



# Japanese Island Grid Experience

**New Energy and Industrial Technology Development Organization  
Smart Community Department**

**Satoshi Morozumi**

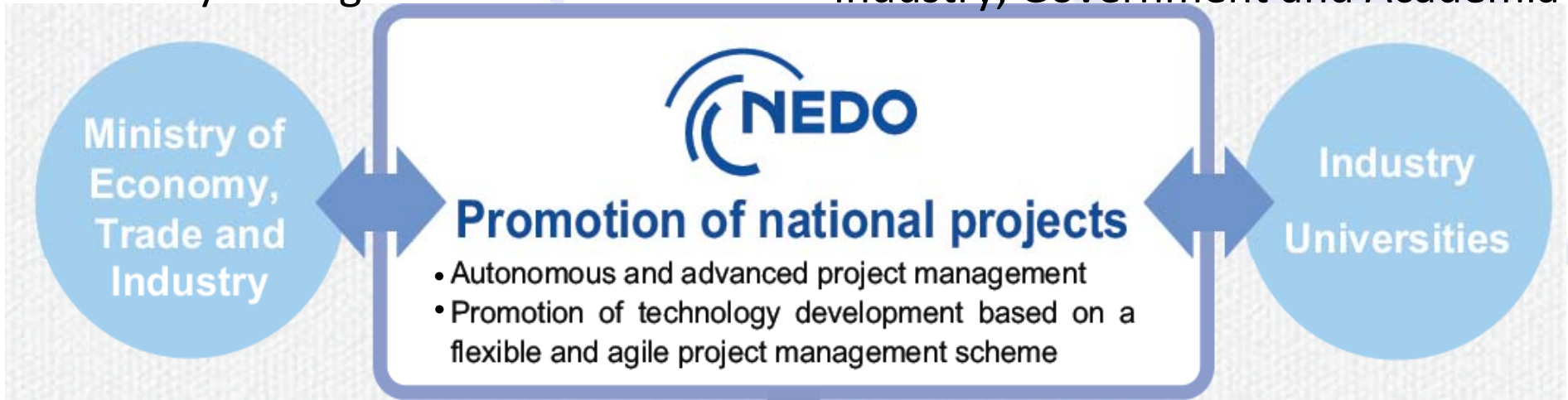
# NEDO's Mission



New Energy and Industrial Technology Development Organization

Coordination with  
Policymaking Authorities

Combined Efforts of  
Industry, Government and Academia



- Addressing energy and global environmental issues through technology development and international collaborative demonstration projects
- Enhancement of cutting-edge industrial technologies

