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

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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.

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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.

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

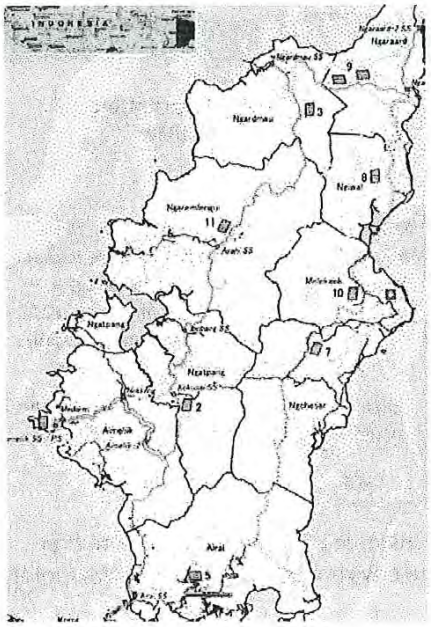
- Collecting the opinions of public and private stakeholders

(3) Reflecting stakeholders' opinions to the MP

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

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 (Koburai)	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.

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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.

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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.

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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.

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

Year	Item	Outline
	Improvement of 34.5kV Nekken feeder	Relocation of 34.5kV Transmission Line (Aimeliik – Ngaraard 2)
2020	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.

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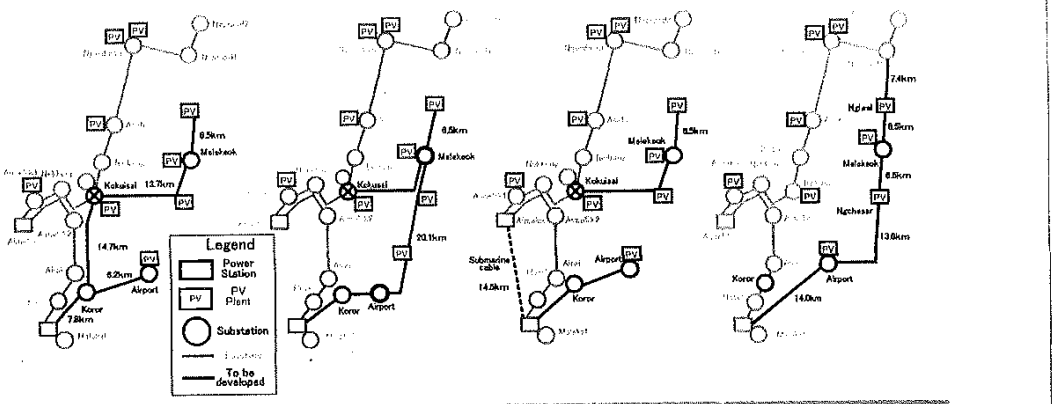
1 (2) 2) Alternatives of T&D network development



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.

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

	Scoping items	Construction phase: Expansion	Construction phase: Relocation	Construction phase: Rehabilitation	Operation phase: Expansion	Operation phase: Relocation	Operation phase: 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.

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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.

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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.

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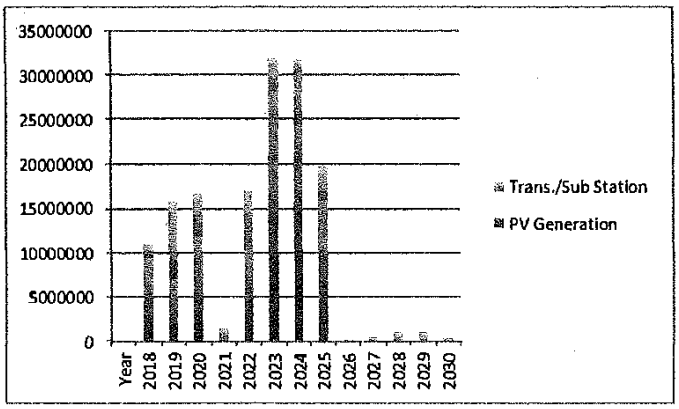
ECONOMIC ANALYSIS OF MASTER PLAN

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

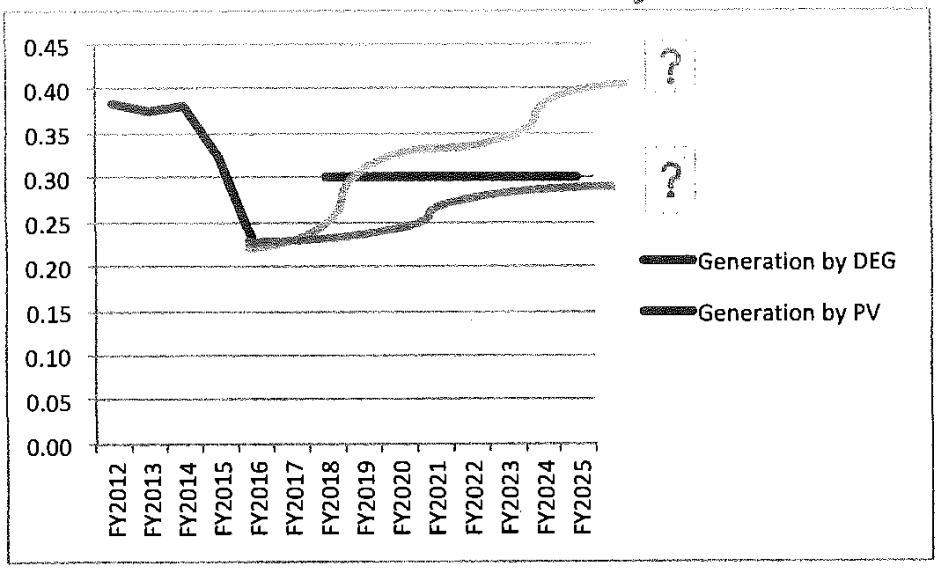
Cost of Generation

- 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

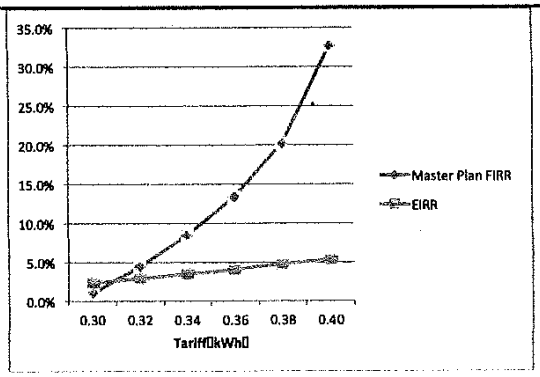
Source: Study Team based of PPUC data

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%



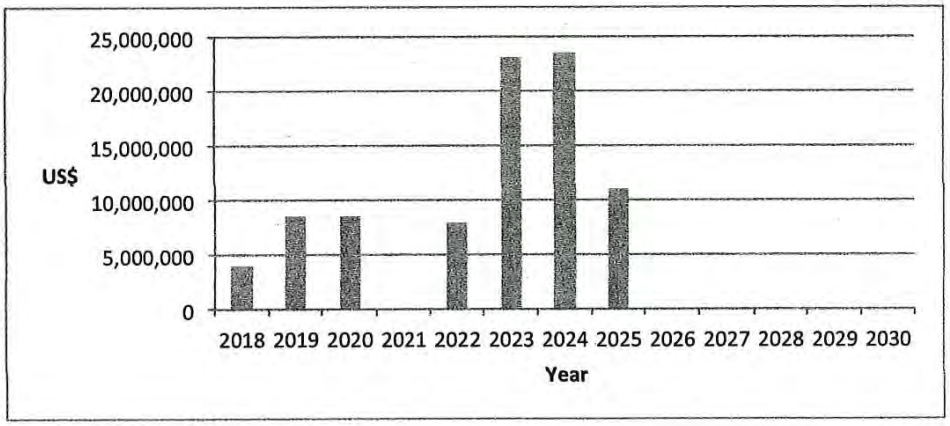
Financing Plan (1)

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

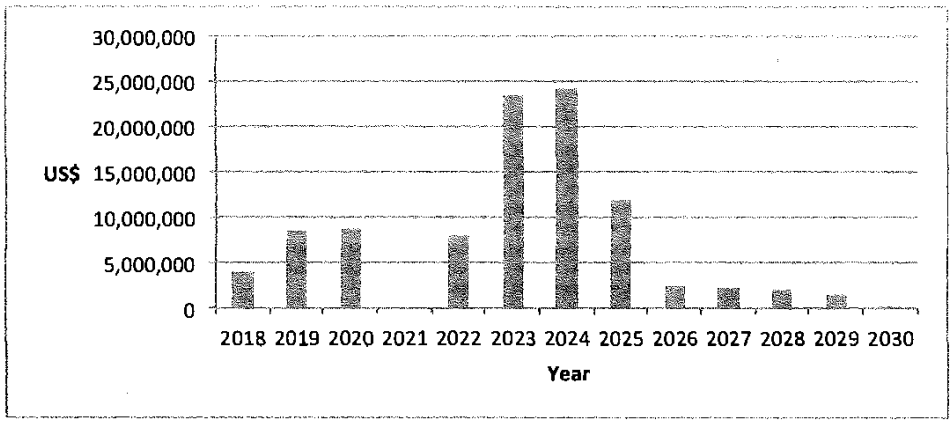
Financing Plan (1)

