# Renewable energy integration to remote island grids – Miyako Island

May 26,2012

The Okinawa Electric Power Company, Incorporated(OEPC)

# Agenda

- Introduction
- Overview of Miyako Island Micro Grid
- Content and Results of Demonstration
- Conclusion

# Introduction

## Background

- The electric supply in the remote island is forced to depend upon diesel-based power generation, because of its special composition of power supply.
- Necessity of reducing $CO_2$ emission
- Responding to the issues arising when introducing Renewable energies.

## issues

| remote island (Diesel power generation) | PV generation/wind power generation (new energy) |
|---|---|
| • Small-scaled, and independent electric power system<br>• The specific $CO_2$ emission is high. | • They are unstable powers whose output fluctuates with the weather.<br>• If such energy is introduced in the small-scaled, independent power system, frequency problems, etc. may arise (making the system unstable). |

# Introduction

## Objectives of the Project

- To utilize renewable energy sources such as PV power and Wind power
- To evaluate the influence on the electricity grid from renewable energy sources
- To demonstrate the stabilization methods of electricity grid with renewable energy sources by storage battery

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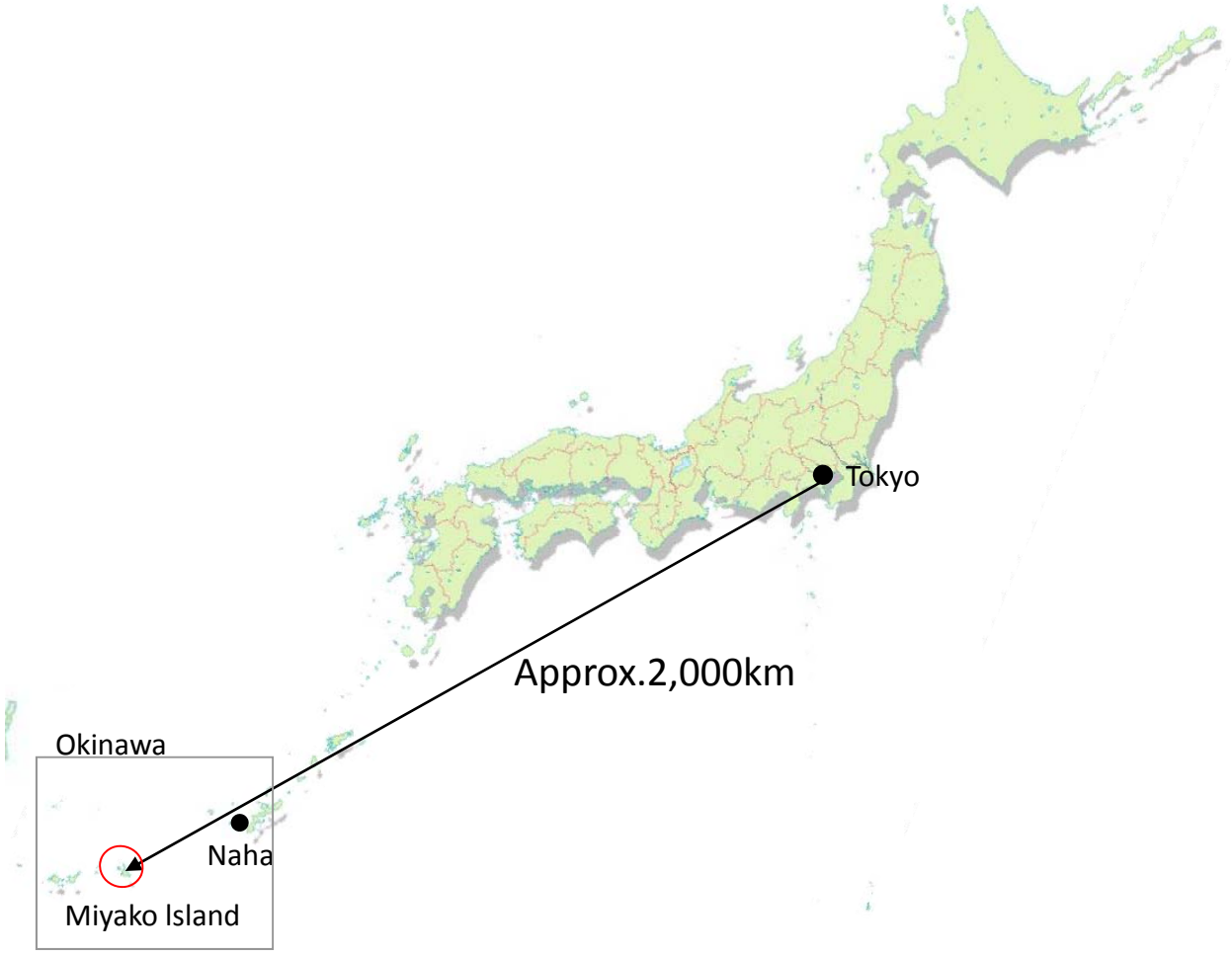
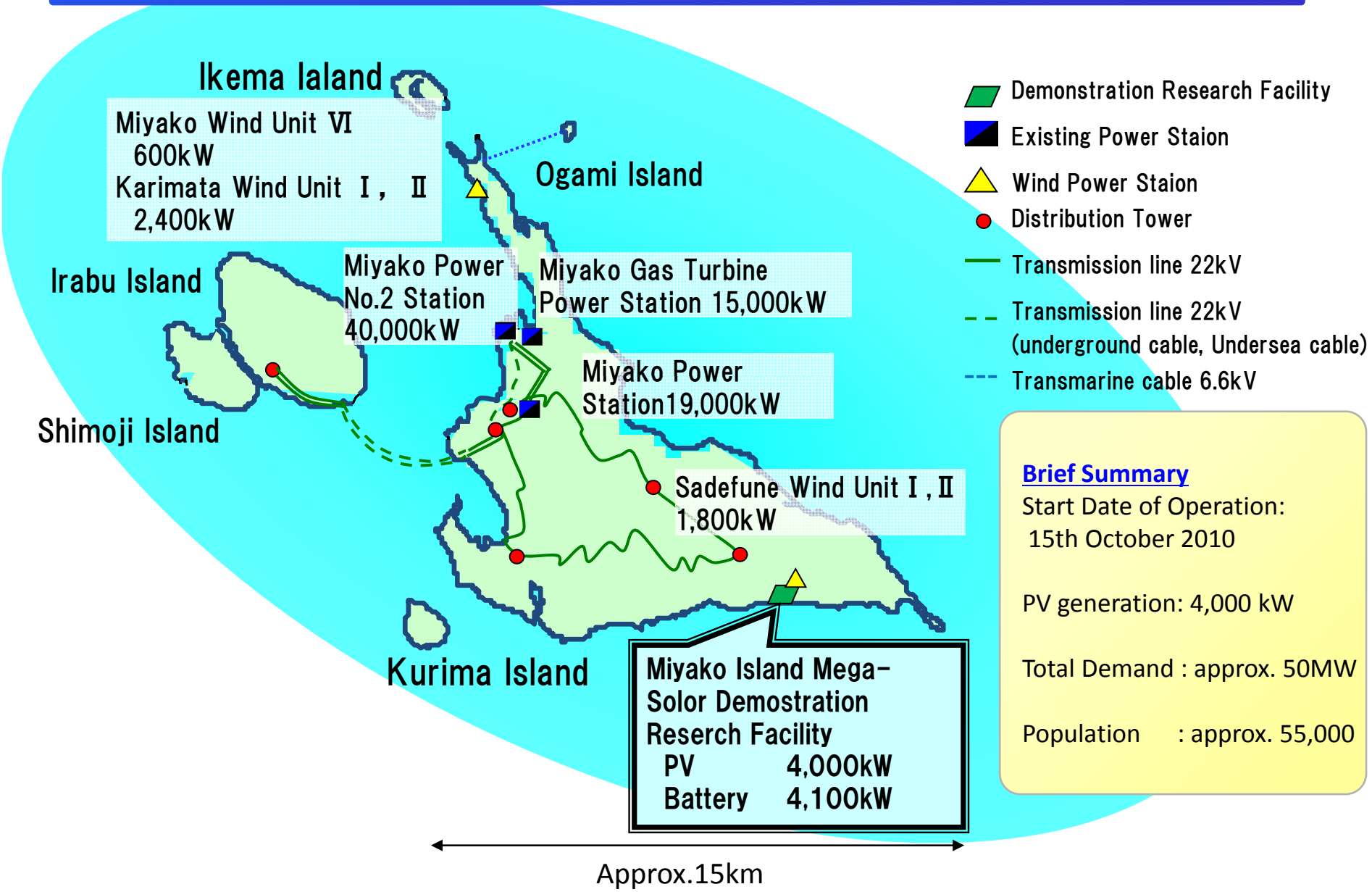
# Overview of Miyako Island Micro Grid



