

**JICA 's Cooperation for Energy Sector
in Pacific Island Counties**

**“Hybrid Islands Program – Smart Energy
Integration for Resilient Islands”**

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AGENDA

1. JICA's Recent Cooperation
2. Knowledge and Experience of OKINAWA
3. JICA's View on the Current Challenges
4. Fukushima Iwaki Declaration (PALM7)
5. JICA's New Program:

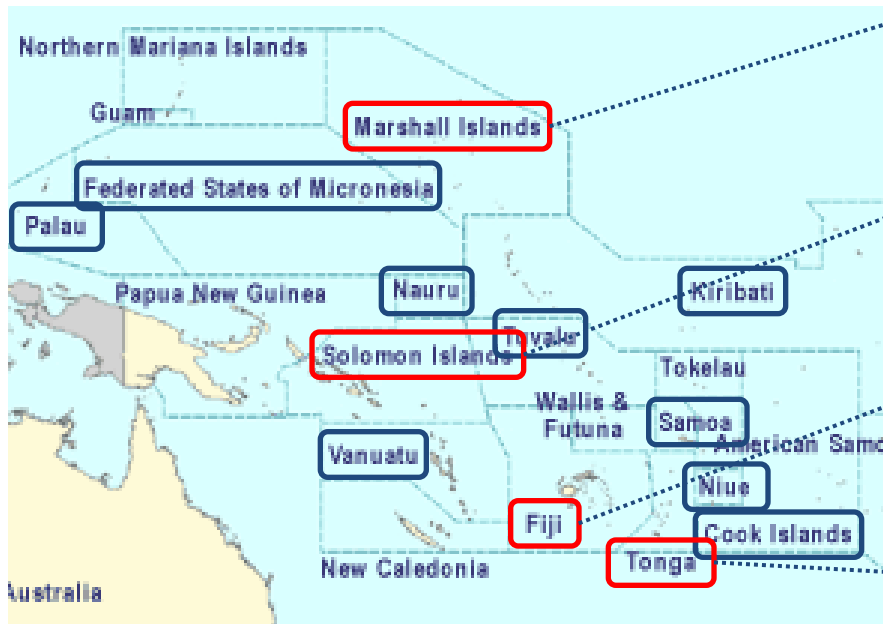
“Hybrid Islands Program

- Smart Energy Integration for Resilient Islands - ”

6. Smart Integration of RE with DEG
7. JICA's contribution to SDG

1. JICA's Recent Cooperation

- ❖ Work together in various cooperation program including T/A and grants
- ❖ Utilize knowledge/experiences from island regions such as Okinawa (*)



Marshall

- ◆ Master Plan Survey for Formulation of Self-Sufficient Energy Supply System (2013-15) (*)

Solomon

- ◆ Study on the Dissemination and Feasibility of Grid-connected PV Generation System (2013-15) (*)

Fiji

- ◆ Master Plan Survey for the Effective and Efficient Use of Renewable Energy Resources (2013-15)

Tonga

- ◆ The Project for Introduction of Clean Energy by Solar Home System (LED included) (2012)
- ◆ Grant Project for Introduction of Micro-Grid System with Renewable Energy (2015) (*)
- ◆ Dissemination Program of Typhoon-Resistant Wind Power Turbines (2014-15) (*)

All

- ◆ Training for Fuel-Reduced Operation of Diesel Power Plants (-2014) (*)
- ◆ Training for Promotion of Renewable Energy in Micro Grid (2014-) (*)

1. JICA's Recent Cooperation

Japan's Past Grant Aid for Diesel Engine Generator and Renewable Energy

Country	Project Title	Description	Completion
FSM	Upgrading of Electric Utilities	DEG(2.5MW x 2units)	1994
FSM	Introduction of Clean Energy by Solar Electricity Generation System	PV(209kW)	2013
Kiribati	Upgrading of Electric Power Supply in Tarawa Atoll	DEG(2.3MW x 2units)	2002
Kiribati	Upgrading of Electric Power Supply in Tarawa Atoll (Phase-II)	DEG(1.4MW)	2005
Marshall	Introduction of Clean Energy by Solar Electricity Generation System	PV(205kW)	2012
Palau	Introduction of Clean Energy by Solar Electricity Generation System	PV(180kW)	2011
Palau	Enhancing Power Generation Capacity in the Urban Area in the Republic of Palau	DEG(5MW x 2units)	2014
Solomom	Lunga Power Generation Development	DEG(4.2MW)	2000
Solomon	Improvement of the Honiara Power Supply	DEG(4.2MW)	2007
Tonga	Introduction of Clean Energy by Solar Home System (SHS)	SHS(105kW)	2013
Tonga	Introduction of a Micro-Grid System with Renewable Energy for the Tonga Energy Road Map	PV(1MW) & Capacitor(10kWh x 2units)	2015
Tuvalu	Upgrading of Electric Power Supply in Funafuti Atoll	DEG(0.6MW x 3units)	2006
Vanuatu	Sarakata River Hydroelectric Power Development Project	Hydro(300kW x 2units)	1995
Vanuatu	Improvement of Sarakata River Hydroelectric Power Station	Hydro(600kW)	2009

Training for Fuel-Reduced Operation of Diesel Power Plants(*)

- ❖ Review the fundamentals of DEGs
- ❖ Understand theory and methodology of economic operation
- ❖ Conduct the economic load dispatch among multiple DEGs
- ❖ Formulate an action plan for dissemination

Training for Promotion of Renewable Energy in Micro Grid(*)