# History of Micro-grid related activities in Japan



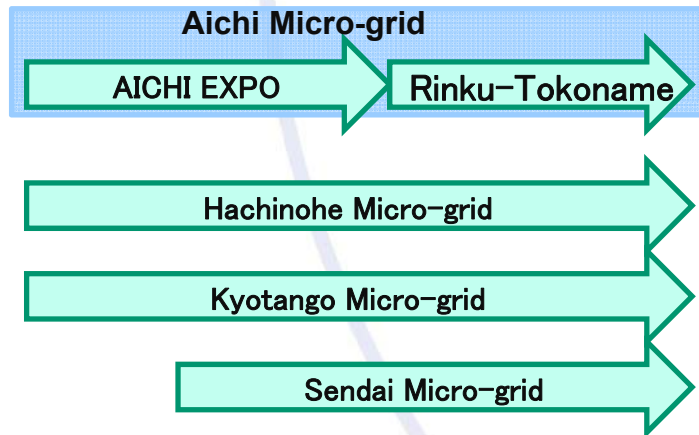
2000

2005

2010

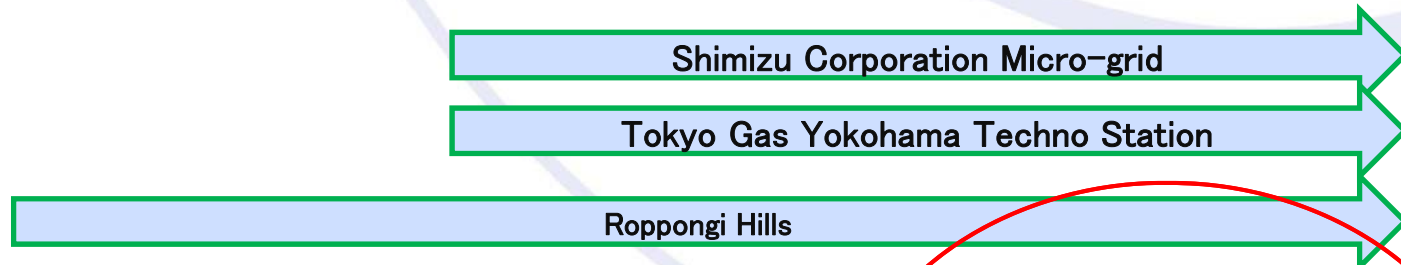
2013

**NEDO four Micro-Grid Projects**



EMS for Hachinohe Project

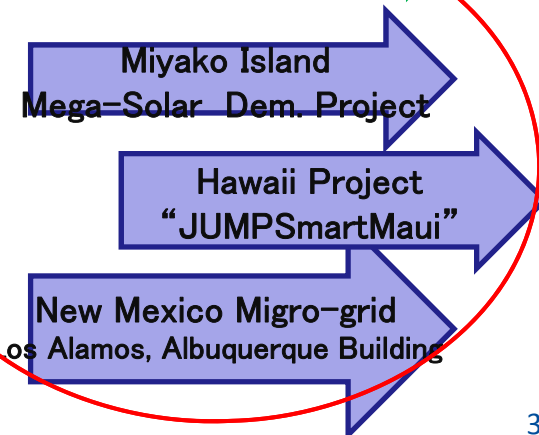
**Private Micro-Grid related Projects**



Miyako-jima Mega Solar by Okinawa Electric

**METI Supported Micro-Grid Related Projects**

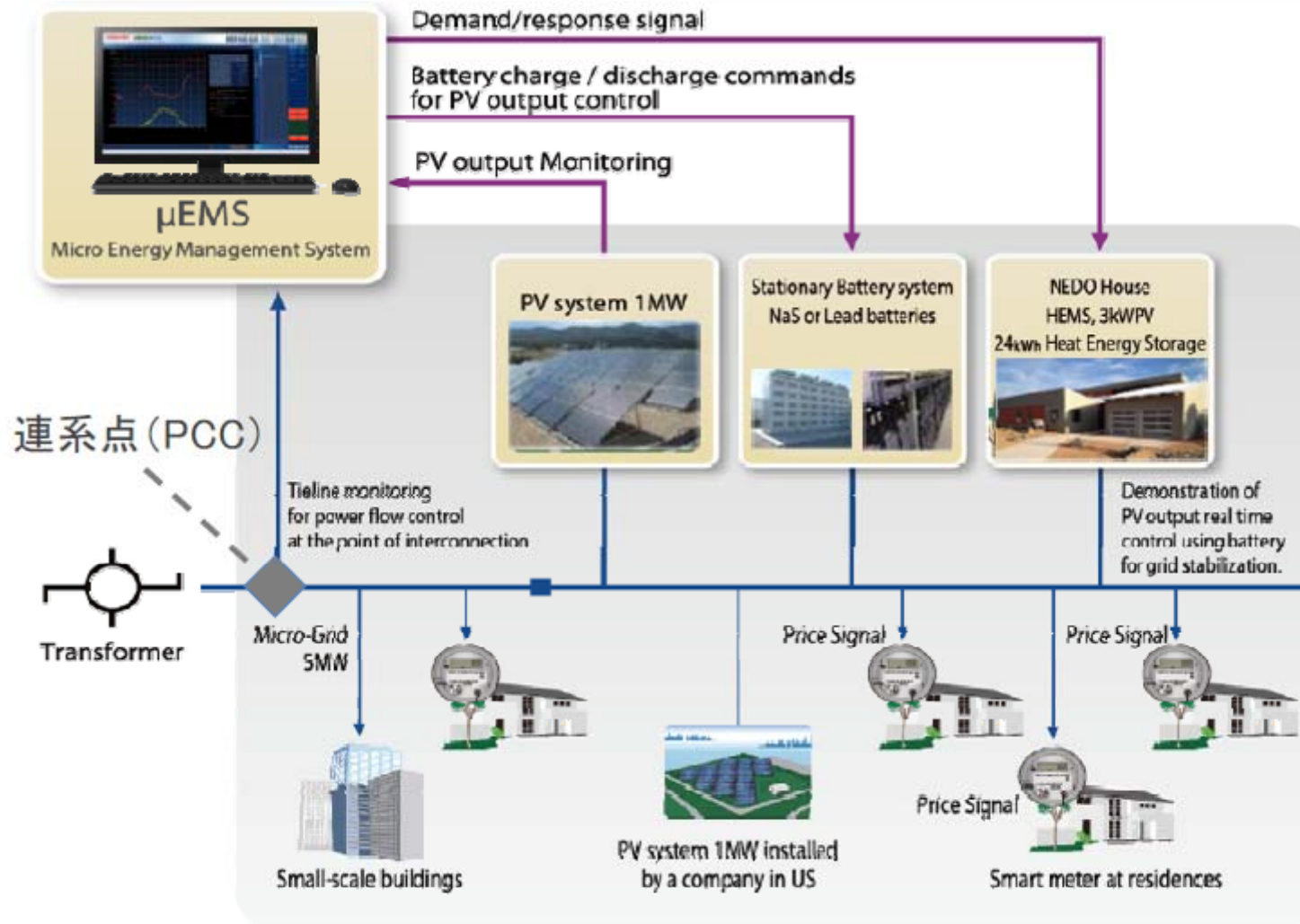
**NEDO Supported Micro-Grid Related Projects**





# NEW MEXICO DEMONSTRATION

# Micro Grid in Los Alamos County



# Demonstration Facilities in Los Alamos



**Long Life Lead Acid Battery**



**NaS Battery**



**Local Energy management system**

**Inverters for Mega Solar**



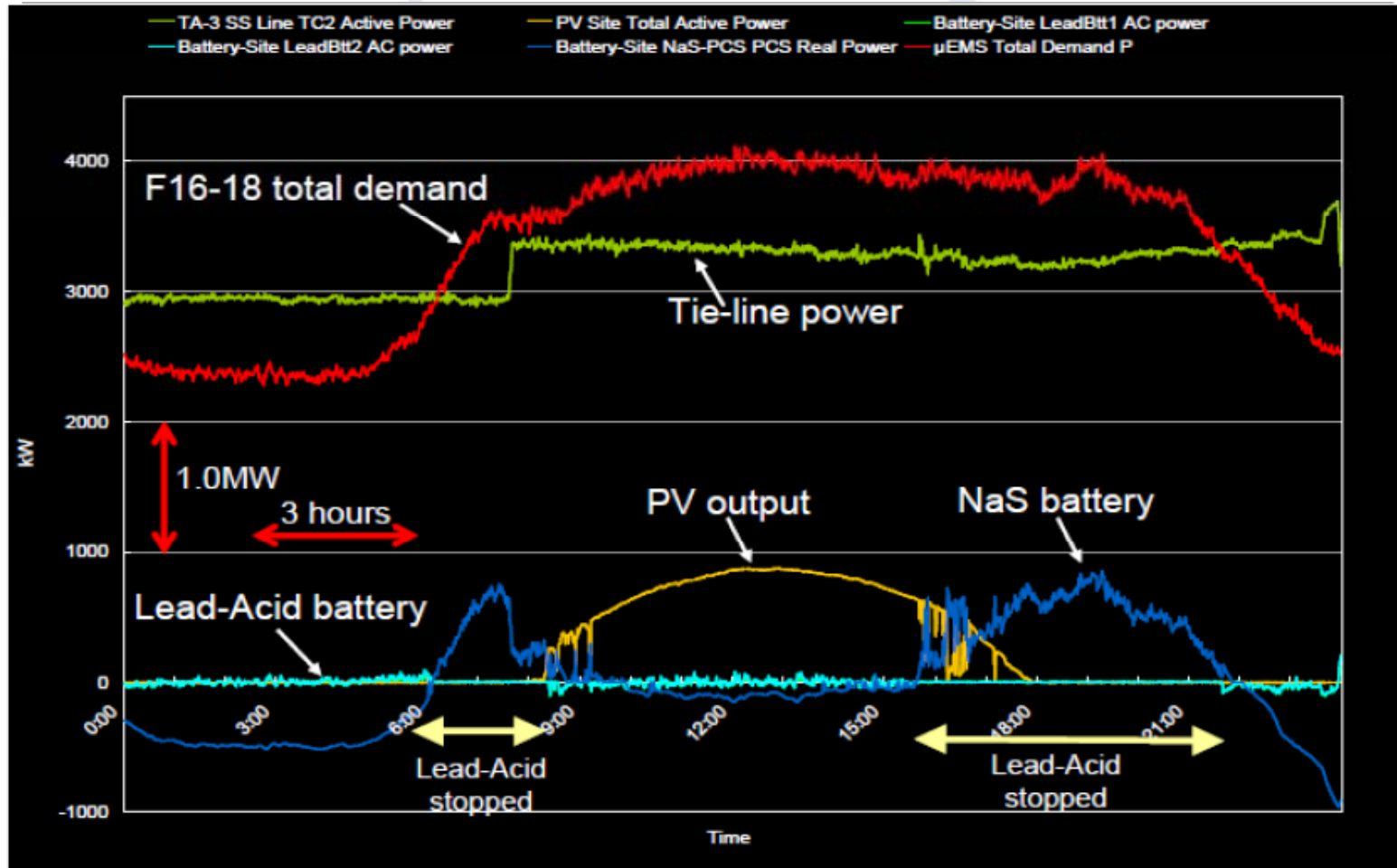
**1MW Mega Solar**



# Daily Operation of Los Alamos Micro-Grid Feeder



“Creating Duck Curve condition artificially, and demonstrating battery operation to make flat power flow at PCC”