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



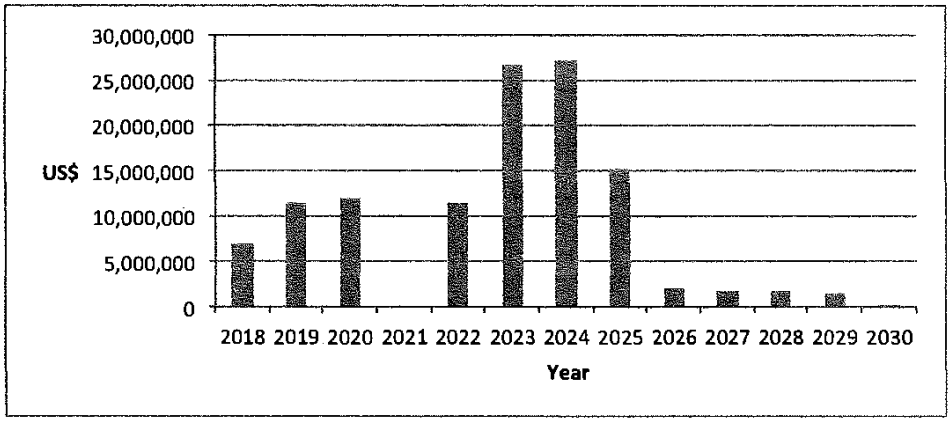
Financing Plan (2)

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



Financing Plan (3)

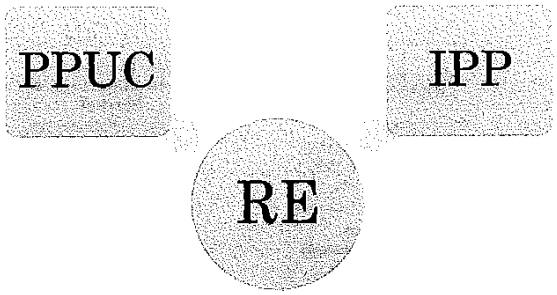
US$0.30kwh, Debt Ratio 30%, Interest 3.0%



If IPPs enter in PV (1)

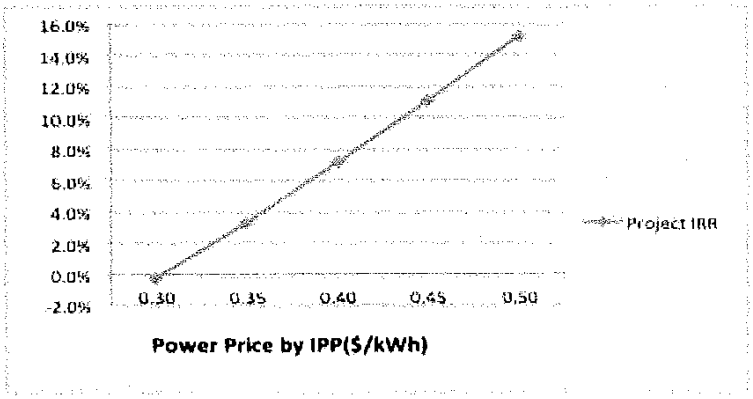
RE Development will be shared between PPUC and IPP.

- IPP will wholesale PV power to PPUC



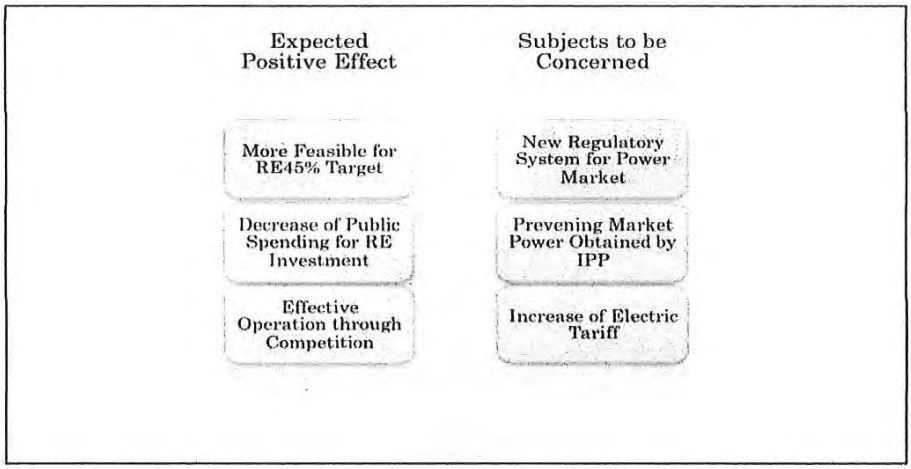
If IPPs enter in PV (2)

- 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)

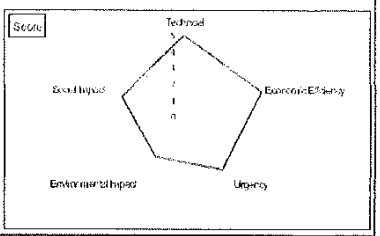
TARGET OF PRE-FEASIBILITY STUDY

APRIL 13TH, 2018
JICA STUDY TEAM

Contents

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



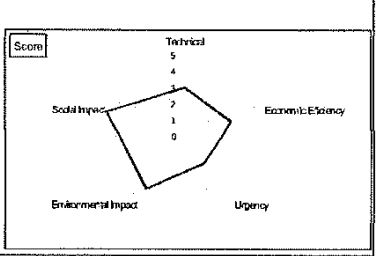
No.	Criteria	Contributing Factor	Specific Information	Score	Weight of Criteria	Evaluation Score
1	Technical	N-1 criterion	By satisfying N-1 criterion, power supply from either Malakal or Aimeliik power plant shall be available in case of fault on the 34.5kV transmission line.	5	25%	1.25
2	Economic Efficiency	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



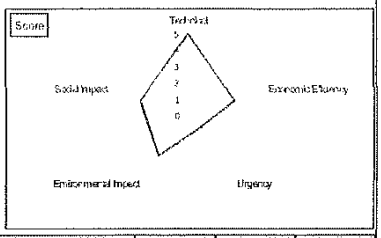
No.	Criteria	Contributing Factor	Specific Information	Score	Weight of Criteria	Evaluation Score
1	Technical	Lifetime	Lifetime of the substation facilities shall be reset by simple replacement work of substatoin equipement.	3	25%	0.75
2	Economic Efficiency	Cost	Impact to the Profitability might be limited 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. 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

Attendance List

Date: April 13, 2018 Location: Palacia 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.	Ker. S	RED Manager	RED		
4	Ms	Rhea Rengulbai	PRO	PPUC		
5	Mr.	Clarence Kitalong J.	PPID	PPID		
6	Mr.	Otto Ertmungam	PGD Mgr	PGD		
7	Mr.	Tatsuo Ueda	Energy Coordinator	DEA		
8	Mr.	Ken Uechara	Gov.	PNES		
9	Ms.	Hasinta Idechong	~~A&F~~ CFO	A&F		
* 10	Ms	Ritsuko Yamada		JICA		
11	Mr.	Tara Cruz	AOB	AOB		
12	Ms	Lynna E Thomas	EQPB	Compliance Specialist		
13	Ms	Alfonsa		ADB		
14	Ms.	Roxanne Bleskan	Executive officer	EQPB		
15	Mr	Nick Ngwa	Chair PNEC	Proj. office		
16	Mr	Cameron Van [illegible]	Int. ED 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	Ellen Billy	CI	FZB		
2	Mr	Norbert Villanueva	NDBP	NDBP		
3	Mr	Anthony Rudimeh	P'	PPUC		
4	Ms	Sasha Linow	RED A.D	PPUC		
5	Mr	Kenni Isechal	CEO	PPUC		
6						
7						
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14						
15						
16						

様式4－3 要員計画

調 査 人 月 表

		担当	氏名	所属	格付	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	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	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	1.07		0.53		1.60	
	◎	系統解析	木下 信行	yec（補強）	3	2.30		0.53		2.83	
		系統解析補助	近藤和晃	yec	自社負担	-		-		-	
	◎	送配電設備	田村 立博	KEPCO	3	1.13		2.80		3.93	
						1.13		3.03		4.16	
		送配電運用維持管理	元治義	KEPCO	4	1.30		2.10		3.40	
						1.30		2.33		3.63	
		変電設備	阿部真	yec	3	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	1.30		0.00		1.30	
		変電設備維持管理（後任）	小西和樹	KEPCO	4			2.20		2.20	
								2.43		2.43	
		-	松岡幸三	KEPCO	自社負担	0.27		0.00		0.27	
		経済・財務分析	長曽香之	yec	3	0.93		1.00		1.93	
		環境社会配慮	杉田昌也	yec	4	1.60		0.53		2.13	
		業務調整／系統計画補助	岸亘矢	yec	自社負担						
								0.40			
						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

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　ファイナルレポート

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	

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
(Explanation of Draft Final Report)

At the last stage of the implementation of the Project for Study on Upgrading and Maintenance Improvement of National Power Grid in the Republic of Palau (hereinafter referred to as "the Project"), 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") submitted ten (10) copies of Draft Final Report of the Project (hereinafter referred to as "DFR") to Palau Public Utilities Corporation (hereinafter referred to as "PPUC") on March 07th 2019 and conducted 2nd Joint Coordination Committee meeting (hereinafter referred to as "JCC") with PPUC on March 13th 2019, in order to explain main contents of the DFR to the parties concerned of Palauan side.

The main contents of DFR explained on 2nd JCC meeting are attached in the Appendix-2.