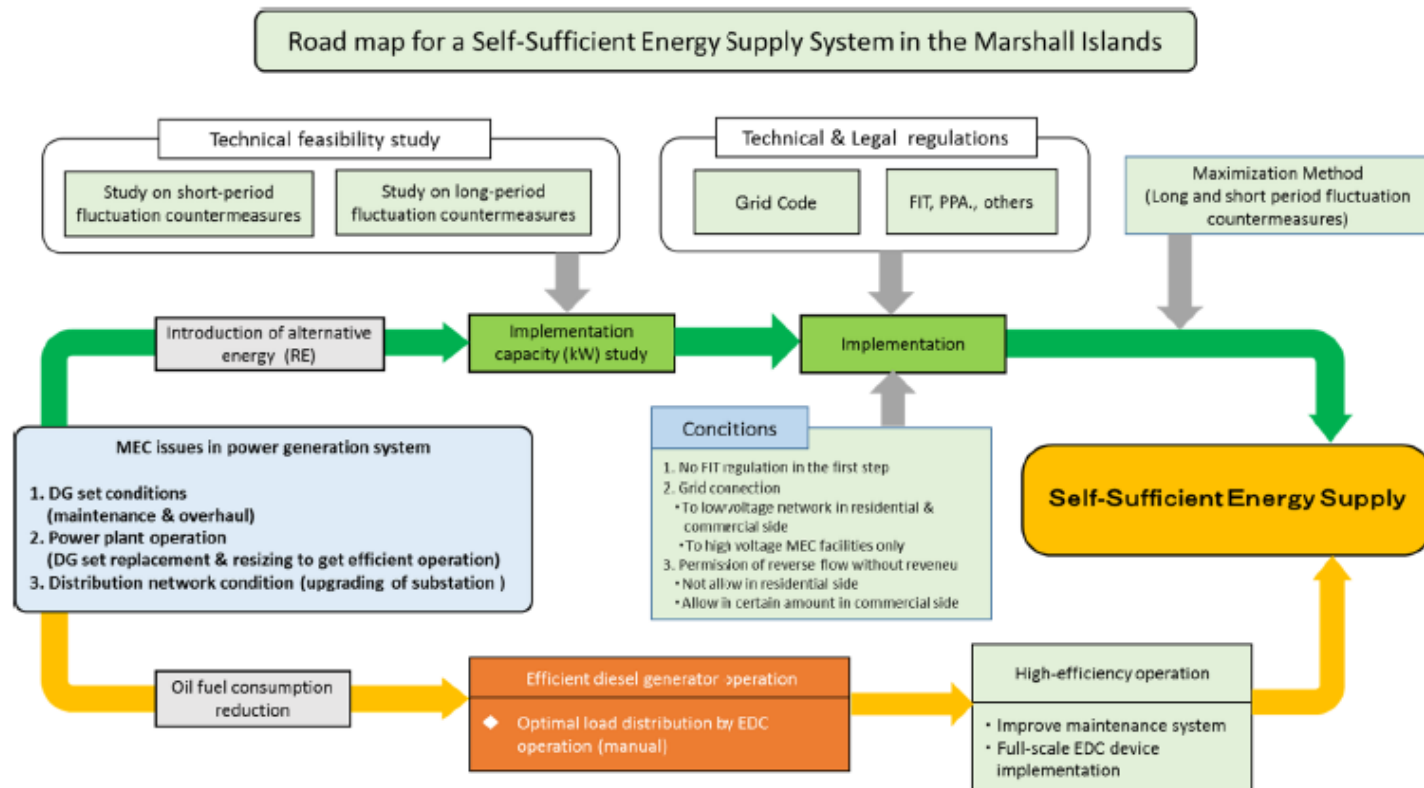
- ❖ Share history and current situation of PV development in Japan
- ❖ Understand how to identify necessary conditions to promote PV penetration
- ❖ Formulate a preliminary plan of micro grid system (renewable energy connected with diesel) in each country



JICA's Cooperation (Ex. 2) : Master Plan for Formulation of Self-Sufficient Energy Supply System in MARSHALL(*)

❖ Enhance the capacity to establish sustainable and self-sufficient energy supply system through:

- 1) Assessing the institutional arrangement to promote RE
- 2) Evaluating the allowable capacity of grid-connected RE
- 3) Planning and designing DEG-PV hybrid grid system
- 4) Conducting Economical operation of DEG



❖ Objective :

To enable stable electricity supply, integrating various energy resources with micro-grid system

❖ Project Component :

- 1) Power generation by RE (solar PV: 1MW)
- 2) Micro-grid controller
- 3) Lithium-ion capacitor (10 kWh, 2 units)



PV array



Micro-grid controller



Li-ion capacitor

2. “Knowledge and Experience of OKINAWA

OKINAWA, Southernmost Remote Island, with more than 160 small islands



(Resource) Okinawa Electric Power Company



Knowledge and experience from Okinawa related to small grid operation with both Diesel Generator and Renewable Energy , have been particularly utilized in recent JICA Projects.

3. JICA's View on the Current Challenges

CHALLENGE

- ❖ High dependency on imported fossil fuel
 - ⇒ High tariff, and fluctuation risk of oil prices
 - ⇒ Low energy security



- ❖ Excessive integration of variable RE
 - ⇒ Unstable outputs associated with weather conditions, disaster risks, and adverse impact on existing generators
 - ⇒ Unreliable power supply

Critical: Ensure the energy security with reliable power supply

3. JICA's View on the Current Challenges

POSSIBLE SOLUTION

Development of Renewable Energy (RE)

- ☺ Solid Effect on Fuel Reduction
- ☹ Unstable Power Output



“Optimal Development of RE”
(ex. RE integration within allowable capacity of grid,
RE integration with grid stabilizer)



Efficient Diesel Engine Generator (DEG)

- ☺ Cost-Effective Method
- ☺ Important Role as Base Load Power Source



**“Appropriate and Economical
O&M on DEG”**

> > > Hybrid System for Fossil Fuel Reduction and Energy Security

4. “Fukushima Iwaki Declaration” (PALM7)

“Recognizing that dependence on fossil fuels for meeting energy needs has been a major constraint to sustainable development in the Pacific region, the Leaders stressed the importance of transition to a sustainable energy future. -----

Prime Minister Abe expressed Japan’s intention to cooperate with Pacific countries for the reduction of fossil fuels consumption with the aim of improving their energy security and contributing to reduction of greenhouse gases (GHG). “

(Part of Article 30)