## **Hawaii Maui Demonstration**



# Status of Maui Island



- State of Hawaii depends fossil fuel as the highest of 50 states in USA. Electric price is around 40cent/kWh and also the highest in the all of states
  - Hawaii state has a target to penetrate renewable energy as 40% of all of energy consumption.
- ↓
- Recent peak demand in Maui island (Population: 144 thousands) is almost 200MW. 70MW of wind power and 40MW of PV are installed. 30% of consumed energy is supplied by renewable energy.
- ↓
- Target of Maui is 100% renewable energy island achieved within the next 30 years.
  - Big issue is how to manage renewable energies whose output can not be controlled.



So, NEDO and state of Hawaii started “Jump Smart Maui” project.

2011	2012	2013	2014-2016
Feasibility Study	System Design	Construction	Demonstration

# Hawaii-Okinawa Clean Energy Cooperation



- The Signing Ceremony of the Memorandum of Cooperation on the Okinawa–Hawaii Clean Energy Cooperation took place on Thursday, June 17<sup>th</sup> at Ministry of Economy, Trade and Industry.
- Signatories included Economy, Trade and Industry Minister Naoshima, U.S. Ambassador to Japan John V. Roos (on behalf of the U.S. Department of Energy), Governor of Okinawa Nakaima and Governor of Hawaii Lingle.



# Japan-U.S. Collaborative Demonstration Project for World-leading Remote Island Smart Grids in Hawaii



## Project Overview

Japan and the U.S. will collaboratively conduct a demonstration project on world-leading remote island smart grids that can absorb the fluctuating output of renewable energy. Use of the smart grids will be promoted for other islands as well as subtropical areas.

Project activities

- Demonstration of smart grids using fragile island grids
- Demonstration of technologies for improving distribution systems

## Objectives

- The objectives of the project are to establish a world-leading remote island low-carbon society using renewable energy as well as EVs, and to promote it as a showcase throughout the world.
- The project also aims to symbolize cooperation between the U.S. and Japan by collaborating with other smart grid projects that are currently being carried out on the island.

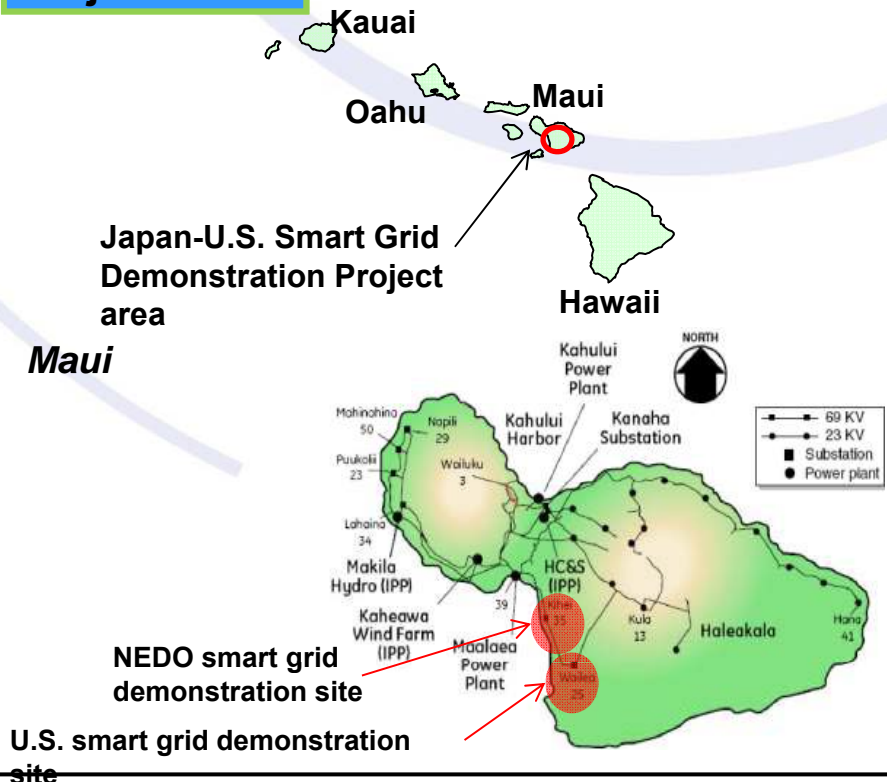
## Background

The project will be carried out based on the Japan-U.S. Clean Energy Technologies Action Plan agreed to during discussions held at the Japan-U.S. summit meeting in November 2009.

## Budget and Period

Project budget: Up to US\$ 375,000 (feasibility study)  
(¥120=\$1,00) Approximately US\$ 55.0 million  
(demonstration project)  
Feasibility study period: First quarter of FY2011  
Project duration: FY2011-FY2016

## Project Sites



# Project Overview



## ***(I) EV Based Remote Island Smart Grid Model on Maui***

- In order to mitigate adverse effects on power grids, including the impact of significant changes in power frequencies caused by the fluctuating output of renewable energy, an EV management system (EVMS) using information communication technologies will be established to control EV charging (30-200 stands) and storage batteries (500 KW-1 MW) for power grids that serve as a substitute for storage batteries for EVs.
- The EVMS will be established to achieve an EV charging management system that does not cause effects (voltage and low-voltage transformers overload ) on the distribution system by charging EVs.

## ***(II) Smart Grid Model at a Substation with One Distribution Grid Level in Kihei***

- A distribution management system (DMS) using information and communications technologies will be established in order to control EV charging, storage batteries for grids, FACTS devices, smart PCSs for PV as well as electric hot water heaters. The effectiveness of the DMS in solving issues such as reverse power flow from PV systems connected to the end of a distribution grid and overload on low-voltage transformers, which occurs when charging multiple EVs simultaneously, will be demonstrated.
- The DMS compatible with higher systems is expected to stabilize the frequency and optimize energy management in the entire grid system.