# Overview of Miyako Island Micro Grid




**Brief Summary**

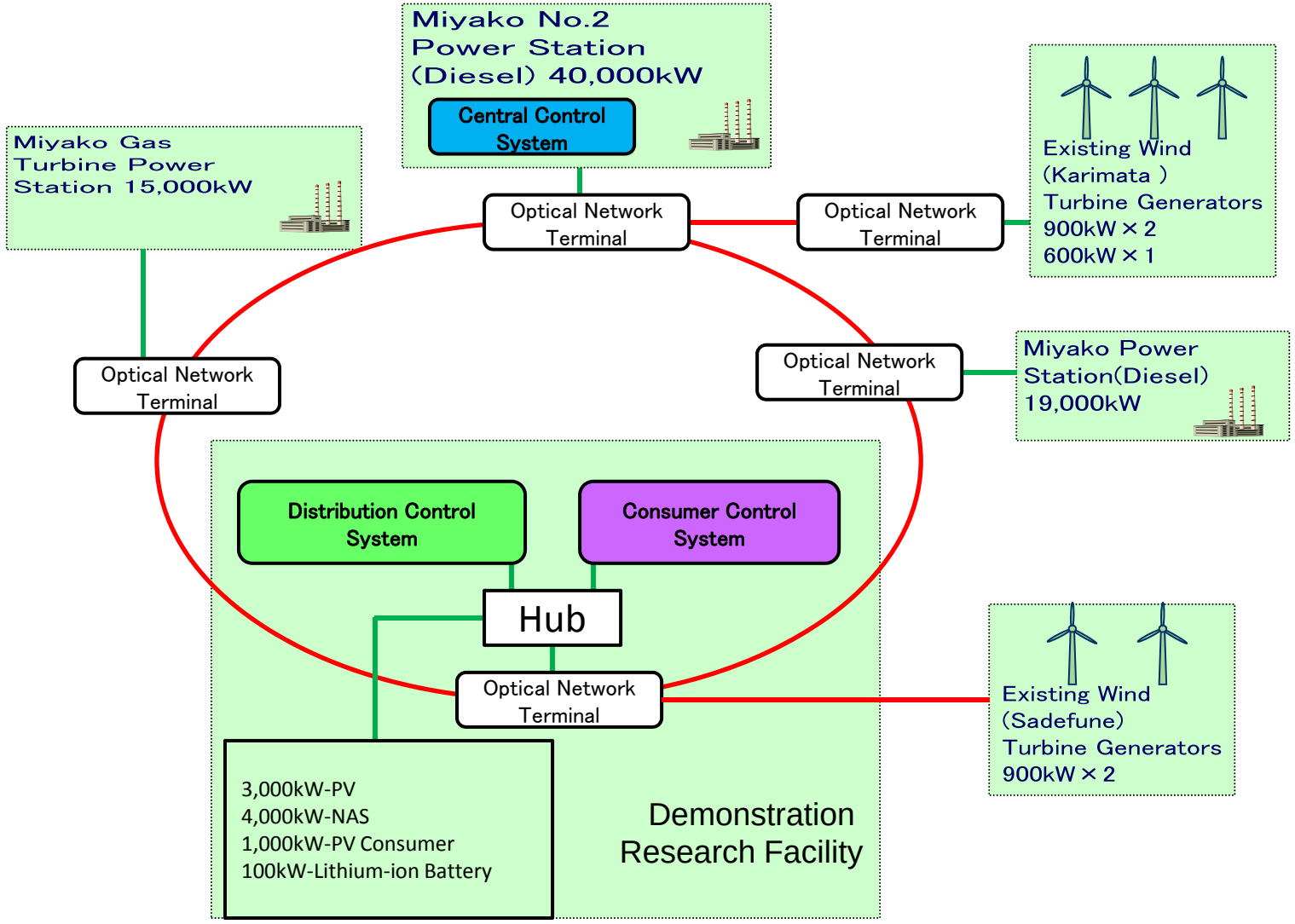
Start Date of Operation:
15th October 2010