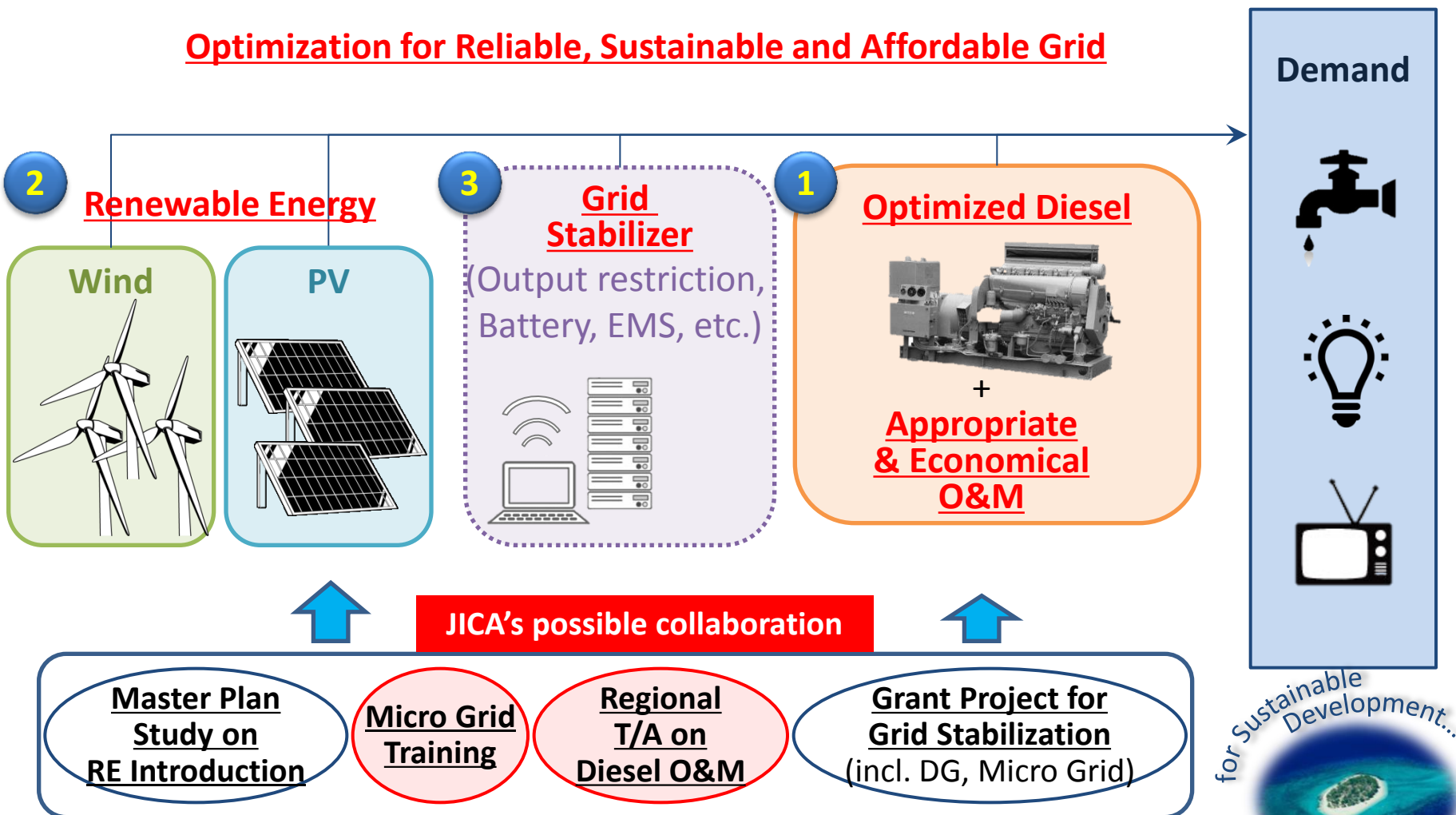


(Resource) Website of Ministry of Foreign Affairs of Japan

5. JICA's New Program: "Hybrid Islands Program"

Smart Energy Integration for Resilient Islands

Optimization for Reliable, Sustainable and Affordable Grid

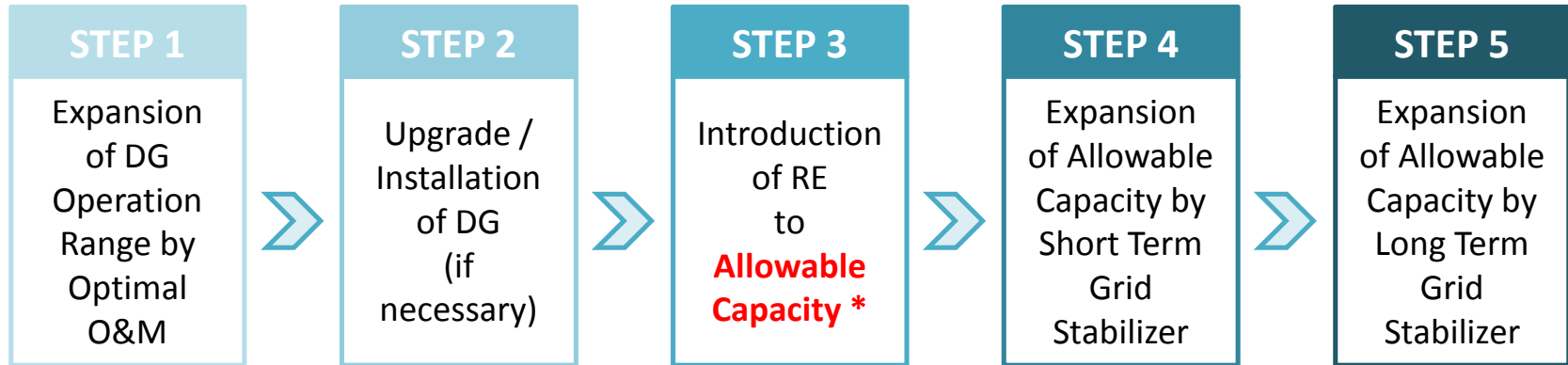


for Sustainable Development...



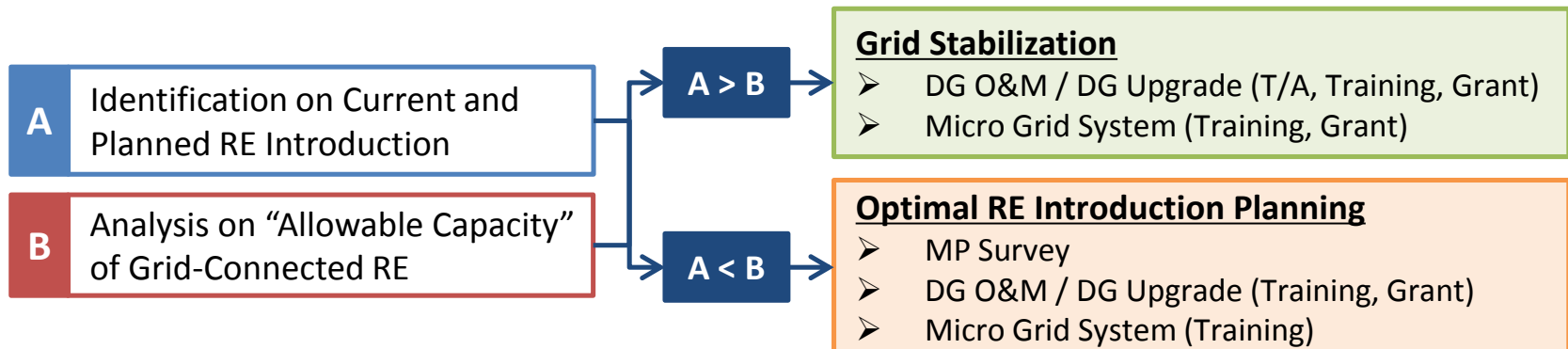
5. JICA's New Program: "Hybrid Islands Program"

[Roadmap for Reliable Power Supply]

