, power supply from either Malakal or Aimeliik power plant shall be available in case of fault on the 34.5kV transmission line.	5	25%	1.25
2	Economic Efficiency	Cost	Impact to the Profitability cant expect to become high after completion of the project evan though the Profitability at the initial stage might be limited because of high initial construction cost.	5	20%	1.00
3	Urgency	Power supply reliability	Power supply reliability for the load center (Koror and Airai) shall be improved by satisfying N-1 criterion and re-configuration of 13.8kV network.	4	25%	1.00
4	Environmental Impact	Environmental protection	Environmental impact should be minimized by choosing adequate locatoin of substation facilities.	3	15%	0.45
5	Social Impact	Land acquisition and involuntary resettlement	Involuntary resettlement could be avoidable by choosing adequate line route and locatoin of substation facilities.	4	15%	0.60
			Total	21	100%	4.30

[Remark]Evaluation Score: Low1<Average3<High5

6. Evaluation for Prioritization-Project No.3

Project No.: 3
Target Year: 2026
Project: Improvement of the existing Substation facilities
Component: Replacement of the existing Substation equipment (Aimeliik substation)
Replacement of the existing Substation equipment (Aimeliik-1 substation)
Replacement of the existing Substation equipment (Aimeliik-2 substation)
Replacement of the existing Substation equipment (Nekkeng substation)

Main Objective: Countermeasure for aged equipment
Remarks: Lifetime of those mentioned existing equipment will meet 40-year-old by 2026



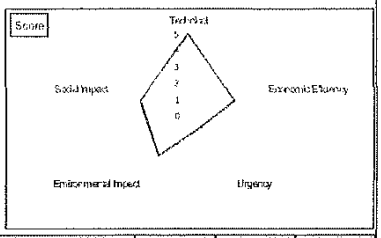
No.	Criteria	Contributing Factor	Specific Information	Score	Weight of Criteria	Evaluation Score
1	Technical	Lifetime	Lifetime of the substation facilities shall be reset by simple replacement work of substatoin equipement.	3	25%	0.75
2	Economic Efficiency	Cost	Impact to the Profitability might be limited at the initial stage because of high initial construction cost.	3	20%	0.60
3	Urgency	Lifetime	Lifetime of the substation facilities is just a rough indicator and the equipment could be utilized longer if needed.	2	25%	0.50
4	Environmental Impact	Environmental protection	Environmental negative impact will be limited since the location of substation facilities remain unchanged and the replacement activity will be held within or in the vicinity of the existing premises.	4	15%	0.60
5	Social Impact	Involuntary resettlement	Involuntary resettlement is not expected since the location of substation facilities remain unchanged.	5	15%	0.75
			Total	17	100%	3.20

[Remark]Evaluation Score: Low1<Average3<High5

7. Evaluation for Prioritization-Project No.4

Project No.: 4
Target Year: 2026
Project: Expansion of 34.5/13.8kV 1 bank 10MVA at Koror Substation
Component: Expansion of 34.5/13.8kV 1 bank 10MVA at Koror Substation
Decommissioning of Airai Substation
Expansion of 34.5/13.8kV 1 bank 10MVA at Malakal Substation (Option)

Main Objective: Improvement of Maintenance Manageability and Countermeasure for future load demand after the period of master plan
Remarks: Lifetime of existing equipment at Airai substation will meet 40-year-old by 2026



No.	Criteria	Contributing Factor	Specific Information	Score	Weight of Criteria	Evaluation Score
1	Technical	N-1 criterion	By satisfying N-1 criterion, power supply for load-center (Koror state) could be more reliable and reliable power supply to the Airai state could be available as well.	5	25%	1.25
2	Economic Efficiency	Cost	Impact to the Profitability might be limited at the initial stage because of high initial construction cost.	3	20%	0.60
3	Urgency	Lifetime	Countermeasure for future load is not an urget issue.	1	25%	0.25
4	Environmental Impact	Environmental protection	Environmental impact should be minimized during decommissioning work.	3	15%	0.45
5	Social Impact	Involuntary resettlement	Environmental impact should also be minimized during decommissioning work.	3	15%	0.45
			Total	15	100%	3.00