Koror, Palau, 14th March, 2019

Mr. Mitsuhisa Nishikawa
Team Leader
JICA Study Team
Japan International Cooperation Agency (JICA)

Mr. Ngiratmetuchel R. Belechl
Acting Chief Executive Officer
Palau Public Utilities Corporation (PPUC)
The Republic of Palau

Mr. Yoshikazu Tachihara
Resident Representative
JICA PALAU Office

ATTACHMENT

1 Explanation of the Draft Final Report (DFR) on JCC meeting

The Program of JCC meeting is attached on Appendix-1 and Explanation materials (the Power-Point slides) are attached on Appendix-2.

Main contents explained on JCC meeting are as follows:

(1) Pre-conditions and the Forecasted results of the Power demand up year 2030.
(2) Updated of Renewable Energy Roadmap.
(3) Summary of Power transmission and distribution Planning.
(4) Substation planning and Summary of facility planning
(5) Environmental and Social Considerations
(6) Financial and Economic Analysis including Summary of IPP introduction analysis
(7) Maintenance of Transmission, Distribution and Substation Equipment
(8) Outcomes of the Technology Transfer by Power to Distribution Division (PDD), System Control Division (SCD) and Renewable Energy Division (RED).
(9) Target of Pre-feasibility Study and Project package

2 List of participants to JCC meeting is attached on Appendix-3

3 Additional Questions to DFR and JCC meeting

(1) PPUC agreed to send, collectively, additional questions and comments to DFR and/or JCC meeting, by e-mail to the Study Team (to Mr. Mitsuhisa NISHIKAWA (E-mail: nishikawa@yachiyo-eng.co.jp)) until April 10th 2019.
(2) After receiving questions and comments above, the Study Team will examine and study them under the consultation by JICA headquarters / JICA Palau Office, and the results will be reflected on the Final Report.

4 Submission of the Final Report

(1) Fifteen (15) copies of the Final report, reflected the study results of the PPUC questions and comments, will be submitted to JICA headquarters by May 10th 2019.
(2) Submission of the Final Report to PPUC will be conducted through JICA Palau Office on the middle of June 2019.

- End -

Appendix List

Appendix-1: The Program of JCC meeting
Appendix-2: Explanation materials (the Power-Point slides) for JCC meeting.
Appendix-3: List of participants to JCC meeting

Appendix - 1

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: PALAU ROYAL RESORT, MALAKAL, PALAU
DATE: 13TH MARCH, 2019.

Time	Event/Activity	Action by
09:00-09:05	Opening Remarks	Representative from PPUC
09:05-09:10	Introduction	Self-introduction of all participants
09:10-09:20	Key Note Address	Resident Representative of JICA Palau Office
----------	Draft Final Report	----------
09:20-09:30	Power Demand Forecast	Mr. Mitsuhisa Nishikawa on behalf of Mr. Tomoyuki Inoue
09:30-09:40	Renewable Energy Roadmap	Mr. Ryosuke Ishii
09:40-09:50	Power Transmission and Distribution line	Mr. Tatsuhiro Tamura
09:50-10:00	Substation Planning & Summary of Facility Planning	Mr. Makoto Abe
10:00-10:10	Environmental and Social Considerations	Mr. Yoshiyuki Choso on behalf of Mr. Masaya Sugita
10:10-10:25	Questions and Answers	All
10:25-10:35	Coffee break	All
10:35-10:45	Economic Analysis of Master Plan	Mr. Yoshiyuki Choso
10:45-10:55	Target of Pre-feasibility Study and Project package	Mr. Makoto Abe
----------	Technical Transfer	----------
10:55-11:05	Outcome of the Technical Transfer Renewable Energy (RED)	Mr. Sherwin Wasai
11:05-11:15	Maintenance of Transmission and Distribution Equipment	Mr. Tatsuhiro Tamura
11:15-11:25	Outcome of the Technical Transfer Power Distribution Division (PDD)	Mr. Robert Patris
11:25-11:35	Maintenance of Substation Equipment	Mr. Kazuki Konishi
11:35-11:45	Outcome of the Technology Transfer System Control Division (SCD)	Mr. James Mengeolt
11:45-11:55	Questions and Answers	All
11:55-12:00	Closing Remarks	Representative from PPUC

Appendix – 2

EXPLANATION SHEETS FOR JCC MEETING

CONTENTS

Upgrading and Maintenance of National Power Grid in Palau

1

Power Demand Forecasts and Evaluation

Contents

March 2019

1. Preconditions for the model building

2

(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
Airiai(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	12,061	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	18,288	17,661	17,927	18,197	18,471	18,750	19,033

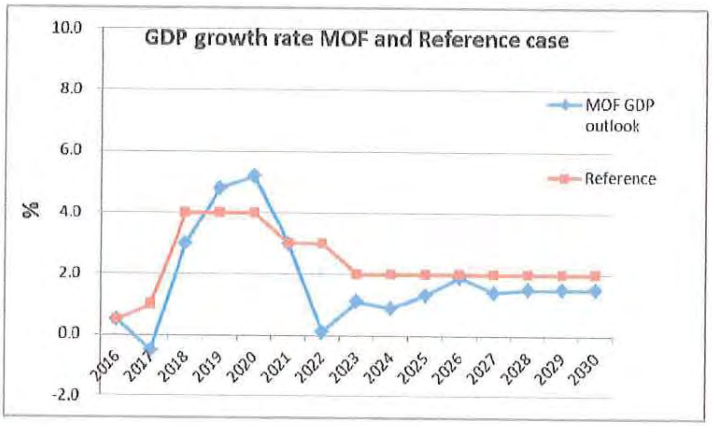
- The state population are forecasted under considering regional investment schedules.
- Future country population is estimated by MOF. The increase rate is 0.3 % per year.
- The state population are forecasted by elasticity to the increase rate of the country population

(2) GDP growth rate as Reference case

3

< 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

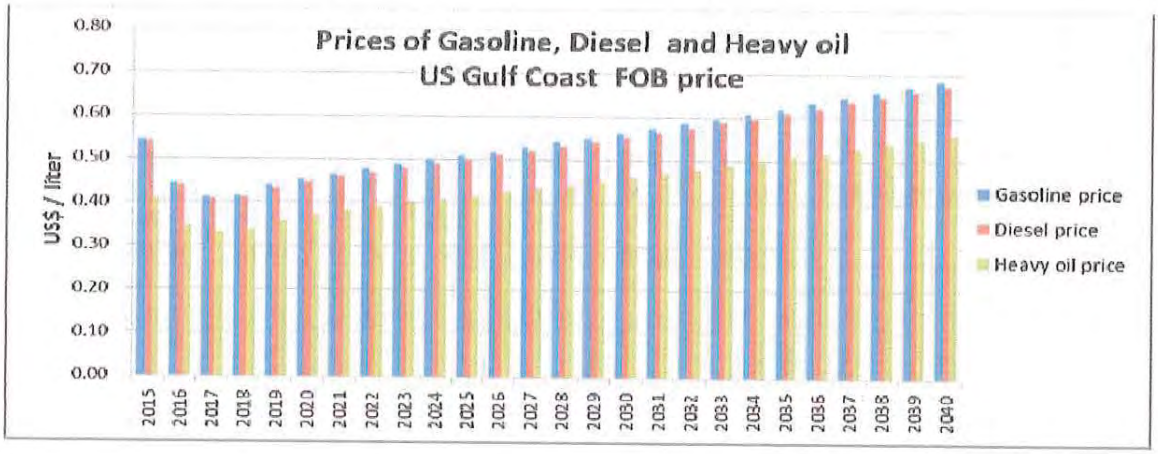


(3) Crude oil and Fuel prices for estimating power tariffs

4

	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 (EE&C) factors

5

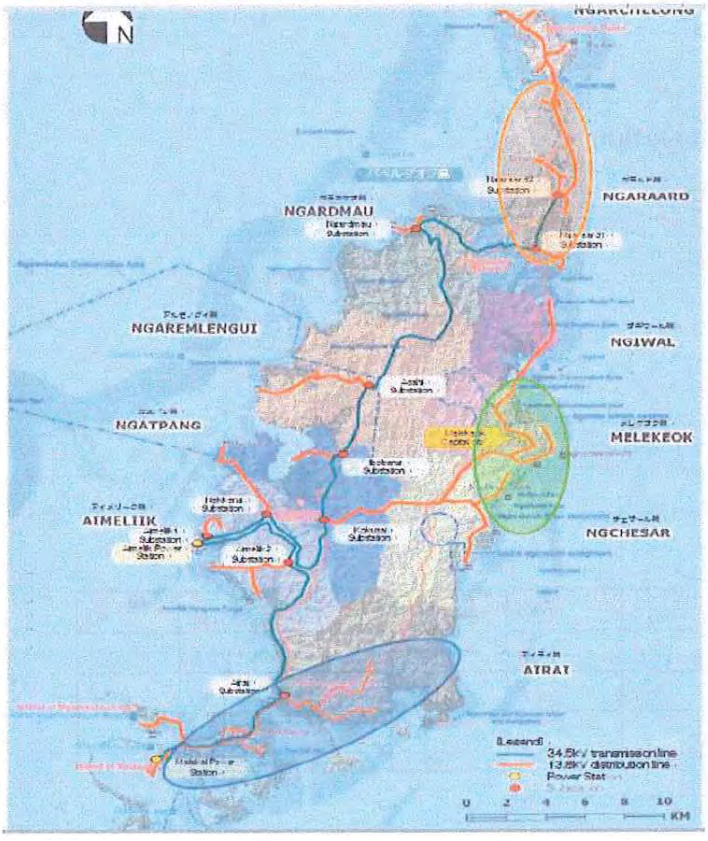
Sector	Items	Unit	2017	2018	2019	2020	2025	2030	2035	2040
Commercial	EE&C rate	Saving%	0.0	0.5	0.5	0.5	1.0	1.0	1.0	1.0
	EE&C Indicator	2017=100	100.0	99.5	99.0	98.5	96.1	91.4	86.9	82.6
Gov. & Public	EE&C rate	Saving%	0.0	0.5	0.5	0.5	1.0	1.0	1.0	1.0
	EE&C Indicator	2017=100	100.0	99.5	99.0	98.5	96.1	91.4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