PV generation: 4,000 kW

Total Demand : approx. 50MW

Population : approx. 55,000

# Overview of Miyako Island Micro Grid



1MW PV : photovoltaic generation

4kW PV : photovoltaic generation

150kW PV : photovoltaic generation

0.5MW NAS : NAS : Sodium-Sulfer battery

LiB : LiB : Lithium ion Battery

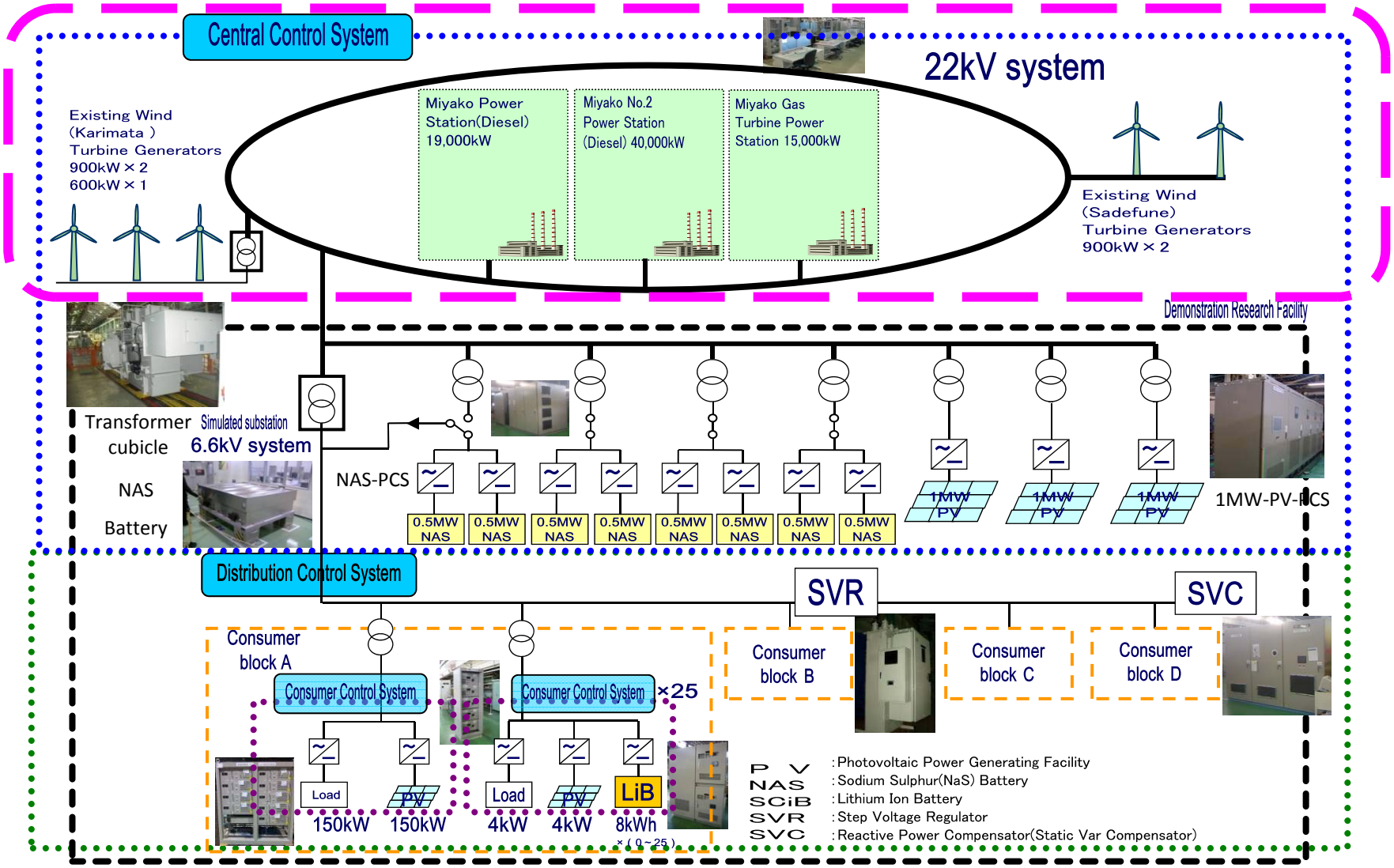
SVR : SVR : Step Voltage Regulator

SVC : SVC : Static Var Compensator

load : Load 150kW : Simulated load

load : Load 4kW : Simulated load

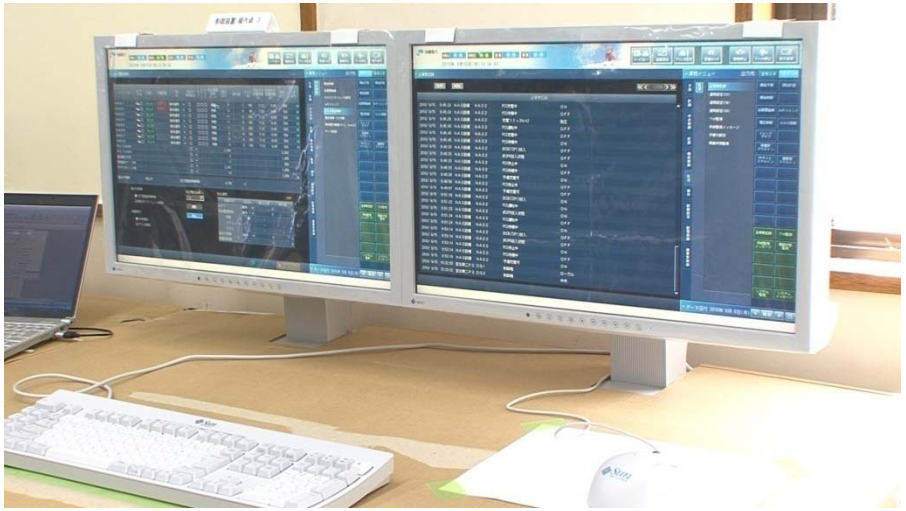
# Configuration of Miyako Island Mega-Solar Demonstration Research Facility



Existing Wind Turbine Generation

Miyako No.2 Power Station

Central control room of Miyako No.2 Power Station



Central Control System


NAS PCS

MW PV

NAS Battery

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# Contents of the Demonstration Research

1. Smoothing-Out Effect of the Output Power of PV
2. Smoothing-Out Effect of the Frequency by storage battery
3. Scheduled Operation of PV
4. Optimal Control Hierarchy Using Test-use Power Distribution Lines

# Contents of the Demonstration Research

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# 1) Smoothing-Out Effect of the Output Power of PV