## ***(III) Smart Grid Project for Low-voltage Transformer Level Systems***

- A  $\mu$ -DMS using information and communications technologies will be established at the low-voltage transformer level in order to control EV charging, storage batteries, smart PCSs for PV and electric water heaters.
- The effectiveness of the  $\mu$ -DMS compatible with DMS in solving issues such as reverse power flow from PV systems connected to general users and overload on low-voltage transformers, which occurs when charging multiple EVs simultaneously, will be demonstrated.

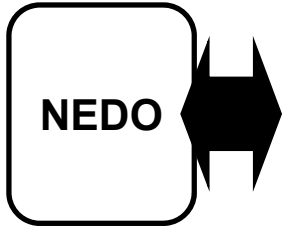
## ***(IV) Comprehensive Research***

- The effectiveness of smart grids developed for this collaborative project will be analyzed and evaluated.
- Cyber security activities will be evaluated.
- The economic efficiency of systems developed for the project will be evaluated.
- Business models for establishing a low-carbon society on a remote island will be established and assessed.

# Project Framework

Japanese side

Entrustment



**Hitachi, Ltd.**

- Project leader
- EV-based remote island smart grid model on Maui
- Smart grid model at a substation with one distribution grid level in Kihei
- Smart Grid Project for Low-voltage Transformer Level Systems
- Collective research on overall project

**Mizuho Corporate Bank, Ltd.**

- Collective research on overall project (analysis and evaluation of the effectiveness of smart grids and the economic efficiency of systems developed for the project, establishment and assessment of business models)

**Cyber Defence Institute, Inc.**

- Collective research on overall project (evaluation on cyber security)



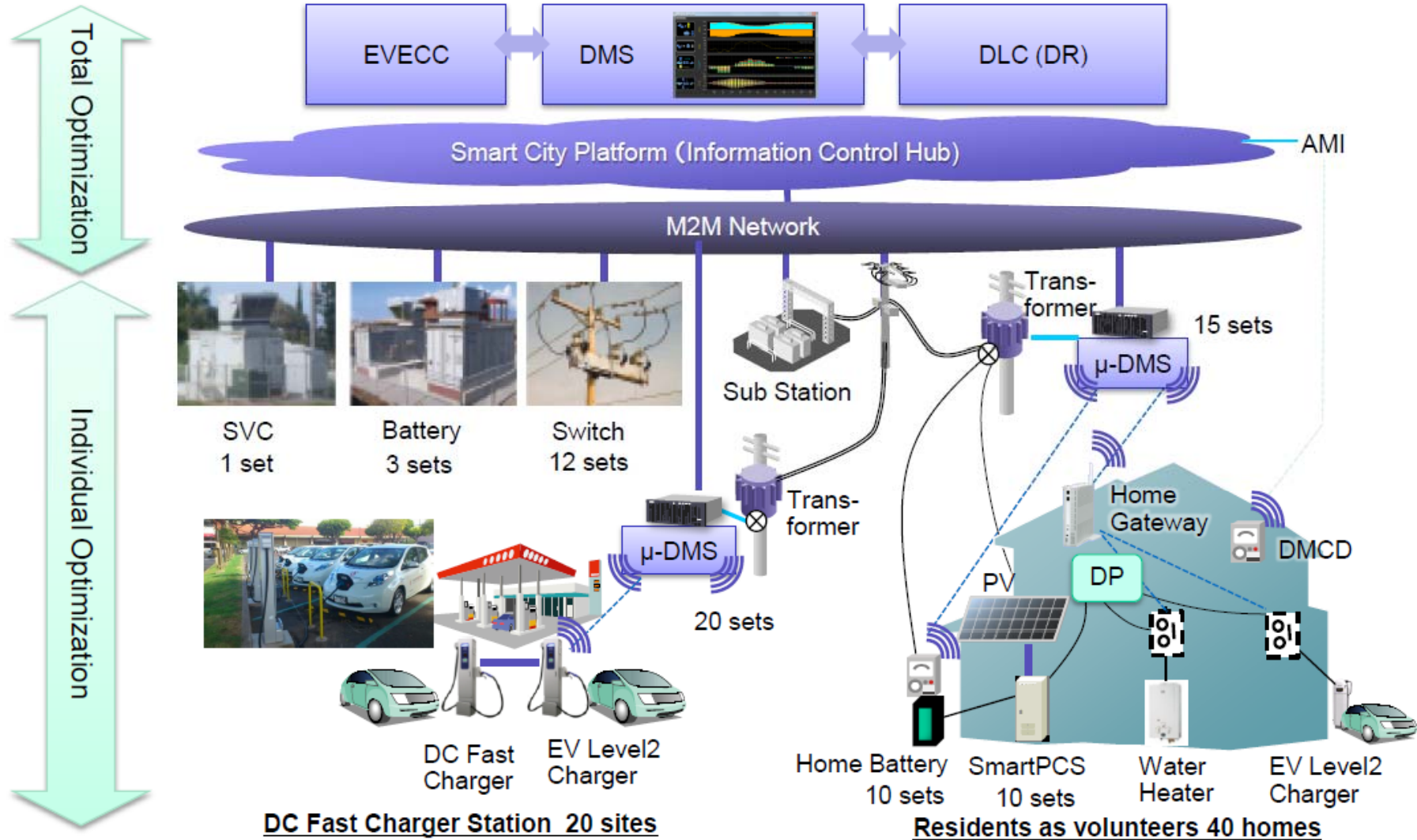
USA side



Hawaii State (DBEDT)