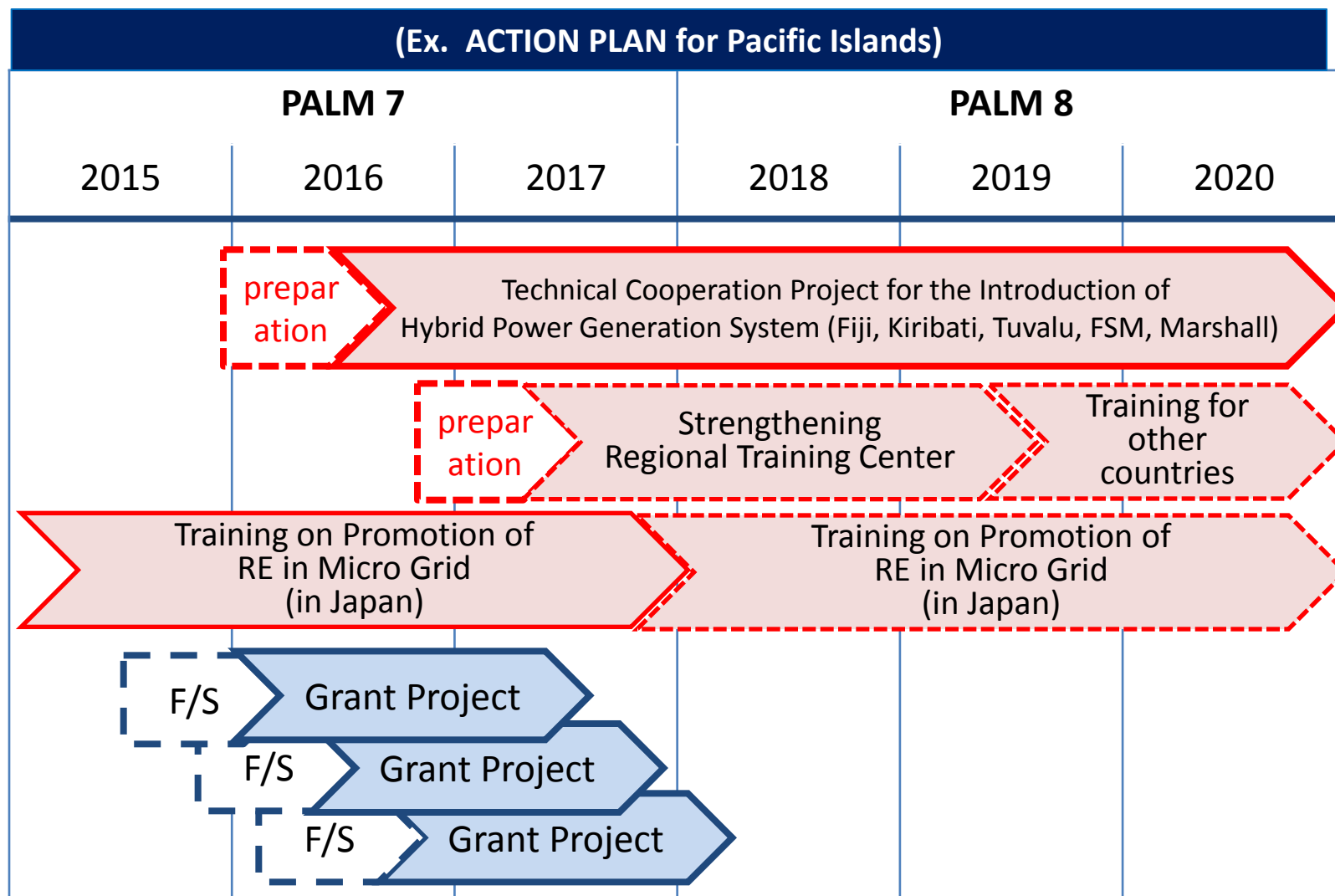


* **JICA's "Allowable Capacity"**: Maximum capacity of RE which can be connected to grid without serious damage on the stability of power and the generator, with neither stabilizer or new/upgraded generator provided.

[Assessment Method for Candidate Assistance]



5. JICA's New Program: "Hybrid Islands Program"



(Remark) This schedule is tentative and consultation is undergoing with GOJ, Pacific Island countries, etc.

6. Smart Integration of RE with DEG

Challenges of integrating RE with DEG

Short-term fluctuation of power output by RE



☹ Frequency of power system is disturbed



Long-term fluctuation of power output by RE



- ☹ Excessive power supply during low-demand period
- ☹ DEGs are damaged due to continuous low-demand operation
- ☹ Economy of fuel consumption by DEGs may be deteriorated