6



- 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

7

◆ 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

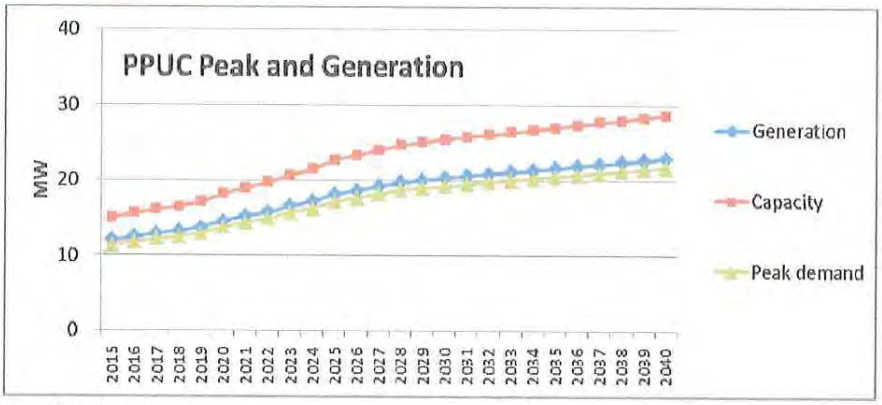
Unit: kW

	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

2. Results of PPUC Power Demand

8

(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
Peak Generation	12.5	12.9	13.7	14.6	18.2	20.3	21.6	23.0
Required Equipment Capacity	15.6	16.1	17.1	18.2	22.7	25.4	27.0	28.7

(2) Annual power and peak demands

9

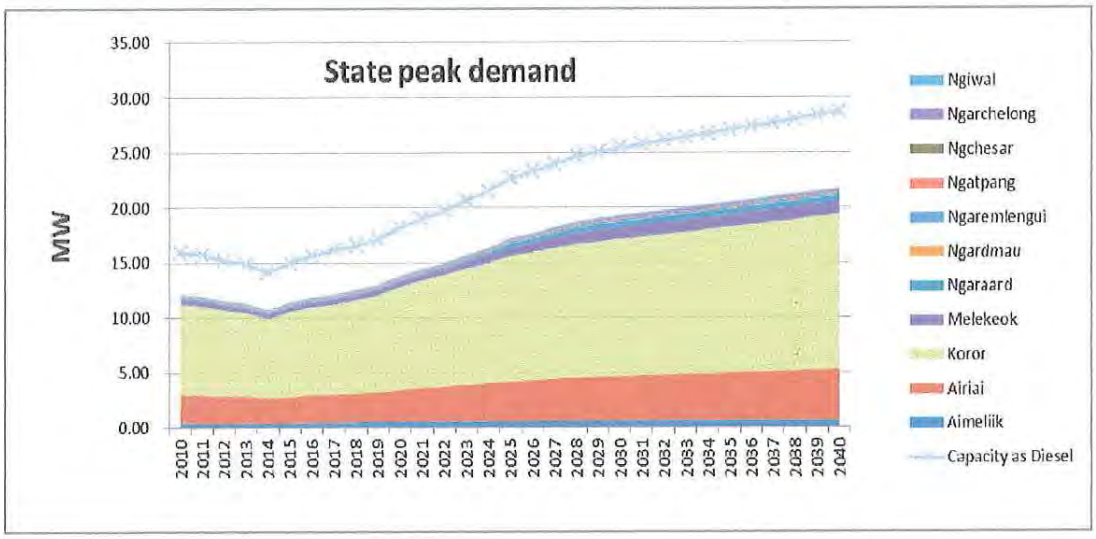
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Gross generation	MWh	83,430	84,870	88,020	91,290	96,880	100,210	102,920	106,920	110,040	115,110
Load factor	%	76.3	76.0	76.0	76.0	76.0	75.2	74.5	73.7	73.0	72.3
Reserve margin	%	20	20	20	20	20	20	20	20	20	20
Required capacity	kW	15,610	16,130	16,530	17,140	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

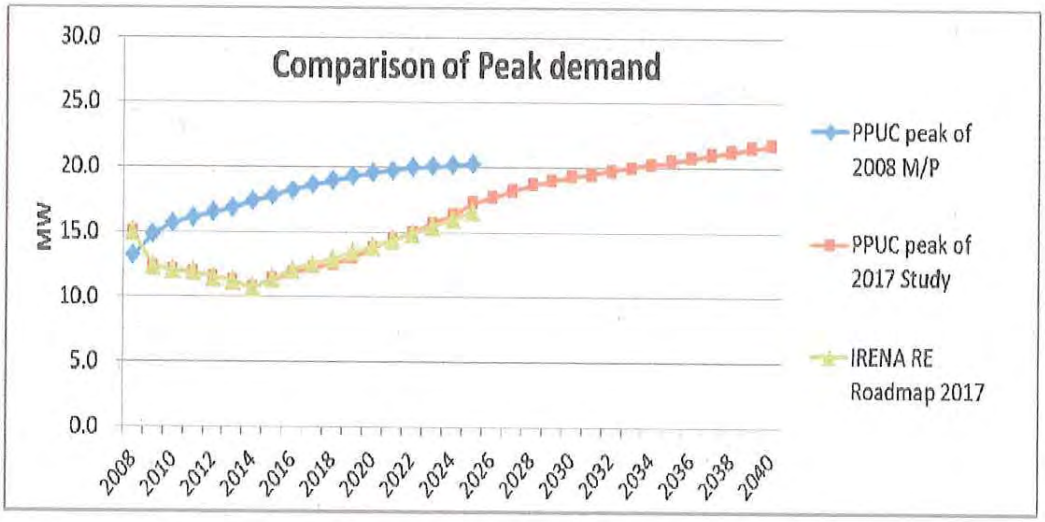
10



Source: Study team

3. Comparison of power Demands

(1) Comparison of IRENA 2017, M/P 2008 and Study team 2018



Japan International Cooperation Agency

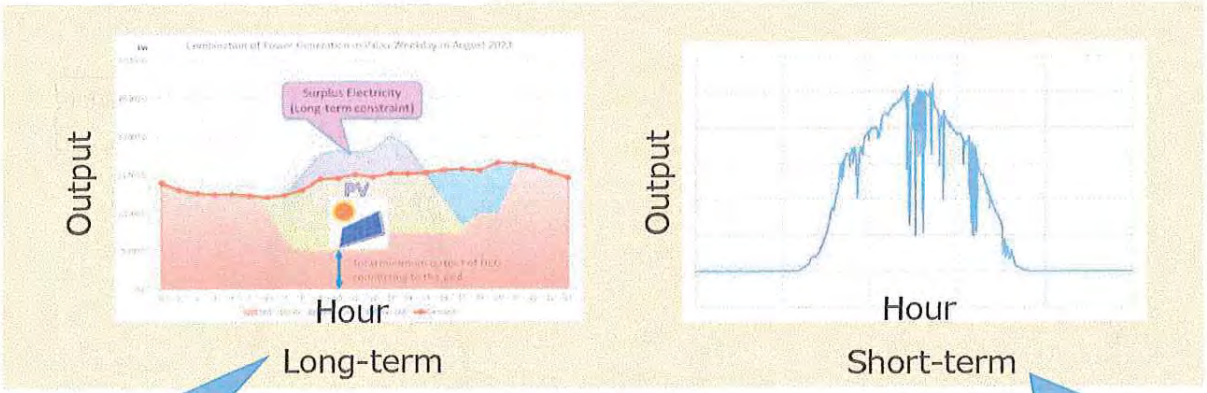
YACHIYO ENGINEERING CO.,LTD.
Consulting Engineers & Architects

Kansai Electric Power

Renewable Energy Roadmap

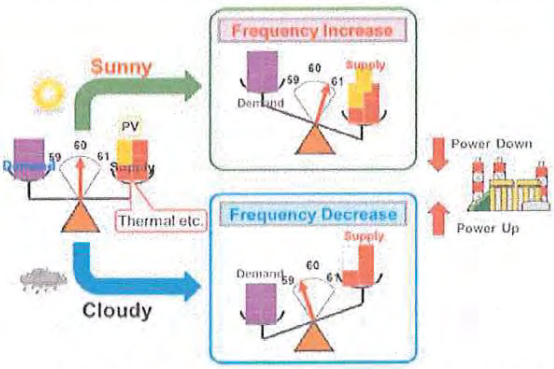
13 March 2019

Characteristics of Renewable Energy



Demand supply balance simulation

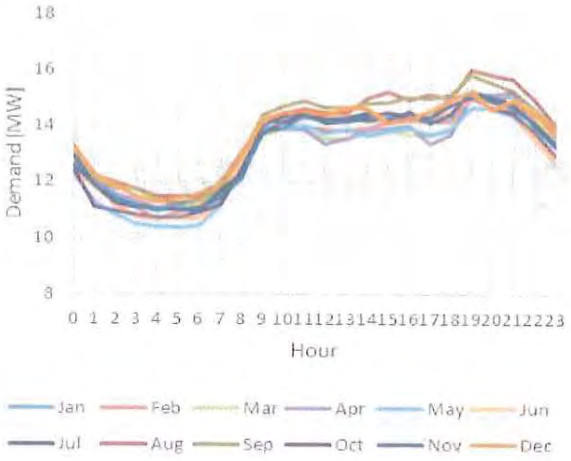
Algebraic Method



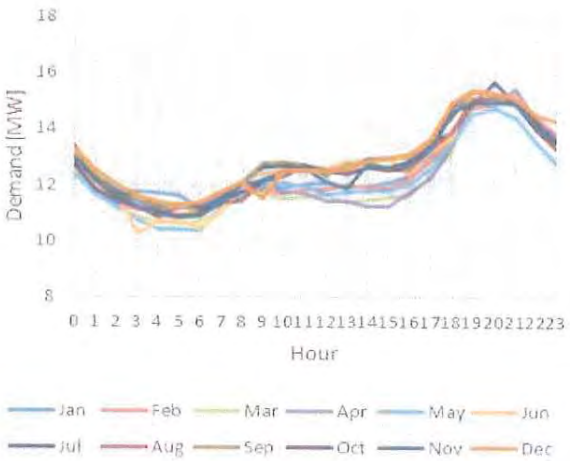
A battery system is required for absorbing fluctuation caused by PV output.