[Remark]Evaluation Score: Low1<Average3<High5

8

8. Selection of target project for Pre-feasibility study

Priority	Project	Achievement	Com. ID	Project	Target (MP)	Evaluation Score	Pre-FS Study	Remarks
1	2	Improvement of Power Supply Reliability		**Construction of Koror Substation**	2020	4.30	Yes	Tentative rough cost estimation is approx. 16.9 million USD
			1-3	34.5/13.8kV 1 bank 10MVA				
			1-4	Construction of 13.8kV distribution line (1 feeder)				
				Construction of 34.5kV Transmission Line	2023			
			2-1	Construction of 34.5kV Transmission Line (Malakal – Melekeok)				
			2-2	Expansion of 34.5kV outgoing bay at Malakal Substation				
			3-1	Construction of 34.5kV Transmission Line (Melekeok – Ngaraard 1)	2025			
			3-1	Expansion of 34.5kV feeders at Ngaraard 1 Substation				
2	1	Improvement of Maintenance Manageability		**Improvement of 34.5kV Existing Transmission Line**	2020	4.10	Yes	Tentative rough cost estimation is approx. 13.0 million USD
			1-1	Relocation of 34.5kV Transmission Line (Airai – Ngaraard 2)				
			1-2	Replacement of Ngardmau Substation facilities				
			1-2	Replacement of Ngaraard 1 Substation facilities				
			1-2	Replacement of Ngaraard 2 Substation facilities				
3	3	Countermeasures against aging equipment		**Improvement of the existing Substation facilities**	2026	3.20	No	This is excluded from the Pre-FS Study because of just simple replacement work
			4-1	Replacement of the existing Substation equipment (Almelik substation)				
			4-1	Replacement of the existing Substation equipment (Almelik-1 substation)				
			4-1	Replacement of the existing Substation equipment (Almelik-2 substation)				
			4-1	Replacement of the existing Substation equipment (Nekkeng substation)				
4	4	Improvement of Maintenance Manageability		**Expansion of 34.5/13.8kV 1 bank 10MVA at Koror Substation**	2026	3.00	No	This is excluded from the Pre-FS Study because of non-urgent project
			4-2	Expansion of 34.5/13.8kV 1 bank 10MVA				
			4-2	Decommissioning of Airai Substation				
				Expansion of 34.5/13.8kV 1 bank 10MVA at Malakal Substation (Option)	-			
			2-2	Expansion of 34.5/13.8kV 1 bank 10MVA				

[Remark] Evaluation Score: Low1<Average3<High5
Concerning the Priority 1, cost related to RE roadmap is not included in the estimation

9

Attendance List

Date: April 13, 2018 Location: Palasia Hotel

Purpose: JOINT COORDINATION COMMITTEE

No.	Mr/Ms	Name	Title	Organization	Telephone	E-Mail
1	Mr.	James. M	SCD Mgr	SCD		
2	Mr.	Hilton . H	PDD Manager	PDD		
3	Mr.	Ken. S	RED Manager	RED		
4	MS	Rhea Rengulbai	PRO	PPUC		
5	Mr.	Clarence Kitalong Jr.	PPID	PPID		
6	Mr.	[illegible]	PGD Mgr	PGD		
7	Mr.	[illegible]	Energy Coordinator	DEA		
8	Mr.	Ken Ueohara	Consv.	PNEC		
9	Ms.	Hasintha Idechong	~~A&F~~ CFO	A&F		
* 10	Ms	Ritsuko Kawabe		JICA		
11	Mr.	Tom Carey	ADB	ADB		
12	Ms	Lynna E Thomas	EQPB	Compliance Specialist		
13	Ms	Alfonsa		ADB		
14	Ms.	Roxanne Bleram	Executive Officer	EQPB		
15	Mr	NICK NGIWAL	Chair, PNEC	Pres. office		
16	Mr	CAMERON VANSTEEN	INT. EC FIB	FIB		

Attendance List

Date: April 13, 2018 Location: Palasia Hotel

Purpose: JOINT COORDINATION COMMITTEE

No.	Mr/Ms	Name	Title	Organization	Telephone	E-Mail
1	Mr	Ellaen Elly	CI.	FZB		
2	Mr	Norbert Villanueva	~~NDBP~~	NDBP		
3	Mr	Anthony Pundmah	D'	PPUC		
4	Ms	Sasha Limon	RED A.D	PPUC		
5	Mr	Keoni Isechal	CEO	PPUC		
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様式4－3 要員計画