HECO  
HNEI  
MECO  
Maui County  
MEDB  
.....  
Several US companies

# Demonstration Facilities on Maui

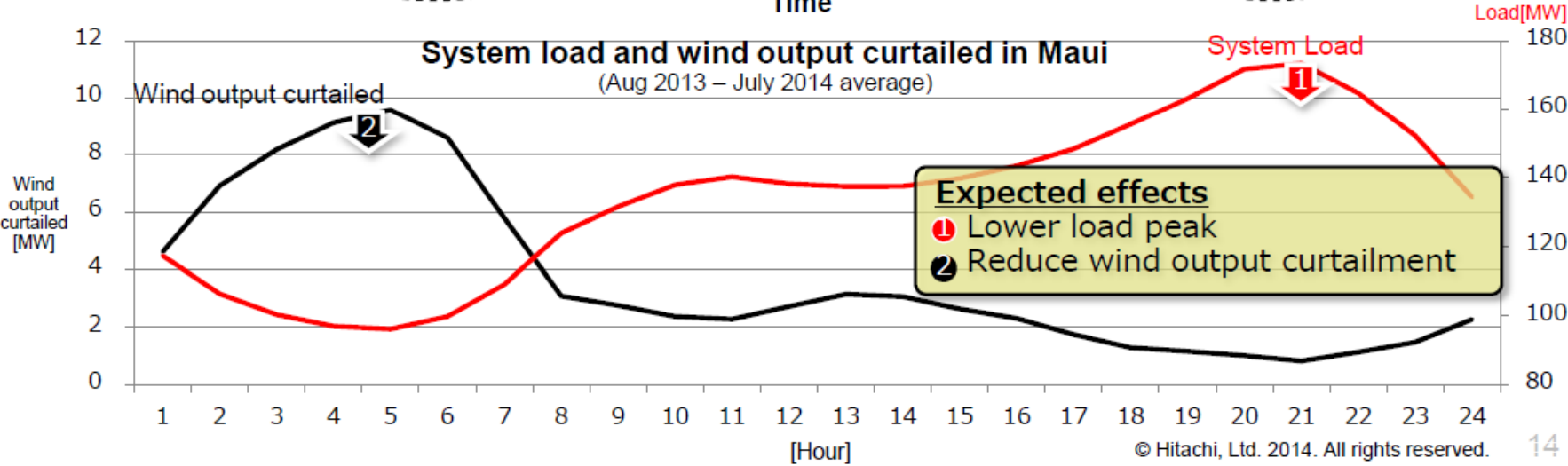
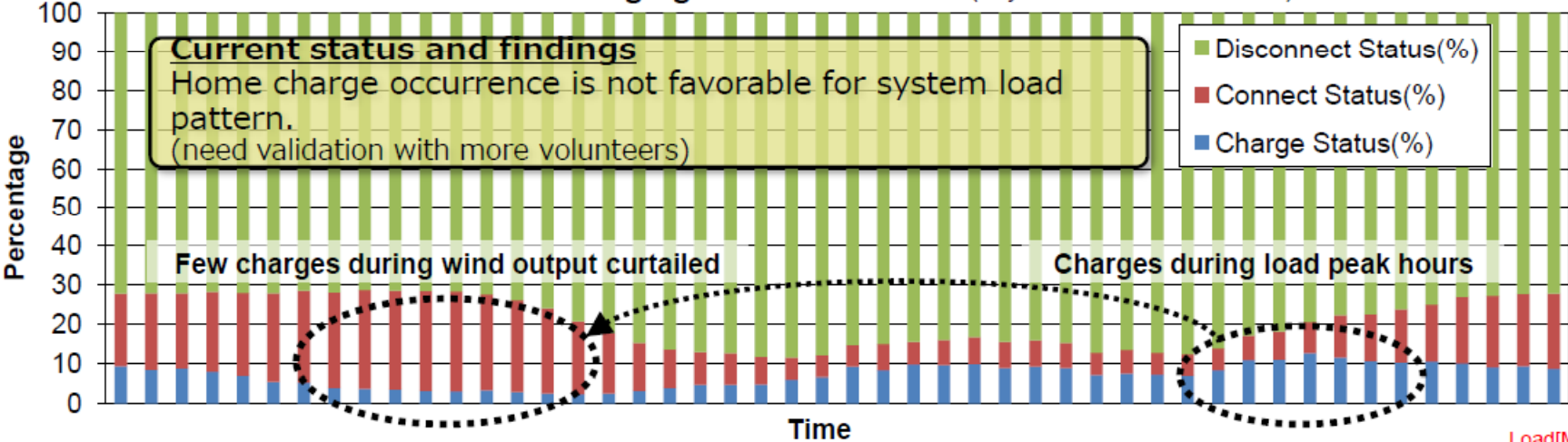


By Hitachi

# Shifting of Charging Demand of EV



**JSM volunteer charging behavior at home** (July – Mid-Oct. / 45 volunteers)



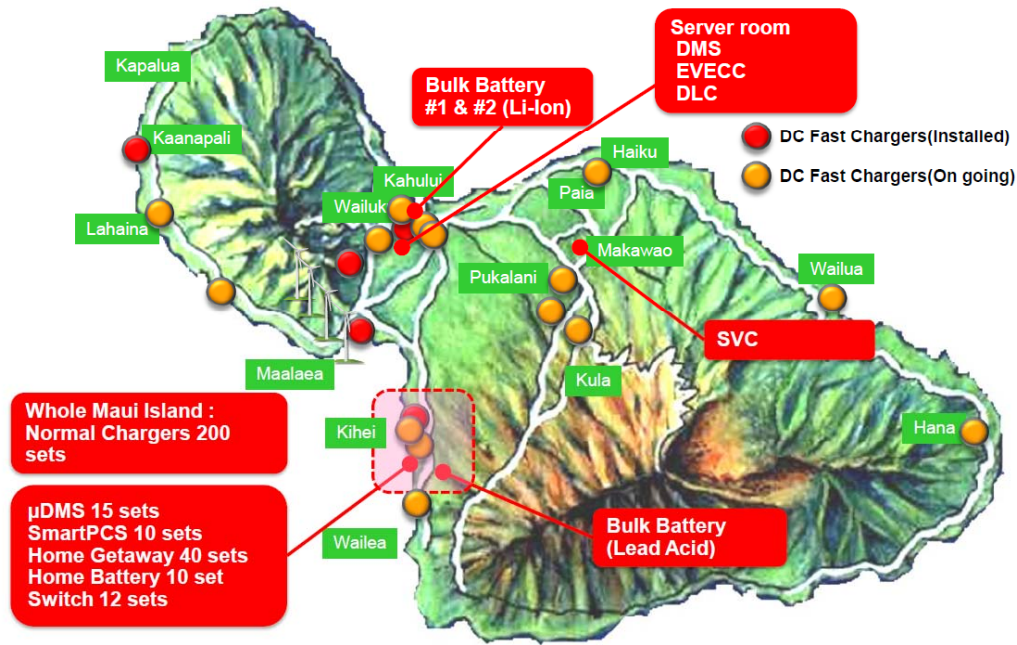
# Installation of Quick Charger



Participated EVs  
Of the volunteers

250 (Currently)

↓  
400 (March 2016)