Demand Curve

3



Weekday in 2025

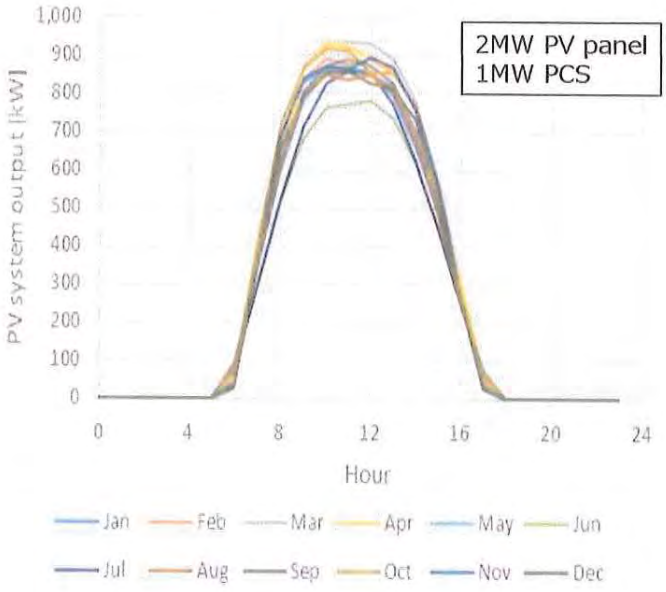


Weekend in 2025

PV Output Curve

4

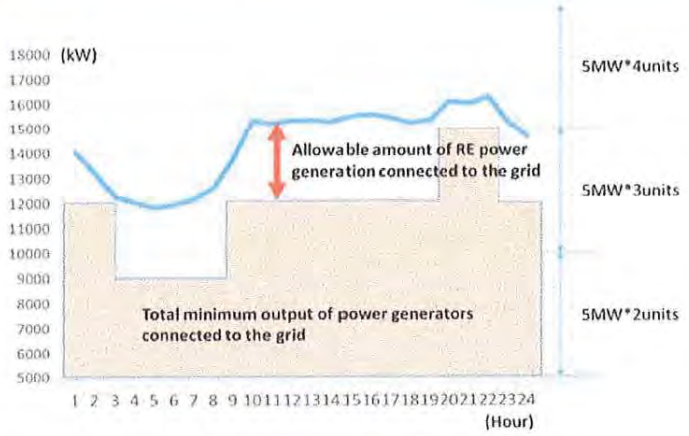
PVWatts calculator produced by the National Renewable Energy Laboratory



Average output of a PV system for each month

Operation on Diesel Engine Generator

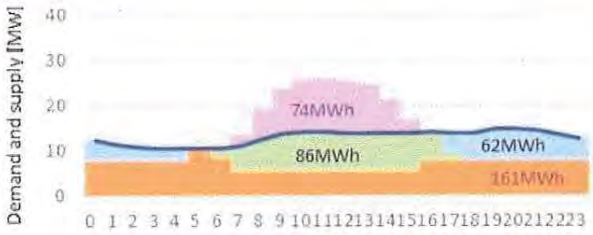
5



- Number of DEG to be operated is set as amount of demand divided by the rated power of DEG.
- DEGs are operated at allowable minimum output basically, in order to consume the PV energy as much as possible.
- Under above conditions, RE fraction is calculated to be 41%, which is lower than the target values of 45%.
- Therefore, one unit of DEG is forced to stop for appropriate time.

Example of Demand and Supply Balance Simulation

6



Necessary capacity of Battery: 74MWh
(62MWh + 12MWh of charge-discharge loss)

Weekday on May 2025

Necessary capacity of Battery: **78MWh**
(65MWh + 13MWh of charge-discharge loss)

Weekend on May 2025

- In this case, amount of PV panel of PV power stations is set to be 44 MW.
- The result of RE fraction in May 2025 is calculated to be 47%.
- Necessary capacity of battery is 14 MW and 78 MWh.
- Necessary capacity of PCS for the battery is calculated to be 14 MW .

Example of Summary

7

Input	
Rooftop pannel	3,000 kW
PV Station pannel	44,000 kW
Target of PV Fraction	45 %

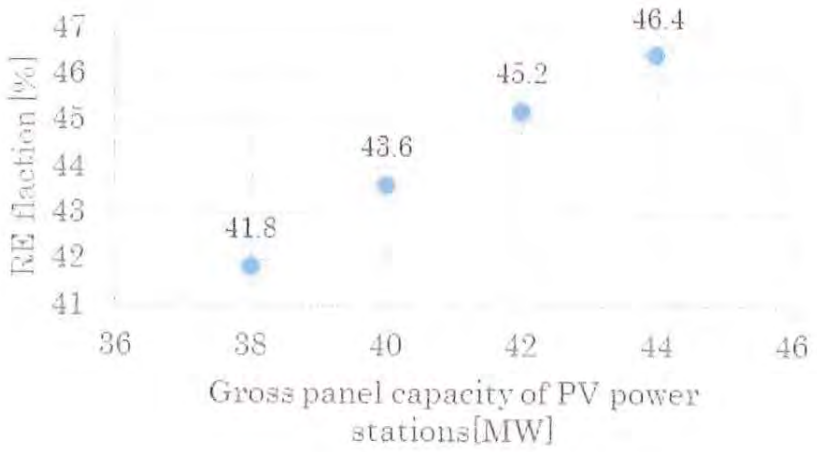
Output (WeekDay)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Power Supply		Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough
Monthly PV Fraction (%)		46	49	48	48	48	43	44	44	46	49	48	46
Battery (MW)	14 MW	12	12	14	13	12	9	11	11	11	13	12	11
Battery (MWh)	83 MWh	73	83	79	78	74	55	62	72	72	81	82	72
Days		22	20	23	20	23	22	21	23	21	22	22	21
Demand (MWh/Year)	83,296	7,082	6,362	7,279	6,344	7,098	6,982	6,714	7,661	6,954	6,942	7,025	6,853
DEG (MWh/year)	44,559	3,817	3,259	3,795	3,300	3,696	4,008	3,766	4,274	3,772	3,520	3,621	3,731
PV (MWh/Year)	38,737	3,265	3,103	3,484	3,044	3,402	2,974	2,948	3,388	3,182	3,422	3,404	3,122

Output (WeekEnd)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Power Supply		Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough	Supply Enough
Monthly PV Fraction (%)		47	47	45	46	46	44	45	47	47	46	47	47
Battery (MW)	16 MW	14	14	16	15	14	11	13	13	13	15	14	13
Battery (MWh)	87 MWh	87	85	76	81	78	68	74	81	81	80	86	87
Days		9	8	8	10	8	8	10	8	9	9	8	10
Demand (MWh/Year)	31,814	2,735	2,395	2,339	2,973	2,334	2,429	3,093	2,433	2,785	2,751	2,432	3,118
DEG (MWh/year)	17,164	1,463	1,280	1,280	1,600	1,260	1,365	1,709	1,300	1,485	1,485	1,280	1,658
PV (MWh/Year)	14,650	1,272	1,115	1,059	1,373	1,074	1,064	1,383	1,133	1,300	1,266	1,152	1,461

Total	
Demand	115,110 MWh/year
DEG	61,723 MWh/year
PV	53,387 MWh/year
DG+PV	115,110 MWh/year
DEG fraction	53.6 %
PV fraction	46.4 %
Battery	16 MW
Margin for Battery	5.0 %
Battery	92 MWh

Relationship between Panel capacity and RE fraction

8



In order to achieve 45% fraction in 2025, 44 MW (42MW + 2MW of margin) of panel capacity is required for PV power station.