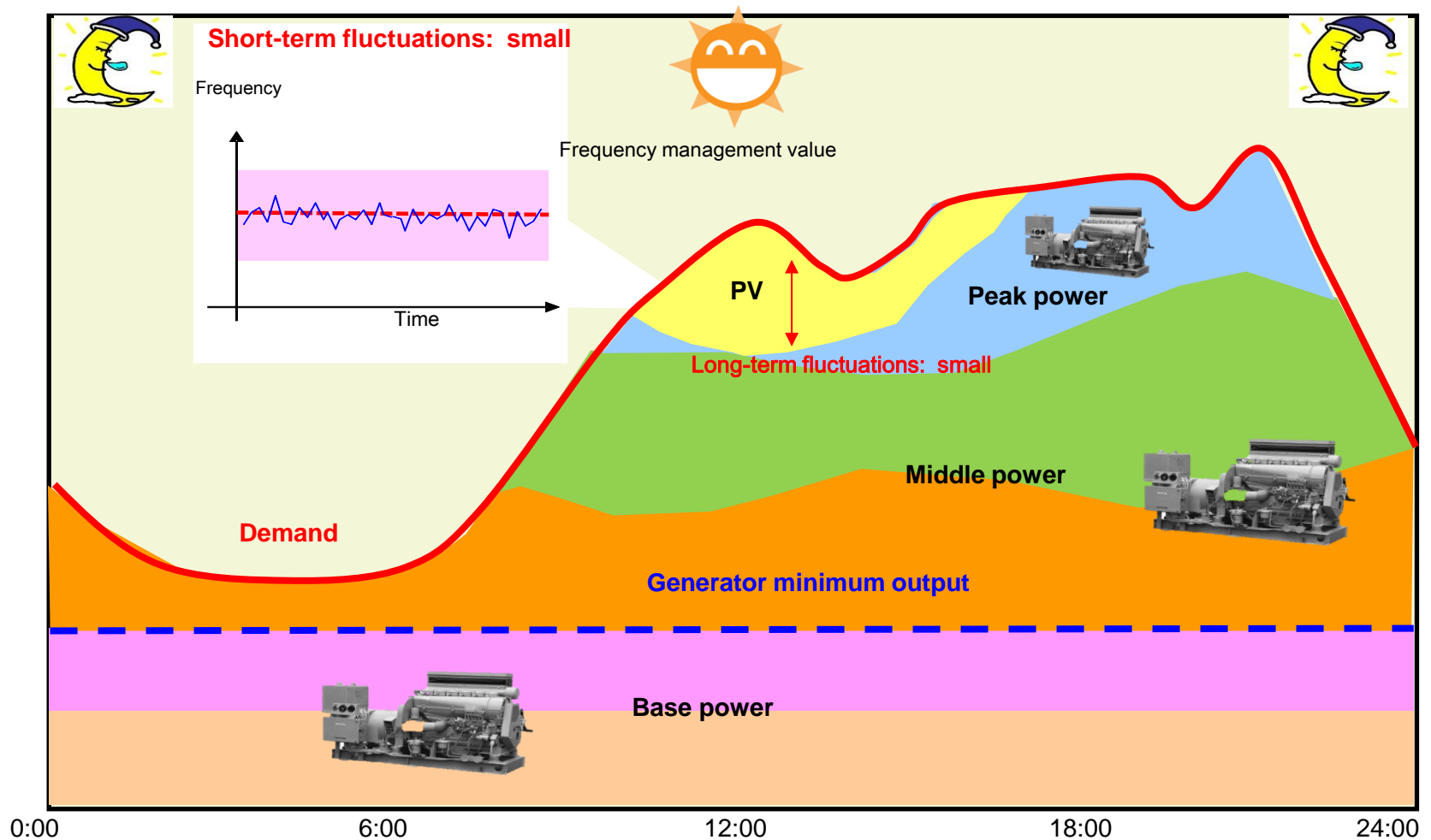


Energy storage system (e.g. battery) will be necessary beyond certain penetration of RE