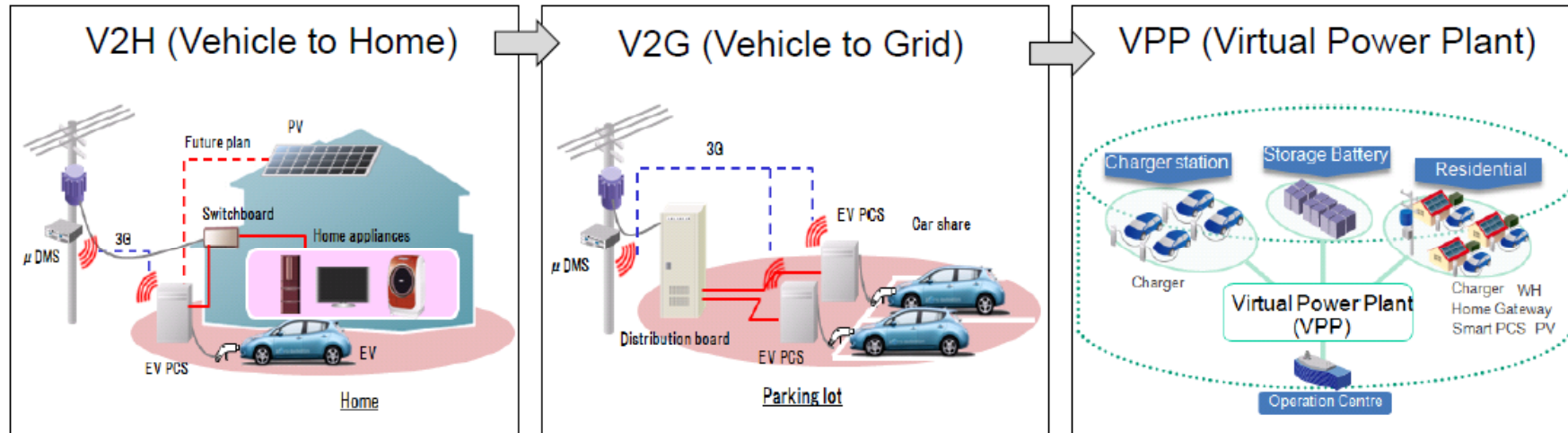




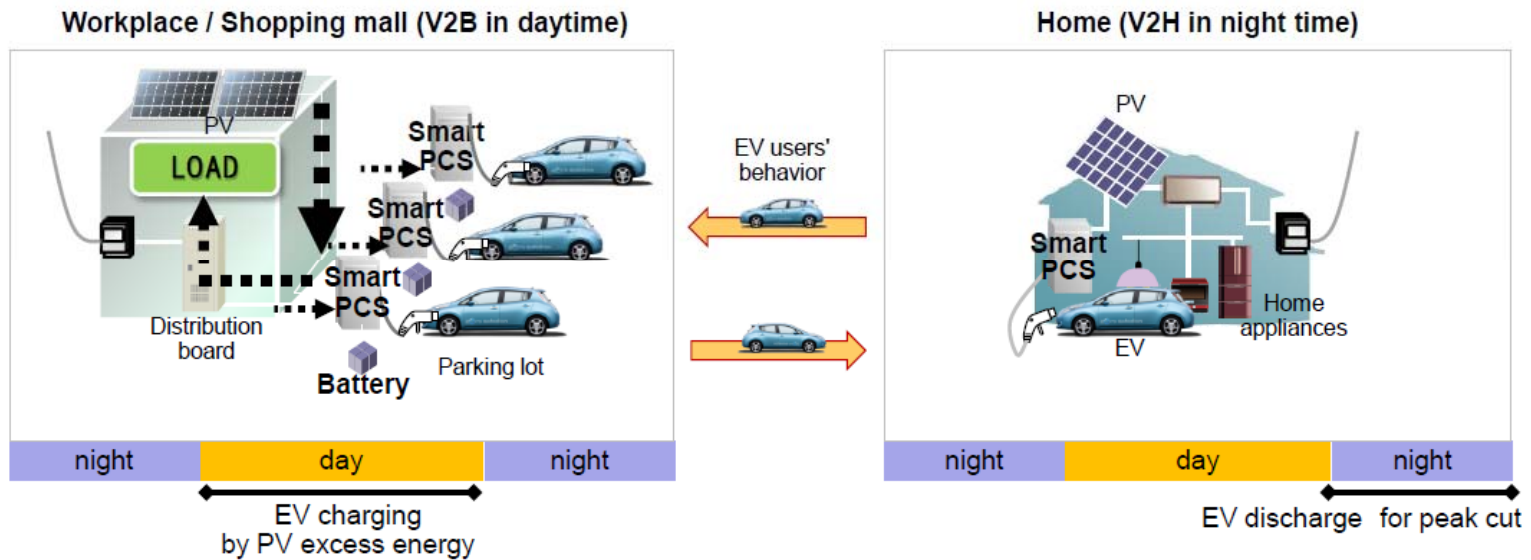
# V2X demonstration



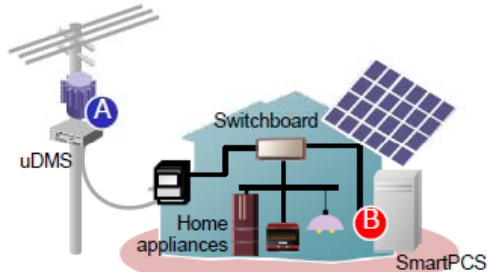
## 1) From V2H to VPP



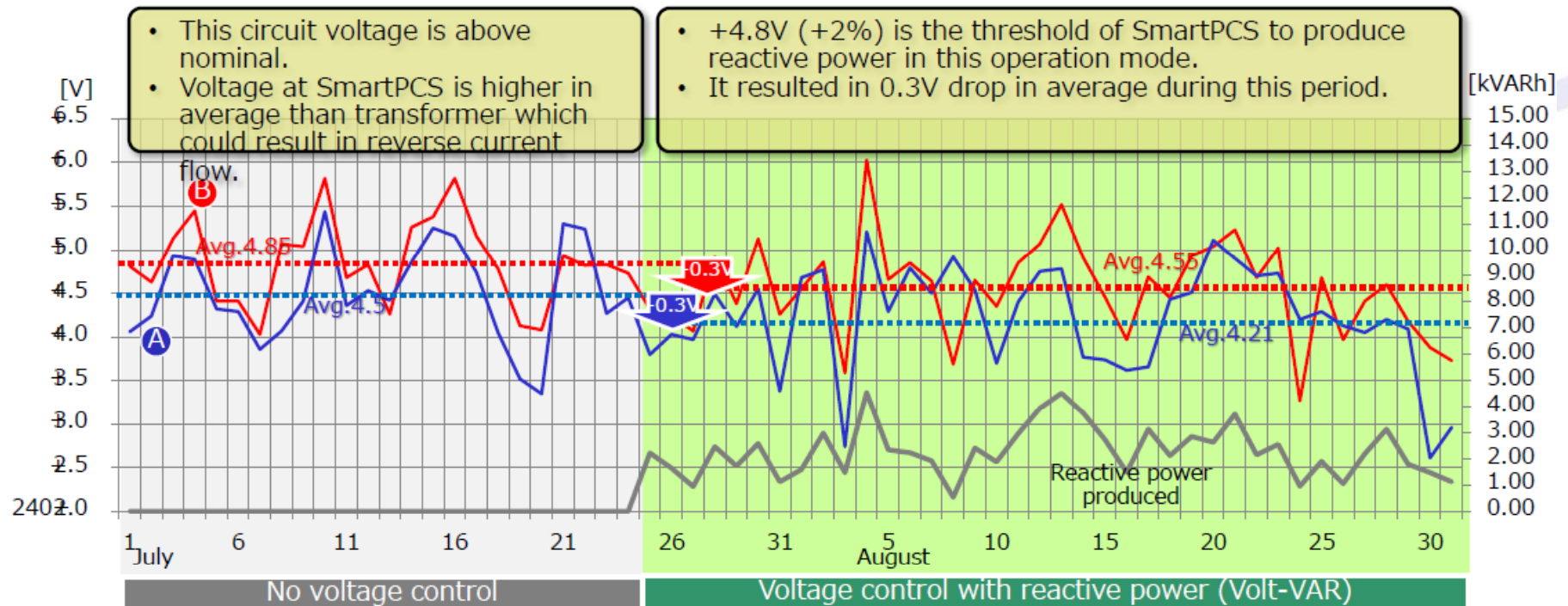
## 2) Strategic choice of charging point