RE Road Map

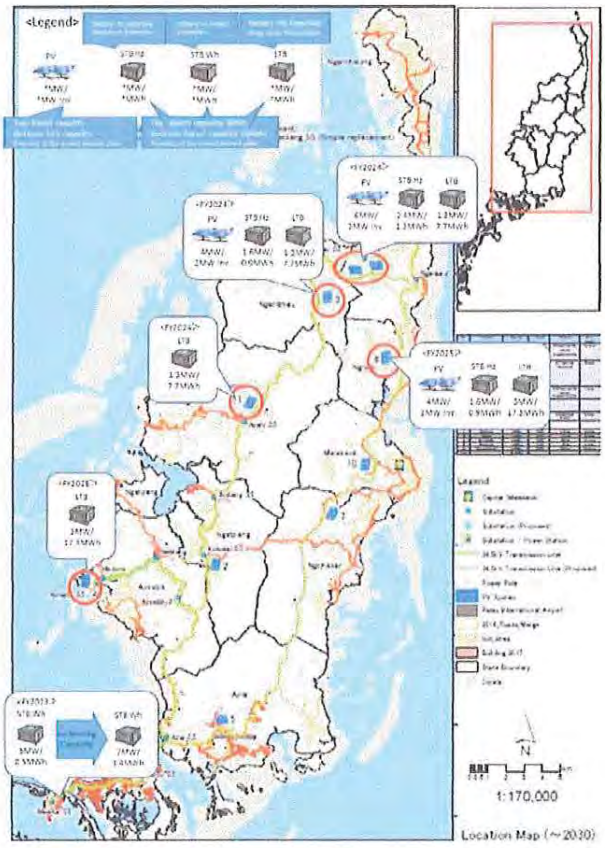
9

			2019	2020	2021	2022	2023	2024	2025	Last report	Difference
PV power station											
	Panel	kW	10,000	16,000	16,000	22,000	30,000	40,000	44,000	44,000	0%
	PCS	kW	5,000	8,000	8,000	11,000	15,000	20,000	22,000	22,000	0%
Battery system for absorbing long-term fluctuation											
	Battery	kW	-	-	-	-	6,000	10,000	16,000	22,000	-27%
	Battery	kWh	-	-	-	-	34,500	57,500	92,000	92,400	0%
	PCS	kW	-	-	-	-	6,000	10,000	16,000	22,000	-27%
Battery system for absorbing short-term fluctuation											
	Battery	kW	4,000	6,400	6,400	8,800	12,000	16,000	17,600	21,000	-16%
	Battery	kWh	2,300	3,500	3,500	4,800	6,500	8,600	9,400	10,500	-10%
	PCS	kW	4,000	6,400	6,400	8,800	12,000	16,000	17,600	21,000	-16%
Battery system against poweroutage											
	Battery	kW	-	5,000	5,000	5,000	7,000	7,000	7,000	7,000	0%
	Battery	kWh	-	500	500	500	1,400	1,400	1,400	1,400	0%
	PCS	kW	-	5,000	5,000	5,000	7,000	7,000	7,000	7,000	0%

- Calculation method for the **capacity (kW) of the battery** system for absorbing **long-term fluctuation**
  - In last report, the capacity (kW) was set to be equal to that of PCS of PV power station, simply.
  - The capacity has been **revised by the results of supply and demand balance simulation**.
- Calculation method for the **capacity (kW) and (kWh) of the battery** system for absorbing **short-term fluctuation** is calculated as below.
  - In last report, the capacity (kW) was set to be equal to that of PCS of PV power station and the capacity (kWh) was calculated to be the capacity (kW) x 0.5 (h), simply.
  - The capacity has been **revised by the results of Algebraic method**.

Tentative site locations for PV power station

10



The battery capacities for absorbing fluctuations have been revised by the results of detail study.

However, other elements as well as the tentative site locations are not changed.

Thank you for your attention.

1

Power Transmission and Distribution line Planning

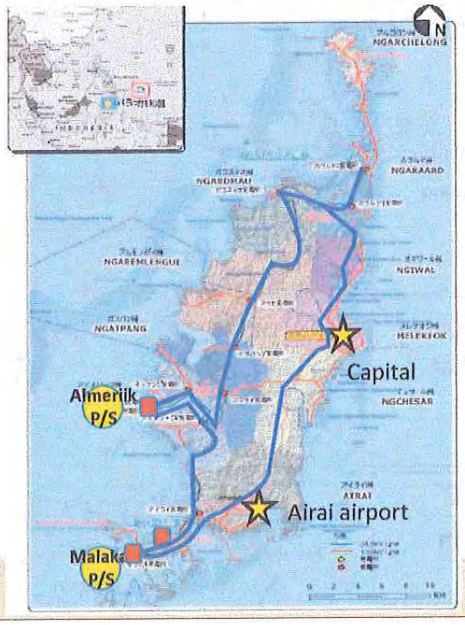
The Kansai Electric Power Co., Inc.

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

2

Existing form

Final form(Master plan)



The Kansai Electric Power Co., Inc.

Power Equipment planning

3

The points considered in planning

(1) Transmission line

- Expansion of T/L to form the master plan network
- Improvement of existing T/L

(2) Distribution line

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

Power equipment planning(Outline of the result)

4

【1】 Expansion
Construction of New T/L
(T/L 48km)

【2】 Improvement
Relocation of existing T/L (near COMPACT road)
(T/L 45km,D/L 6km,S/S 3unit)

【3】 Improvement
Separation of Double circuit of existing T/L (Aimeriik P/S to Nekken S/S)(T/L 9km)

【4】 Expansion
Construction of New D/L from Koror S/S (D/L 2km)

*length of line(km) indicated here is total of new construction and relocation

- Power station: P/S
- Major Substation:
- 34.5kV line(Existing)
- 34.5kV line(New)
- 34.5kV line(Relocate)
- 13.8kV line

【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=48km)**

- 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 45km (with insulated conductor), D/L 6km, S/S 3units**

The old road where land slipped

Line in the bush

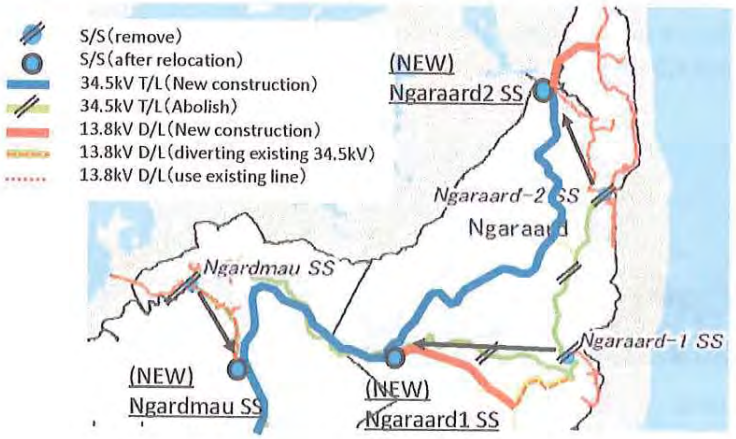
Line on the hill

【2】 Relocation of existing T/L

7

Accompanied with the relocation of transmission line, **existing three Substation needs to be relocated** to the place near the COMPACT road

Nekken T/L(North area)



【3】 Separation of double-circuit section

8

(Aimeriik power plant - Nekken substation)

- Present Situation :
  Two transmission lines from Aimeriik Power Plant are mounted on a pole in this section

- Risk of this section:
  - Risk at pole damage:
    Two lines will stop until restoration.
  - Restrictions on maintenance:
    Two lines has to be stopped during maintenance work

→ To address the situation, separation of Double circuit is planned
  - Construction of a new pole route on the same road
  - Replacement of one circuit to the new pole route

- **Construction volume: T/L 9km**

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

9

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.

- **Construction length: D/L 2km**

2) For other substations

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

Thank you

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

MARCH 13TH, 2019
JICA STUDY TEAM

Contents

1. Facility Planning for the Master Plan (Step)

- **Target Year**
  - Master Plan: 2025
  - Facility planning is introduced in 3 steps in line with the RE roadmap

RE roadmap		Step for facility plan
Phase1	2020	1
Phase2	2021 to 2023	2
Phase3	2024 to 2025	3
-	After 2025	Option

2. Concept for Substation Facility Planning

- **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 from RE roadmap
- **Option**
  - Countermeasures for Aging Substation Facilities
  - Countermeasures for more reliable power supply and to ensure maintenance manageability (N-1 contingency)

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.

No.	Name	Year of Operation	Transformer Ratio (kV)	Main Transformer	Total Capacity (kVA)	Connection
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	Medorm	1986	34.5/13.8	Three-Phase 1000 kVA×1	1,000	Δ-Y
4	Mongami	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

➢ As for countermeasures against aging Airai substation facilities, three ideas were considered to determine more reliable power supply for the load center (Koror state(67.4% of the country as of now)).

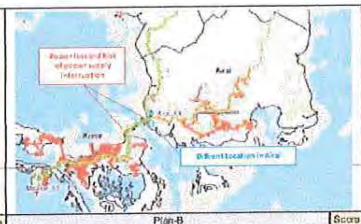
- Ideas (See Considerations (Summary))

➢ PLAN-A Improvement of existing Airai substation

➢ PLAN-B Renewal of the Airai substation

➢ PLAN-C Construction of New Koror substation

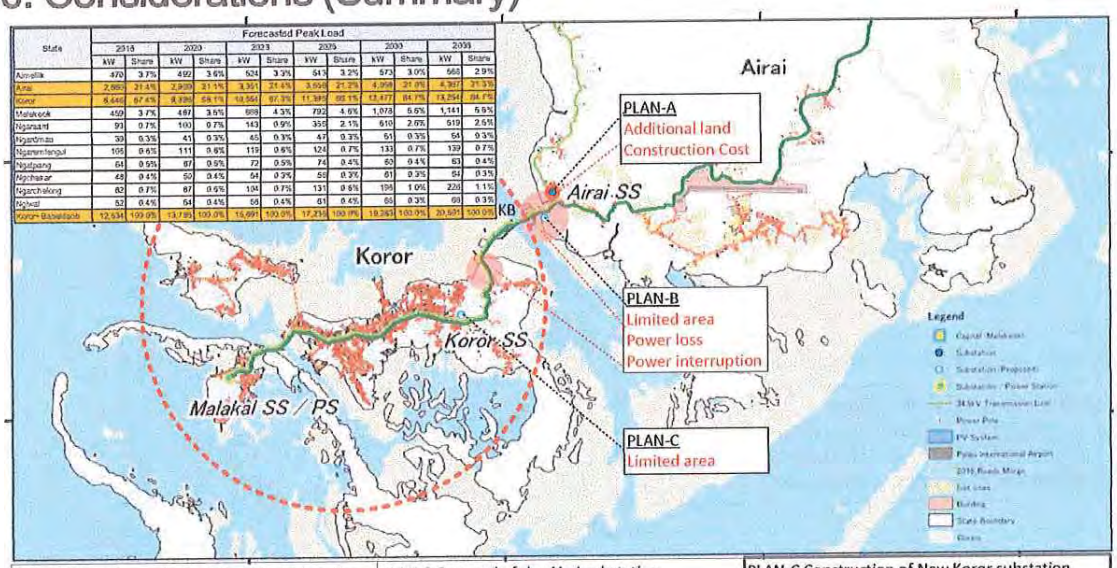
5. Considerations (Detailed)