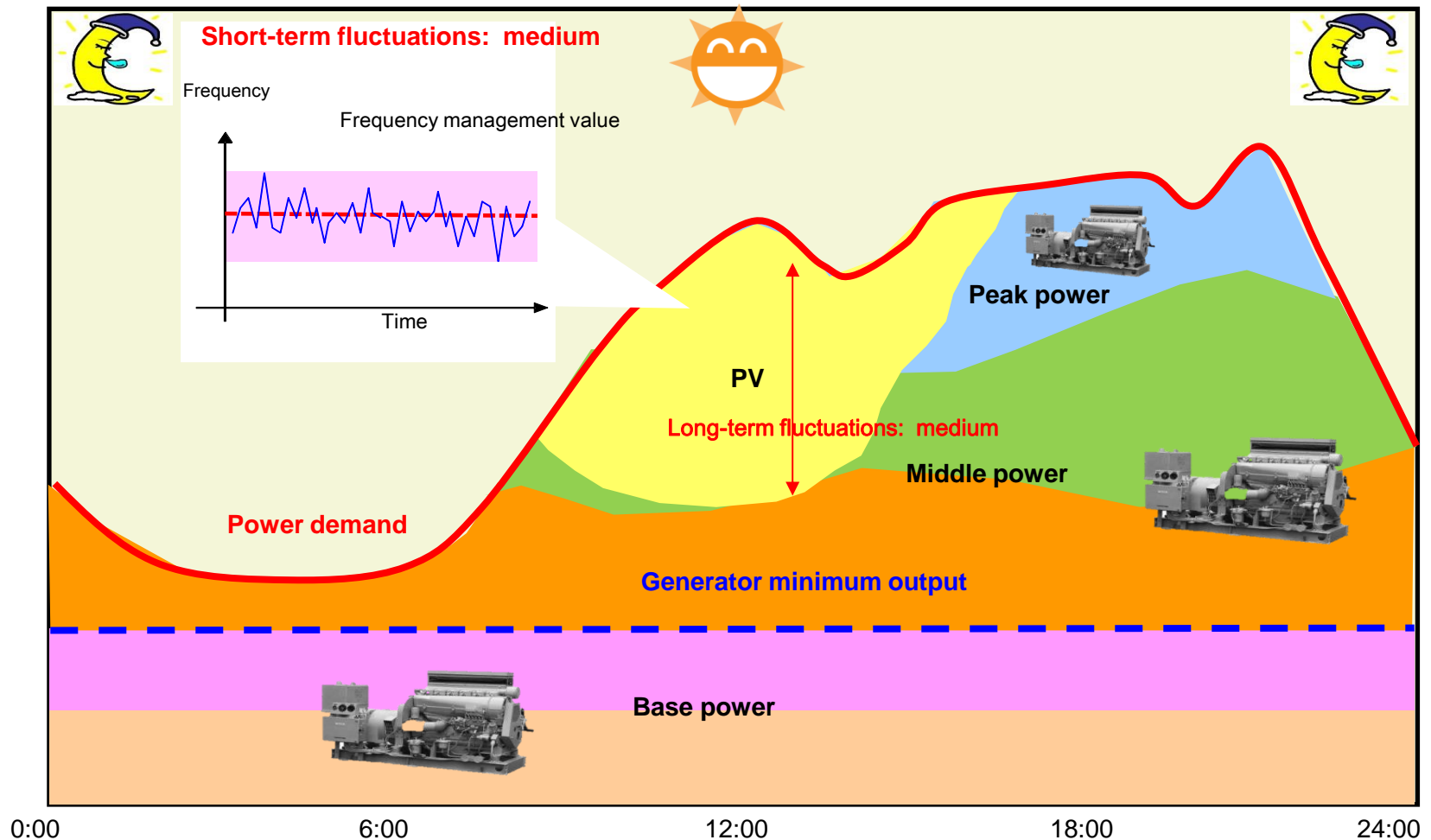
Increasing cost of energy supply

Small Penetration of PV into DEG supply



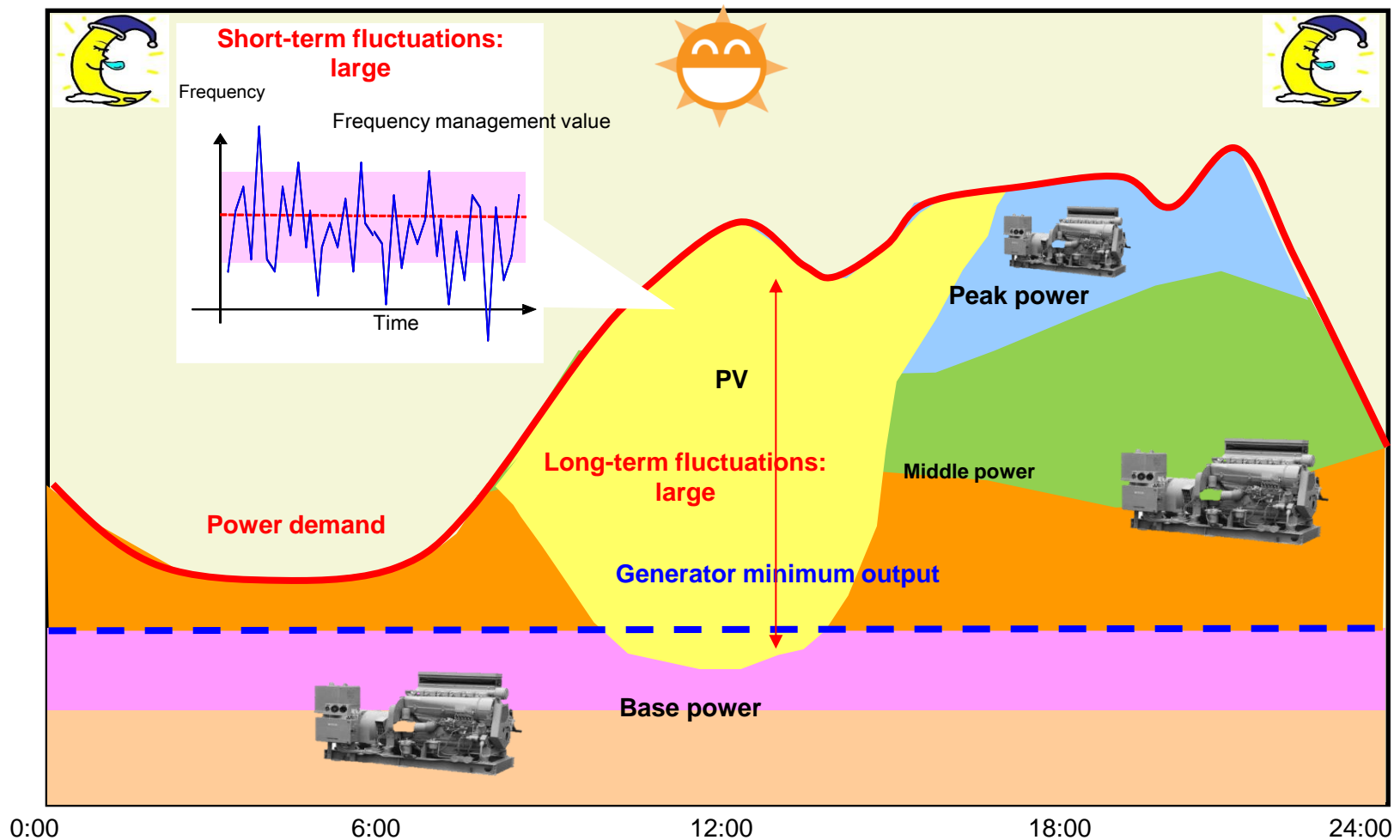
Both short- and long-term fluctuations will not be caused by appropriately adjusting DEGs power output through GF, etc.

Medium Penetration of PV into DEG supply



It is necessary to investigate the necessity of introducing countermeasures for short-term fluctuations.