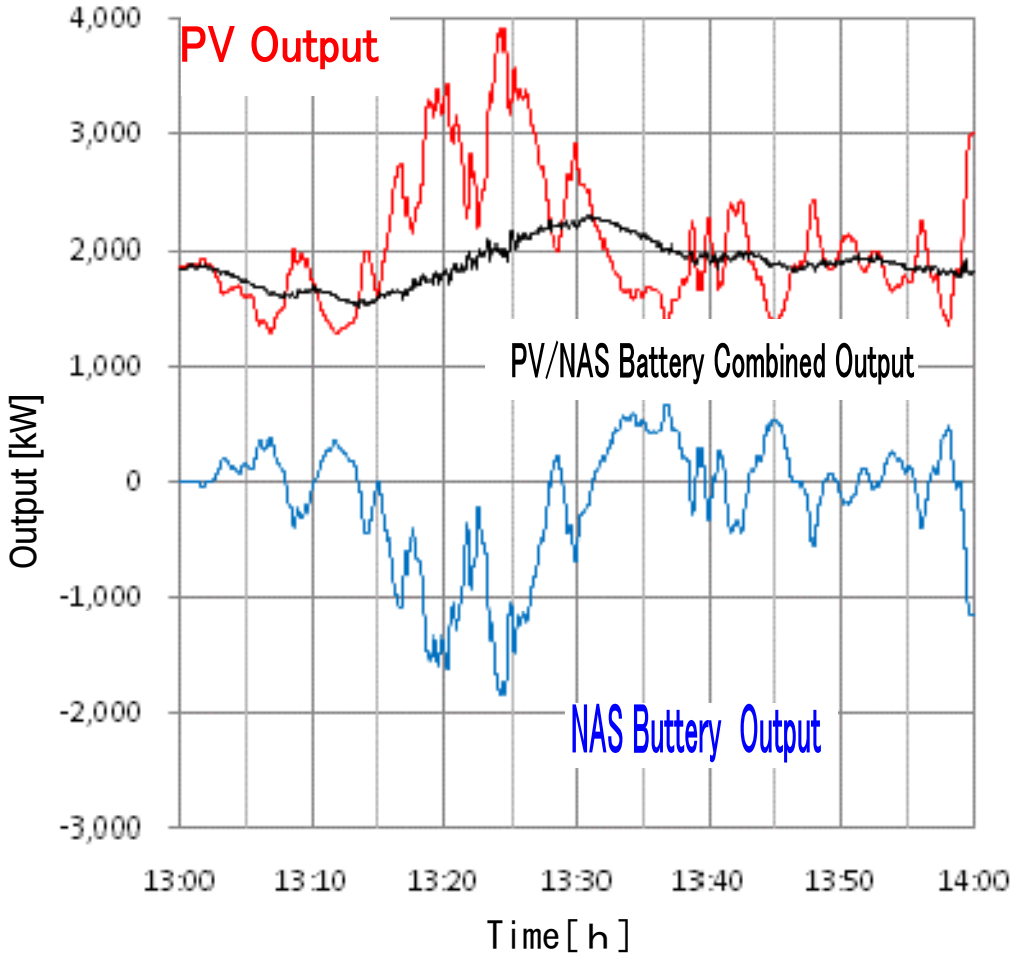
## Objective

- To test the control functions that will smooth the precipitous variations of PV, and to show the optimal capacity of the storage battery.

# 1) Smoothing-Out Effect of the Output Power of PV

(1) Validation of the output fluctuation control effect

We validate the control function that stabilizes the PV power supply, by smoothing abrupt PV output fluctuations, using a combination of PV and storage battery. This validation confirms the smoothing effect that varies with storage battery capacity. Through such validation, the optimum storage battery capacity is determined, and an ideal method of its control is developed.




(1)Validation of the output fluctuation control effect
(Measured value)