Item			Plan-A Improvement of the existing Airai substation	Score 2.7	Plan-B Renewal of the Airai substation	Score 3.3	Plan-C Construction of New Koror substation	Score 4.2
Map								
1	Location	Location	Same Location	3.0	Different Location	3.0	New Location	4.0
		Site	Need to expand(0.14acre→ approx.0.21acre)		Need to secure approx. 0.12 acre		Need to secure approx. 0.12 acre	
		Challenge	Due to expansion of the site, it is necessary for additional site preparation on the slope		It seems like that it is very limited and difficult to secure the land on the existing transmission line route close to Koror island in the Airai state.		It might be difficult to secure land in Koror state compare to Airai state.	
2	Technical Aspect (Facility, Reliability)	Composition	Current T-branch should be changed to in and out connection with necessary switching devices and to secure enough capacity for future load.	3.0	To make in and out connection from the existing transmission line with necessary switching devices and to secure enough capacity for future load.	3.0	To make in and out connection from the existing transmission line with necessary switching devices and to secure enough capacity for future load.	5.0
		Facility	2 x Transmission line bay 2 x Transformer bay (1 is for future extension) 1 unit x other substation equipment		2 x Transmission line bay 2 x Transformer bay (1 is for future extension) 1 unit x other substation equipment		2 x Transmission line bay 2 x Transformer bay (1 is for future extension) 1 unit x other substation equipment	
		Reliability	Due to long distance distribution supply system for Koror island, power supply would not be improved dramatically, and would cost for future network expansion because of cabling at the KB bridge.		Due to long distance distribution supply system for Koror island, power supply would not be improved dramatically, and would cost for future network expansion because of cabling at the KB bridge.		Power supply reliability would be widely improved because of adequate load allocation and possibly to relief Airai load after decommissioning of Airai substation	
3	Construction Aspect (Difficulty, Period)	Construction	Need to expand the site without power outage. Due to the limited space for construction and machineries, construction work would be more difficult.	1.0	Construction constraint such as method or procedure would be mitigated and make the construction easier.	4.0	Construction constraint such as method or procedure would be mitigated and make the construction easier.	4.0
		Power outage	All the substation load, in the most of the construction period, would power outage, and necessary for power supply relief from other distribution network.		Power outage would be needed when changeover from the existing transmission line.		Power outage would be needed when changeover from the existing transmission line.	
		Implementation	Because of the above construction aspects, construction period would be much longer.		Because of the above construction aspects, construction period would be shorter.		Because of the above construction aspects, construction period would be shorter.	
4	Cost Impact	Cost	Construction cost such as expansion of site and retaining wall, expansion of bays and to improve the reliability make cost much higher. Expected additional cost for the additional construction is approximately USD 195,000.	2.0	Cost By selecting the suitable place and because of the shorter construction period, construction cost could be minimized.	4.0	Cost By selecting the suitable place and because of the shorter construction period, construction cost could be minimized.	4.0
5	Environmental Impact	Protection	Necessary to consider protection of historic sites and landscape from the Compact Road. This area is not categorised as a protected area.	3.0	Protection Necessary to select the location not to affect existing historic sites though there are no protected area.	3.0	Protection Proposed location and the surrounding area are not categorized neither protected area nor historic sites.	4.0
6	Social Considerations	Resettlement	There are no household or buildings in the area for the extension. Therefore involuntary resettlement is not expected.	4.0	Resettlement Necessary to consider location without involuntary resettlement.	3.0	Resettlement There are no household or buildings in the target area. Therefore involuntary resettlement is not expected.	4.0

[Remark]Evaluation Score: Low1<Average3<High5

6. Considerations (Summary)

State	Forecasted Peak Load											
	2018		2020		2023		2029		2033		2038	
	kW	Share	kW	Share	kW	Share	kW	Share	kW	Share	kW	Share
Aimeliik	470	3.7%	492	3.6%	524	3.3%	541	3.2%	573	3.0%	565	2.9%
Airai	2,989	21.4%	2,939	21.1%	3,351	21.4%	3,556	21.2%	4,058	21.0%	4,307	21.3%
Koror	8,446	67.4%	8,336	68.1%	10,561	67.3%	11,385	68.1%	13,477	69.7%	13,254	68.1%
Malakal	459	3.7%	497	3.6%	689	4.3%	792	4.6%	1,078	5.6%	1,141	5.9%
Ngaraard	93	0.7%	100	0.7%	143	0.9%	355	2.1%	510	2.6%	519	2.5%
Ngardmau	39	0.3%	41	0.3%	45	0.3%	47	0.3%	51	0.3%	54	0.3%
Ngaremlengui	105	0.8%	111	0.8%	119	0.8%	124	0.7%	133	0.7%	139	0.7%
Ngatpang	84	0.5%	87	0.5%	72	0.5%	74	0.4%	80	0.4%	83	0.4%
Ngchesar	48	0.4%	50	0.4%	54	0.3%	58	0.3%	61	0.3%	64	0.3%
Ngarchelong	82	0.7%	87	0.6%	104	0.7%	131	0.8%	156	1.0%	208	1.1%
Ngiwal	52	0.4%	54	0.4%	58	0.4%	61	0.4%	66	0.3%	68	0.3%
Koror-Babeldaob	12,934	100.0%	13,785	100.0%	15,991	100.0%	17,215	100.0%	19,363	100.0%	20,501	100.0%



PLAN-A Improvement of existing Airai substation
(0.14acre→ approx.0.21acre)
(Evaluation: Low)
---Advantage----------
- Utilization of secured land
- No involuntary resettlement

---Disadvantage----------
- Additional land (private) acquisition
- Additional site preparation on the slope
- Power outage for installation and changeover works.

PLAN-B Renewal of the Airai substation
(approx.0.12acre)
(Evaluation: Medium)
---Advantage----------
- Free-land acquisition
- Construction cost
- Construction Period

---Disadvantage----------
- Limited area closer to the Load-center
- Power loss (approx.: 5km)
- Risk of power interruption

PLAN-C Construction of New Koror substation
(approx.0.12acre)
(Evaluation: High)
---Advantage----------
- Free-land acquisition
- Construction cost
- Construction Period
- Power supply reliability for Koror

---Disadvantage----------
- Limited area closer to the Load-center

7. Master Plan (S/S) (Step1)

Objective: Improvement of Maintenance Manageability

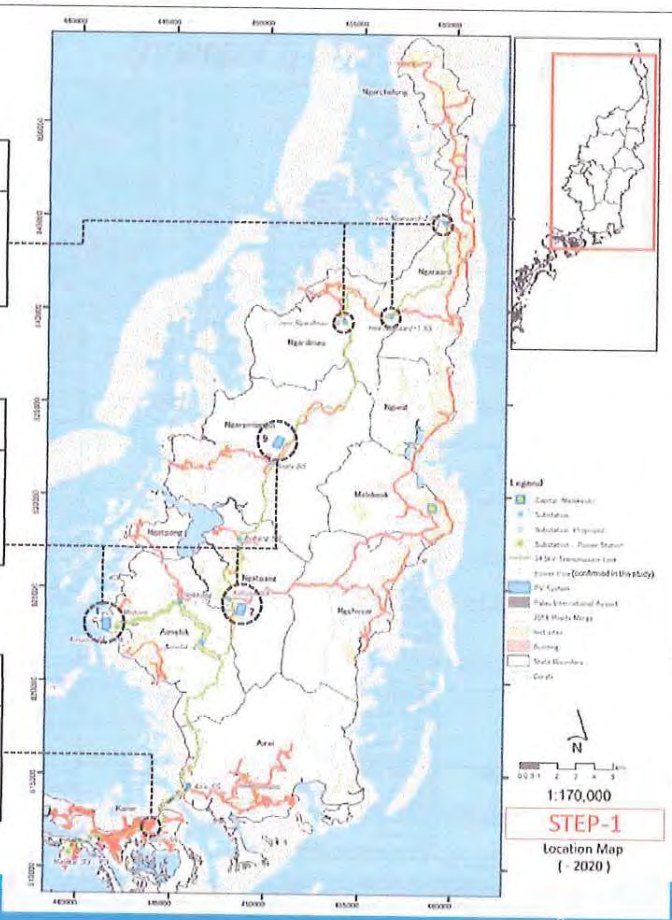
Relocation of existing 3 substations
-Ngardmau
-Ngaraard 1
- Ngaraard 2

Objective: 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)