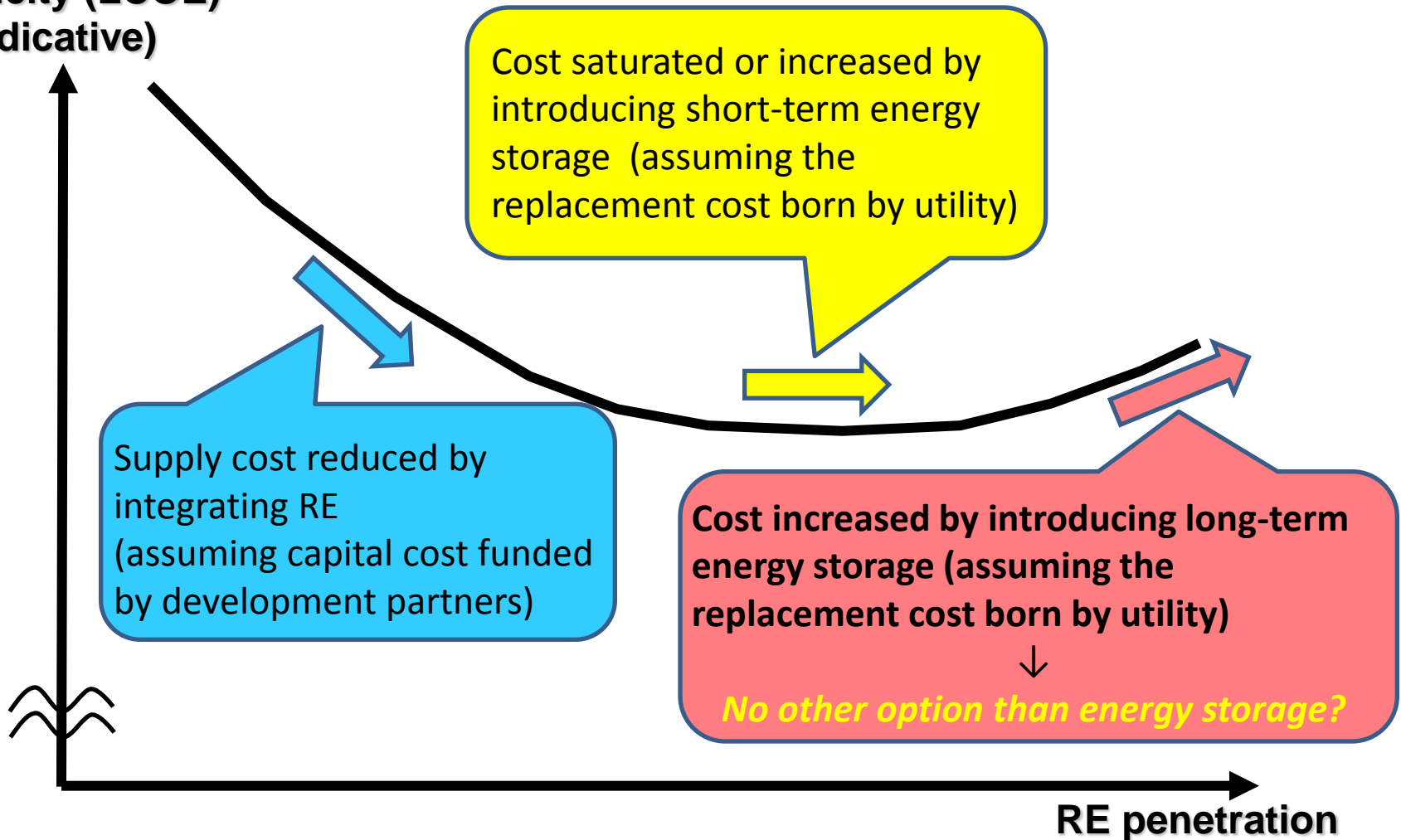
Large Penetration of PV into DEG supply



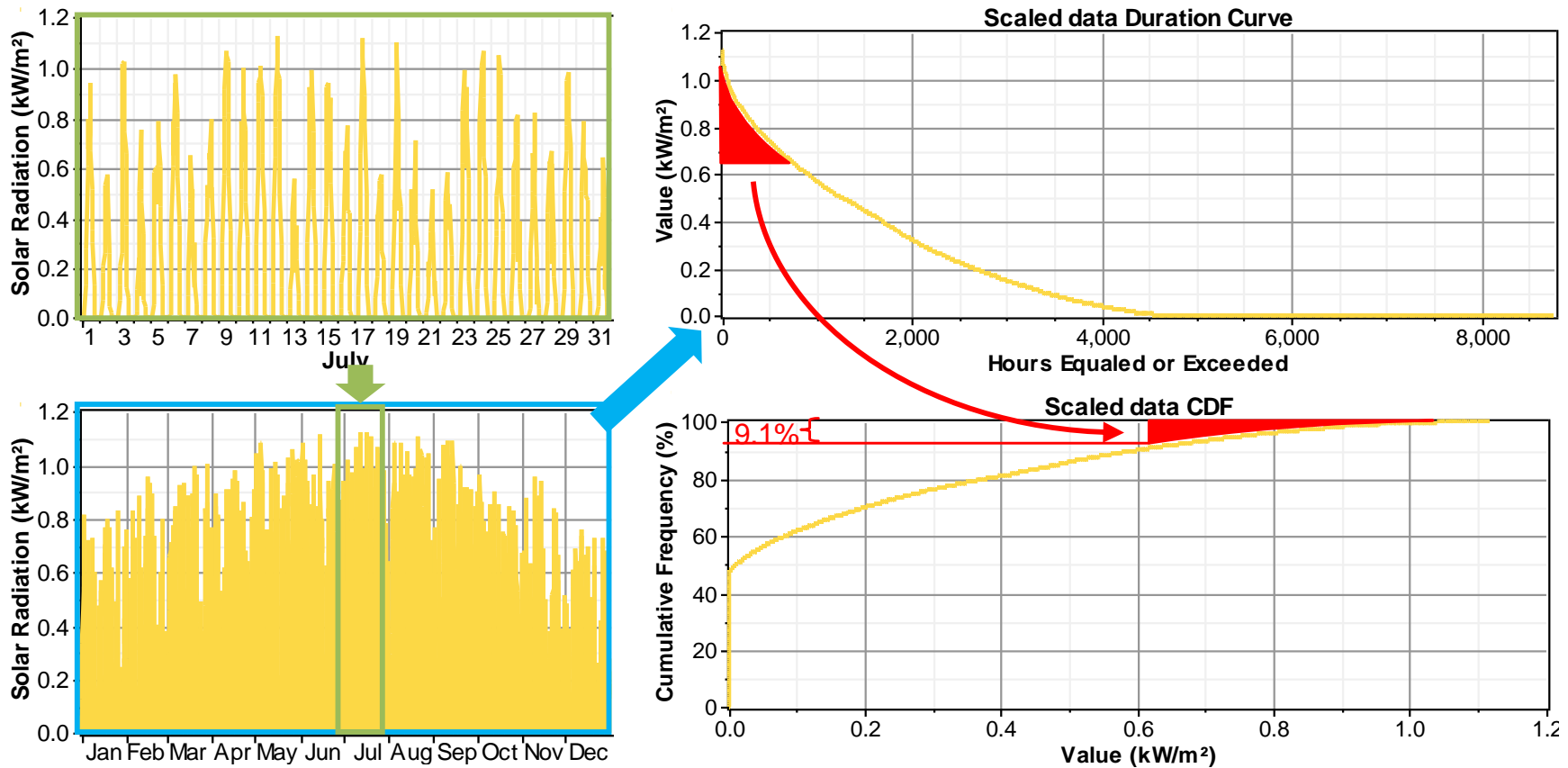
It is necessary to investigate the necessity of introducing countermeasures for both short- and long-term fluctuations.

6. Smart Integration of RE with DEG

Levelized Cost of
Electricity (LCOE)
(indicative)



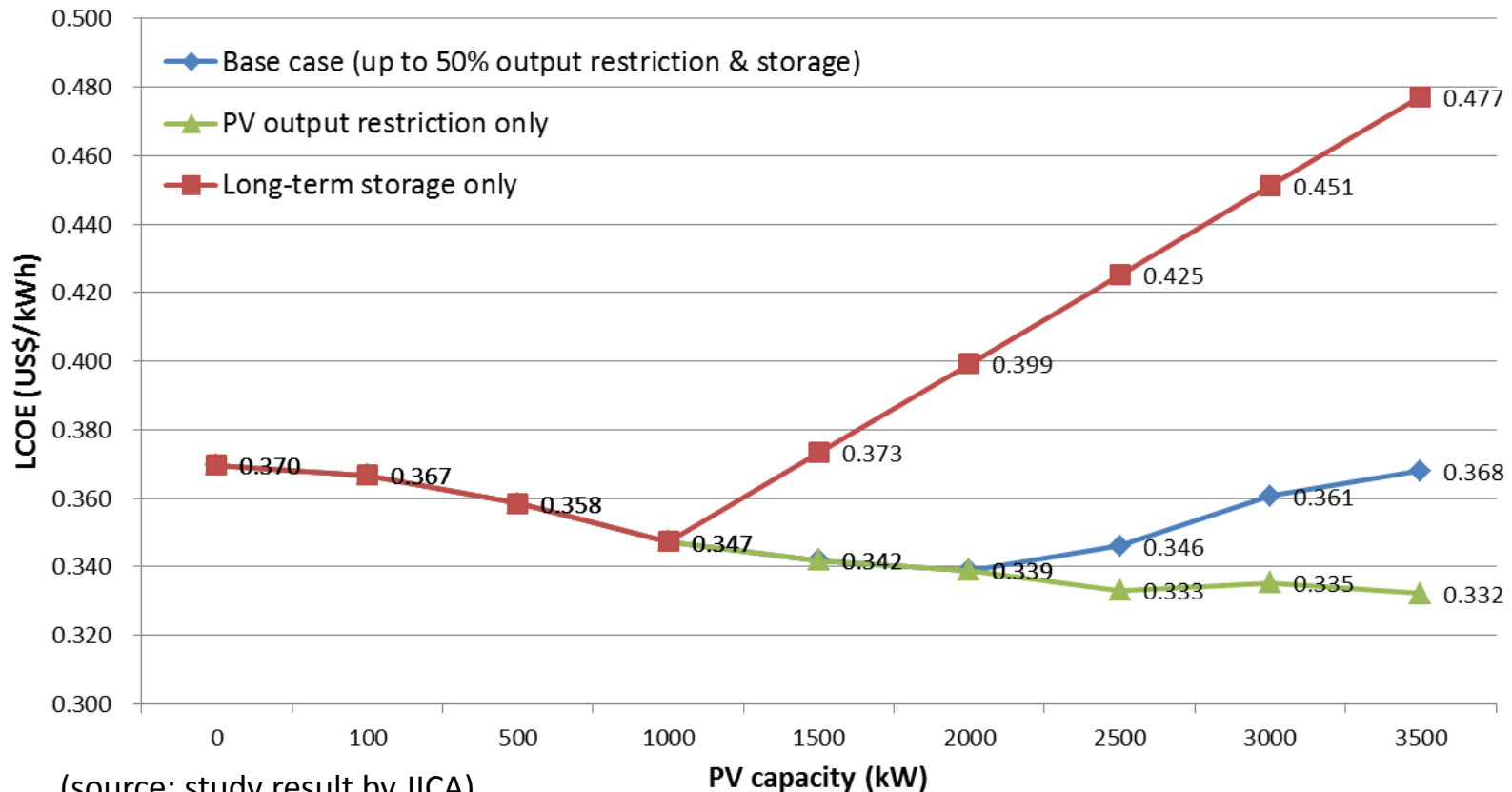
Output Restriction of solar PV system



Solar radiation and cumulative frequency in Okinawa

For example, if PV output is restricted to 50% throughout the year, annual power generation would be reduced by approximately 9.1%. Since the incidence of high output is low, the impact on annual power generation is limited.