調 査 人 月 表

		担当	氏名	所属	格付	2017年度 6	7	8	9	10	11	12	1	2	3	2018年度 4	5	6	7	8	9	10	11	12	1	2	3	2019年度 4	5	人・月 2017年度 現地	2017年度 国内	2018年度 現地	2018年度 国内	計 現地	計 国内
現地業務	◎	総括／系統計画	西川 光久	yec	2		(16) 8 23		(18) 16 1		(16) 18 3					(16) 31 15							(12)				(12)				1.60		0.93		2.53	
																														1.60		0.93		2.53	
	◎	副総括／再生可能エネルギー統合／系統安定化	小林 正樹	KEPCO	3		(21) 9 29		(18) 20 7		(7) 26 2					(21) 25 14		(11)			(10)		(14)							1.53		1.87		3.40	
																														1.53		2.10		3.63	
		電力需要予測	井上友幸	yec（補強）	3		(16) 8 23		(16) 16 1							(16) 3 18														1.07		0.53		1.60	
	◎	系統解析	木下 信行	yec（補強）	3		(23) 8 30		(23) 16 8			(23) 25 17				(16) 31 15														2.30		0.53		2.83	
		系統解析補助	近藤和晃	yec	自社負担		(23) 18 9		(23) 16 8			(23) 25 17				(16) 31 15														-		-		-	
	◎	送配電設備	田村 立博	KEPCO	3				(11) 12 22			(23) 18 10				(21) 25 14		(16)	(16)		(17)		(14)							1.13		2.80		3.93	
																														1.13		3.03		4.16	
		送配電運用維持管理	元治晨	KEPCO	4				(18) 12 29			(21) 19 9				(21) 25 14		(14)			(14)		(14)							1.30		2.10		3.40	
																														1.30		2.33		3.63	
		変電設備	阿部真	yec	3		(16) 8 23			(27) 19 15		(23) 11 3				(23) 20 11			(16)			(15)		(12)			(12)			2.20		2.20		4.40	
																														2.20		2.20		4.40	
		変電設備維持管理（前任）	冬木喬也	KEPCO	4					(11) 4 14		(20) 20 9				(8) 22 29														1.30		0.00		1.30	
		変電設備維持管理（後任）	小西和樹	KEPCO	4											(15) 24 7			(20)			(17)		(14)								2.20		2.20	
																															2.43		2.43	
		-	松岡幸三	KEPCO	自社負担											(8) 24 31														0.27		0.00		0.27	
		経済・財務分析	長曽香之	yec	3				(19) 16 4			(9) 9 17				(30) 24 22														0.93		1.00		1.93	
		環境社会配慮	杉田昌也	yec	4		(16) 18 2			(16) 10 25		(16) 25 10				(16) 31 15														1.60		0.53		2.13	
		業務調整／系統計画補助	岸亘矢	yec	自社負担		(23) 8 30		(30) 12 11			(30) 18 17				(30) 24 22																			
																											(12)			0.40					
報告書提出時期						▲業務計画書、インセプションレポート						▲プログレスレポート1				▲プログレスレポート2						▲ドラフト・ファイナルレポート		▲ファイナルレポート		▲ドラフトファイナルレポート		ファイナルレポート		23.00	2.90	28.12	0.45	50.70	3.35
																														25.90		28.57		54.05	
																																		業務指示書	33.00

yec 八千代エンジニヤリング株式会社　KEPCO：関西電力株式会社

<凡例> ■：現地業務 □：国内作業 □：自社負担 ◎：評価対象

評価対象	23.00
評価対象（指示書）	16.60

Date: 13 April 2018

Technical Transfer Items

Person in charge	Items		Status	Notes
M-Kobayashi	Calculation of allowable amount of Renewable Energy			
	(1) Short-term	Algebraic method	On going	
	(2) Long-term	Demand-supply balance simulation (including how to use HOMER-Pro)	On going	
T-Genji	Maintenance of Transmission & Distribution lines			
	(1) Tree trimming management		On going	
	(2) Facility maintenance & Management Technology		On going	
K-Konishi	Substation System Maintenance PDCA cycle based on the Patrol			
	(1) Formulating Patrol Plan		On going	
	(2) Practicing Patrol		On going	
	(3) Formulating replacement and repair Plans		On going	
	(4) Patrol checklist & recording sheet		On going	
	(5) Accident & failure report		On going	
	(6) Fault calculation		Additional	
T-Inoue	Palau Power Demand Forecasting Seminar			
	(1) Trend Analysis		Finish	
	(2) Preconditions for the Forecasting		Finish	
	(3) Structure of the Model		Finish	
	(4) How to use Simple E		Finish	
	(5) Power Demand Forecasting Model		Finish	