Objective: Improvement of power supply reliability

Construction of Koror substation
-34.5/13.8kV 1 bank x 10MVA



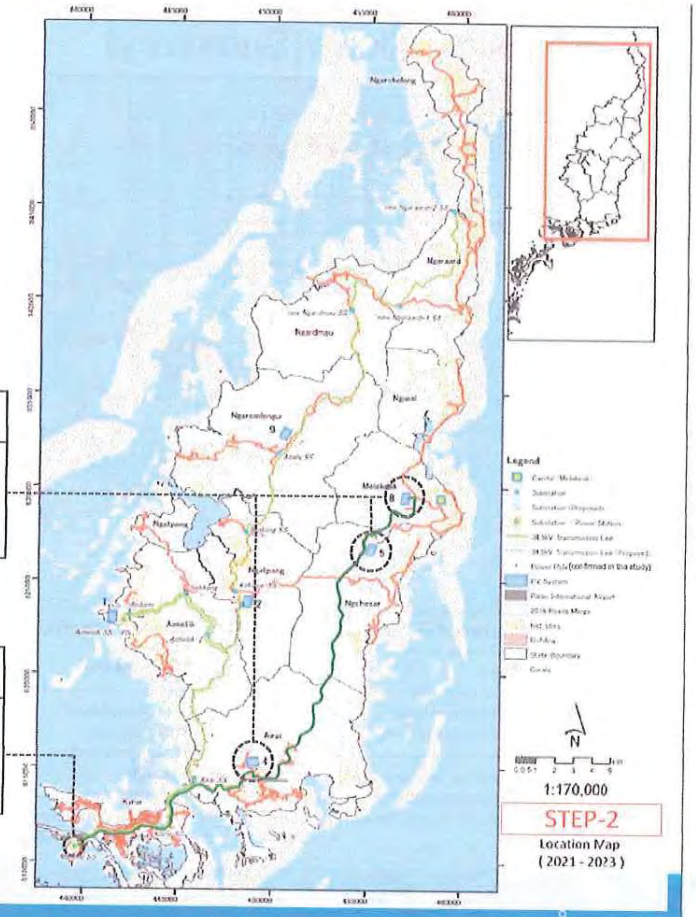
8. Master Plan (S/S) (Step2)

Objective: 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 (Mlelekeok)

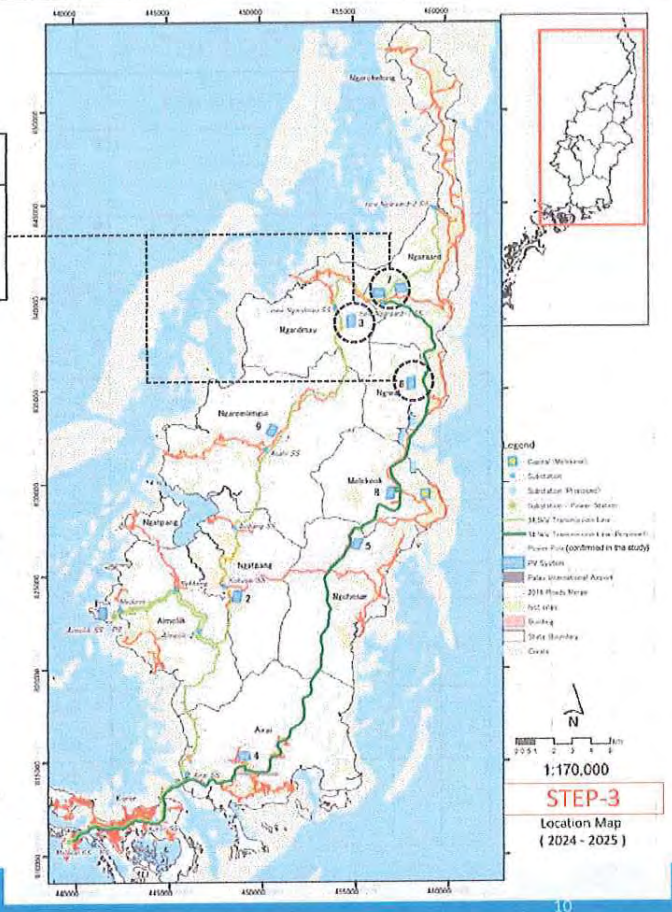
Objective: Improvement of Maintenance Manageability

Expansion of Malakal substation
-Expansion of Malakal outgoing feeder bay



9. Master Plan (S/S) (Step3)

Objective: For grid protection and maintenance
Installation of circuit breaker panel -Grid connected PV system (Ngiwal) -Grid connected PV system (Terraces of Hill) -Grid connected PV system (Ngardmau)



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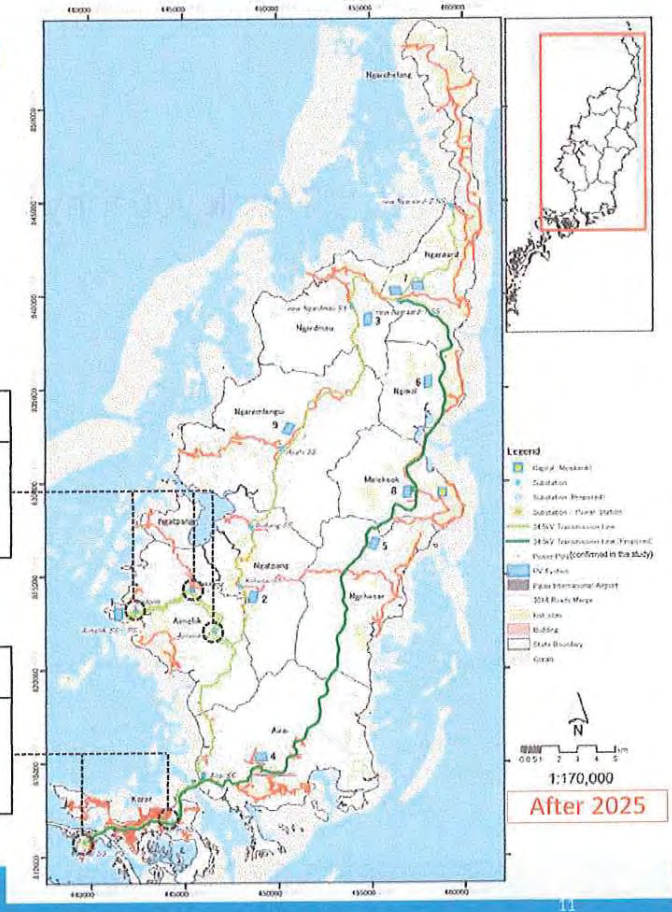
10. Master Plan (S/S) (Option)

Objective: 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 (Mlelekeok)

Objective: Improvement of Maintenance Manageability
Expansion of Malakal substation -34.5/13.8kV 1 bank x 10MVA (Malakal) -34.5/13.8kV 1 bank x 10MVA (Koror)



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11. Summary of Facility Plan and Tentative Rough Cost Estimation

Step	Period	RE roadmap	ID	Year	Facility	Main Objective	Outline	Remark	Rough Cost (Million USD)
1	by 2020	Phase1	1-1	2020	T&D	More manageable maintenance	■ Relocation of existing 34.5 kV transmission line ・ Transmission line (41.8 km) Airai – Aimeliik - Ngaraard 2 ・ Distribution line (4.6 km) Ngaraard 1 ・ Countermeasures against power outages	—	12.7
			1-2	2020	SS	More manageable maintenance	■ Relocation of existing substations ・ Ngardmau ・ Ngaraard 1 ・ Ngaraard 2	—	1.1
			1-3	2020	SS	Improved of power supply reliability	■ Construction of Koror substation ・ 34.5/13.8 kV 1 bank x 10MVA	—	1.9
			1-4	2020	D	More reliable power supply	■ Construction of 13.8 kV distribution line ・ 1 feeder (2 km) x 13.8 kV distribution line	—	0.4
			1-5	-	SS	For grid protection and maintenance	■ Installation of circuit breaker panel ・ Grid-connected PV system (Aimeliik)	Upon construction of grid-connected PV system	0.2
			1-6	-	SS	For grid protection and maintenance	■ Installation of pole-mounted switches ・ Grid-connected PV system (Ngatpang (Kokusai)) ・ Grid-connected PV system (Ngaremlengui)	Upon construction of grid-connected PV system	1.8
2	2021 - 2023	Phase2	2-1	2023	T	For a grid-connected PV system and more reliable power supply	■ Construction of 34.5 kV transmission line ・ Transmission line (33.5 km) Malakal – Melekeok PV site ・ Cabling (0.6 km at KB bridge)	—	8.4
			2-2	2023	SS	More manageable maintenance	■ Expansion of Malakal substation ・ Expansion of Malakal outgoing feeder bay	Option	0.4
			2-3	-	SS	For grid protection and maintenance	■ Installation of Pole-mounted Switches ・ Grid connected PV system (Airai Airport) ・ Grid connected PV system (Ngchesar) ・ Grid connected PV system (Mlelekeok)	Upon Construction of grid-connected PV system	2.6
3	2024 - 2025	Phase3	3-1	2025	T&D	For a grid-connected PV system and more reliable power supply	■ Construction of 34.5 kV transmission line ・ Transmission line (13.9km) Melekeok PVsite - Ngaraard 1 ・ Expansion of outgoing feeder at Ngaraard 1	—	3.3
			3-2	-	SS	For grid protection and maintenance	■ Installation of Pole-mounted Switches ・ Grid connected PV system (Ngiwal) ・ Grid connected PV system (Ngardmau (Terraces of Hill)) ・ Grid connected PV system (Ngardmau)	Upon Construction of grid connected PV system	2.2
								Total	35.0

Thank you for your attention