# Demonstration of Smart Inverter



**A**: on secondary of the transformer  
**B**: at SmartPCS grid connection point



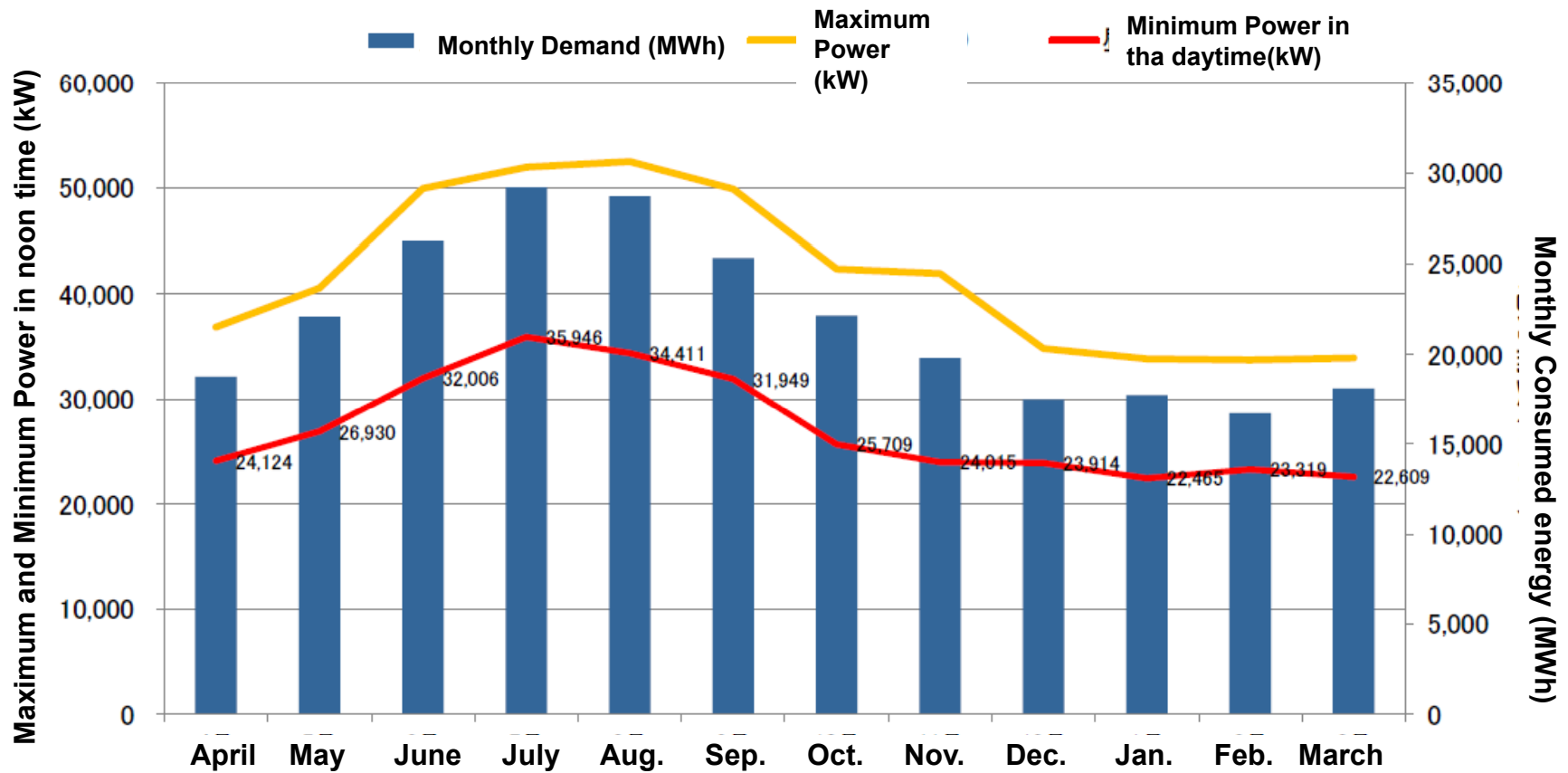


# MIYAKO-JIMA STATUS AND THE PROJECTS

# Recent Situation of Penetration of Renewable Energy in Miyako-jima

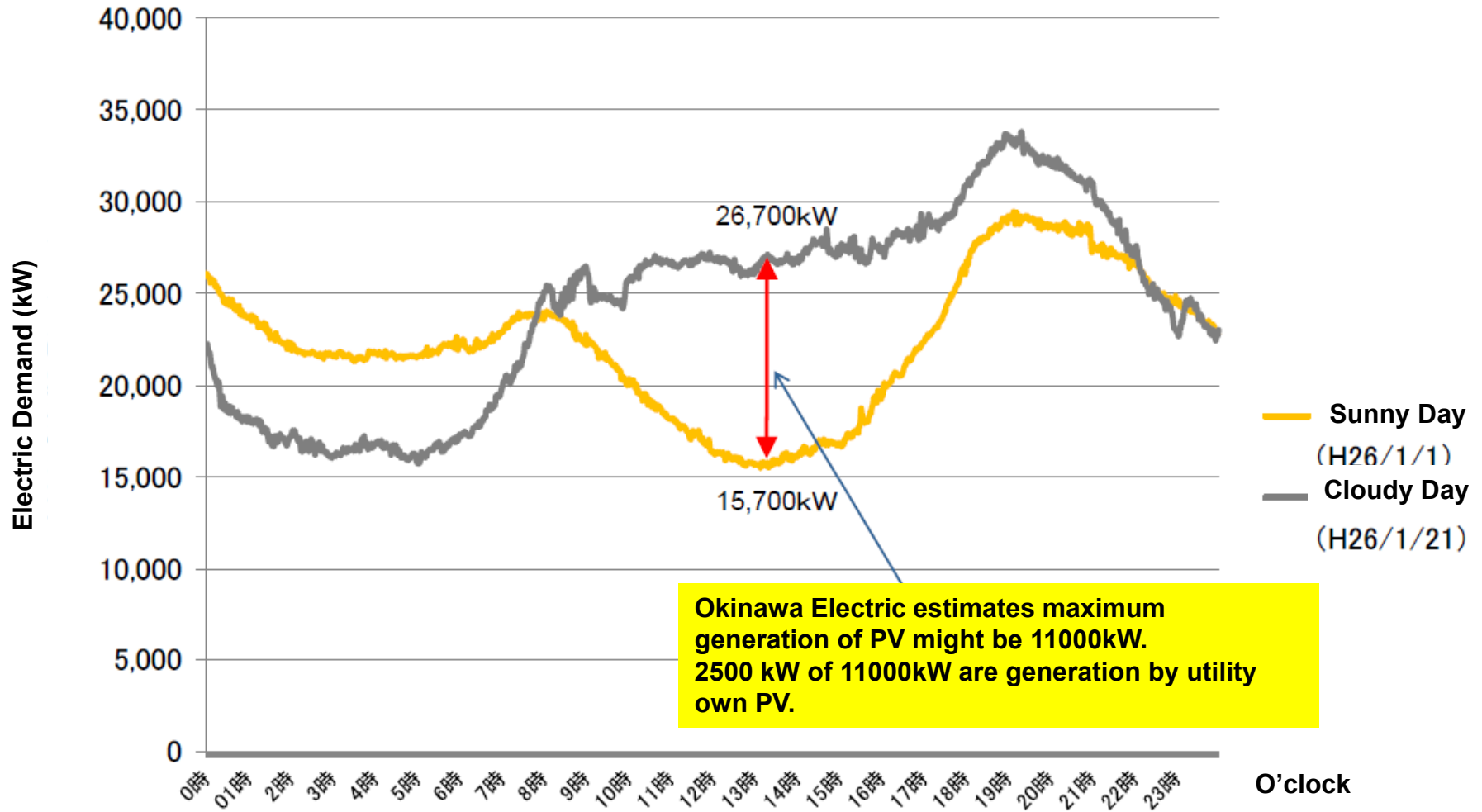


## Electric Demand in Miyako-jima Grid in FY2011



Refer to The Okinawa Electric Power Co.,Inc.

# Recent Situation of Penetration of Renewable Energy in Miyako-Jima



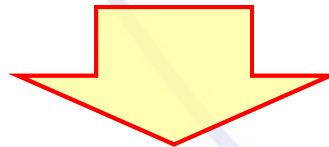
Refer to The Okinawa Electric Power Co.,Inc.

# Connectable Capacity of PV in Miyako-Jima



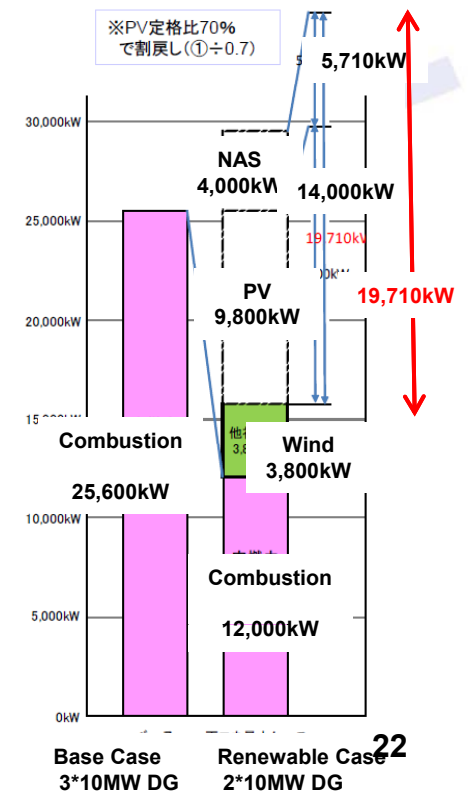
## ■ Connectable capacity of PV

- ✓ Okinawa Electric estimates “connectable PV capacity” from the view point of keeping frequency within  $60 \pm 0.3\text{Hz}$  is 9,830kW.