6. Smart Integration of RE with DEG



Output restriction of RE can be the cost-effective solution compared with long-term storage, since the restricted energy and its benefit is much smaller than necessary capital of storage system.

7. JICA's Contribution to SDG

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

JICA's Hybrid Island Program



7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy

7. JICA's Contribution to SDG

JICA's Technical Cooperation Project

◆ The Project for the Introduction of Hybrid Power Generation System (Fiji, Kiribati, Tuvalu, FSM, Marshall) (Nov.2016 - Oct.2021)

Outputs

1. Appropriate and economical system for O&M of Diesel Generators (DEGs) is enhanced.
2. Methodology for appropriate planning and O&M of renewable energy (RE) is established.

List of Japanese Experts (Tentative)

- A) Hybrid Power Generation System (Fiji)
- B) Operation & Maintenance of DEG
- C) Economic operation of DEG
- D) O&M of RE energy
- E) Integration of Renewable Energy

◆ The Project for Study of Upgrading and Maintenance of the National Electrical Power Grid (Palau)

Outputs

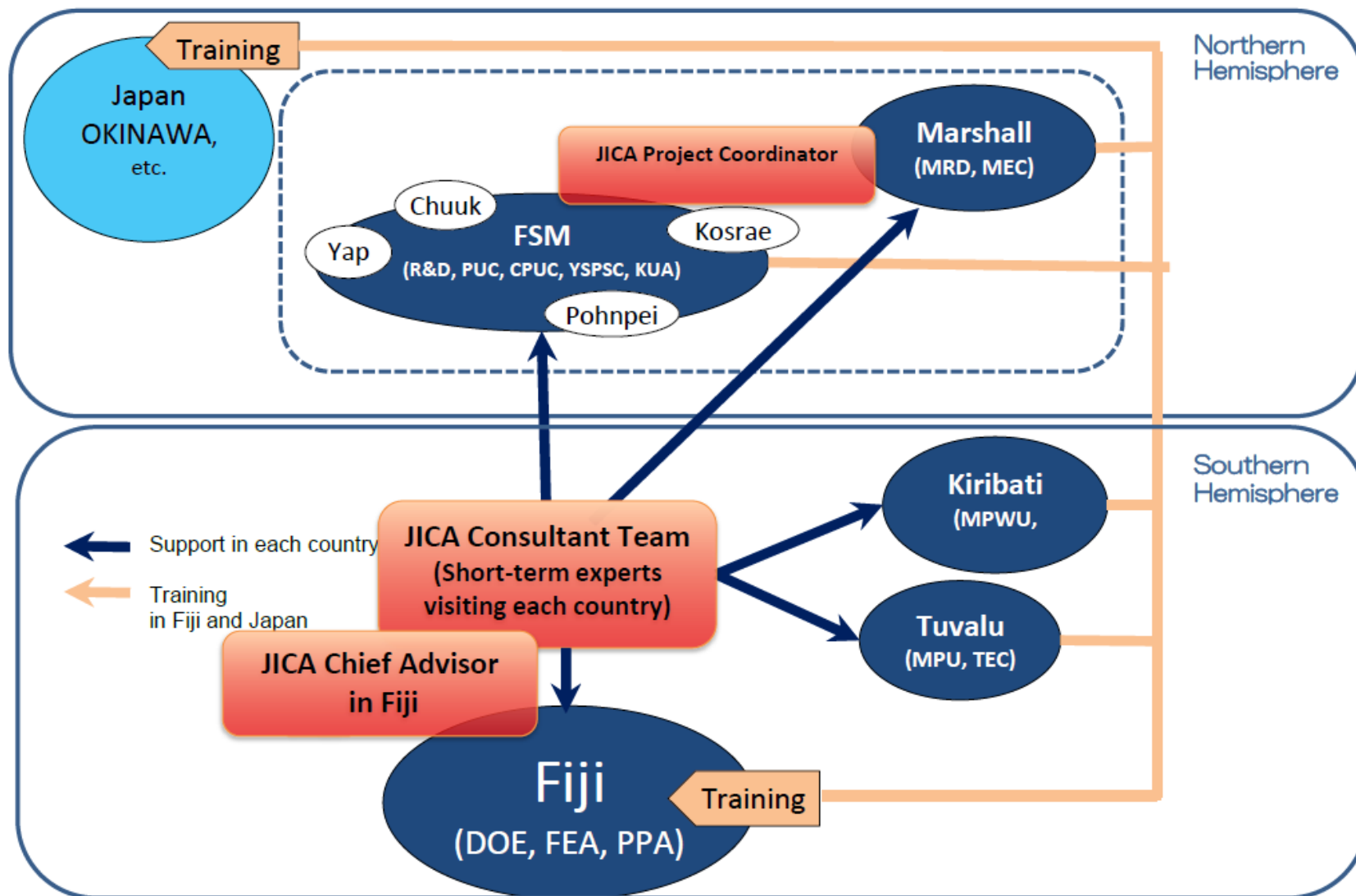
Master Plan Survey including following components .

- A) Upgrading of National Grid
- B) Optimal Development of Renewable Energy



7. JICA's Contribution to SDG

The Project for the Introduction of Hybrid Power Generation System



7. JICA's Contribution to SDG

Japan's Grant Aid

<Committed>

◆ The Project for Power Sector Improvement for the State of Kosrae (FSM)

- Diesel Generator (600kW x 2)
- Preparation for construction

<Pipeline>

◆ The Wind Power Generation System Development Project (Tonga)

- Wind Generator (1.3MW)
- B/D study (Jun.2016 - Feb.2017)

◆ The Project for PV Power Generation System in Ebeye Island (Marshall)

- PV (600kW with/without battery)
- B/D study (Jun.2016 - Mar.2017)



Important Issues

1. Analyzing maximum allowable capacity of RE is Important first step for the optimal development of RE in Pacific Island Countries .
2. Cost-benefit analysis to compare introduction of long-term storage and output restriction of RE should be conducted, since the restricted energy and its benefit could be much smaller than necessary capital of storage system.
3. JICA's Hybrid Islands Program will propose best solutions on these issues for Pacific Island Countries, fully utilizing Japanese resources, especially for the Okinawa's knowledge and experience for small grid operation.

**THANK YOU VERY MUCH
FOR YOUR ATTENTION.**