## 2) Smoothing-Out Effect of the Frequency by storage battery

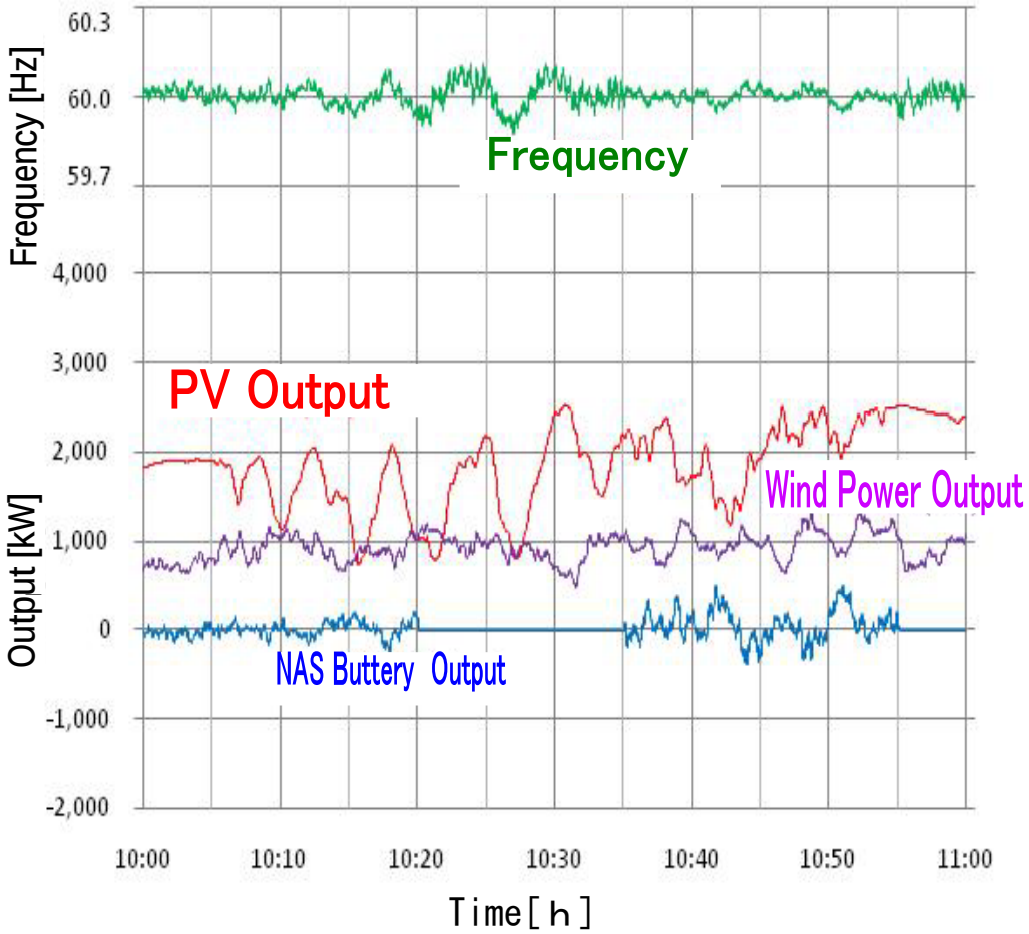
# Objective

- To test the frequency adjustment functions of the combination of PV and storage battery in addition to the frequency control of existing power sources, and to show the optimal capacity of the storage battery.

# 2) Smoothing-Out Effect of the Frequency by storage battery

(2) Validation of the frequency fluctuation control effect

We validate the frequency stabilizing function of the combination of PV and storage battery (means for actively supporting frequency control), with the frequency control of the existing power source. The frequency fluctuation control effect is evaluated both in the normal state and emergency (assuming entire failure of PV power generation due to a system accident). Based on the evaluation results, a storage battery control technique is developed for improving the frequency control effect, while the optimum capacity of the storage battery is determined.




(2)Validation of the frequency fluctuation control effect (Measured value)

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# Conclusion

- The demonstration research was started in Oct. 2010, and the following action was performed
  - Smoothing-Out Effect of Output Power of PV
  - Smoothing-Out Effect of the Frequency

# Following Action

- Determine optimal capacity of the storage battery
- Test the contents of the Demonstration Research as following
  - Scheduled Operation of PV
  - Optimal Control Hierarchy Using Test-use Power Distribution Lines
- Carbon-dioxide and electricity cost reducing by promoting the introduction of renewable energy in remote island with a finding technique for stabilized  of electric power system from demonstration research.
- Expect to spread findings out Pacific counties out, too.

# Power system stabilization - Future Possibilities

## ◆Demand side approach

Supply Side

PV

Battery

Electric Power Plant

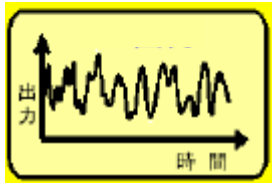
Demand Side

Heat Pump and Thermal Storage System

Electric Vehicle

## ◆Power system stabilization

PV

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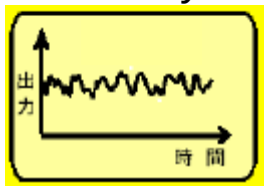
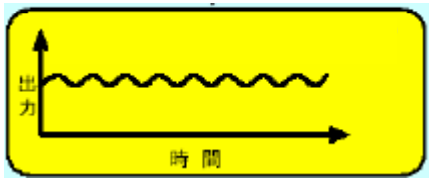
Battery

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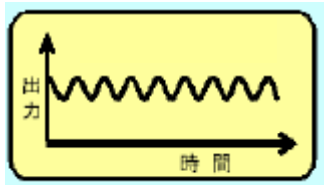
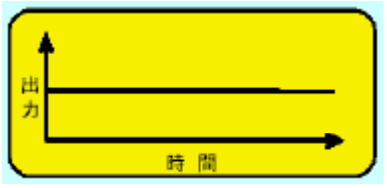
Heat Pump, EV




Stabilized power system



# *Thank you for your attention*