- ✓ Okinawa Electric estimates “connectable PV capacity” from the view point of minimum requirement of combustion generation is 19,710 kW. In this number, 4000kW NaS Battery support is considered. Also, 70% of capacity factor of PV is also considered.

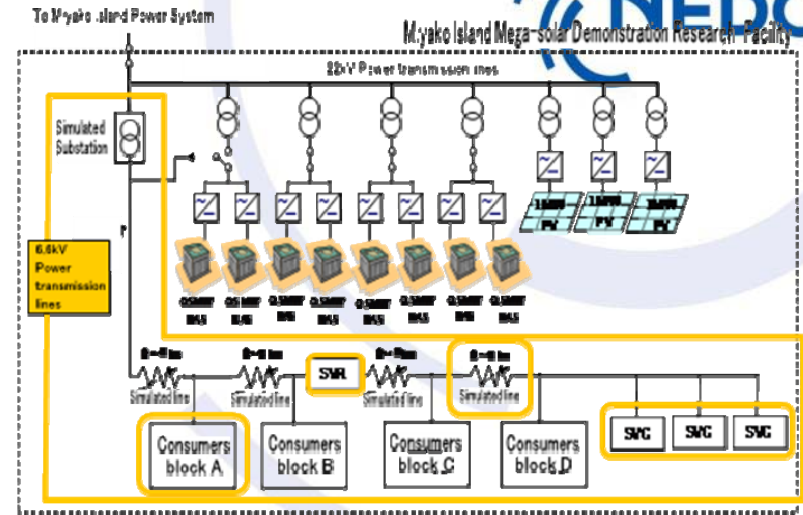


- ✓ Okinawa Electric asks to new PV connection to make contract to disconnect PV in winter three months, or installed “PV capacity (kW × 6hours)” capacity of battery storage system. The battery system must discharge in the period between 18 O’ clock and 8 O’ clock.

Refer to The Okinawa Electric Power Co.,Inc.



# Miyako Island Mega-Solar demonstration project (2009-2014)



- PV 4.0MW
- Battery 4.1MW(NAS, LiB)
- Existing Wind Turbine (900kW x 2)

Demonstrative Project of Renewable Energy on Off-Islands with Small Independent Grid in 2009 from METI



Refer to The Okinawa Electric Power Co.,Inc.

# Miyako Island Mega-Solar demonstration project



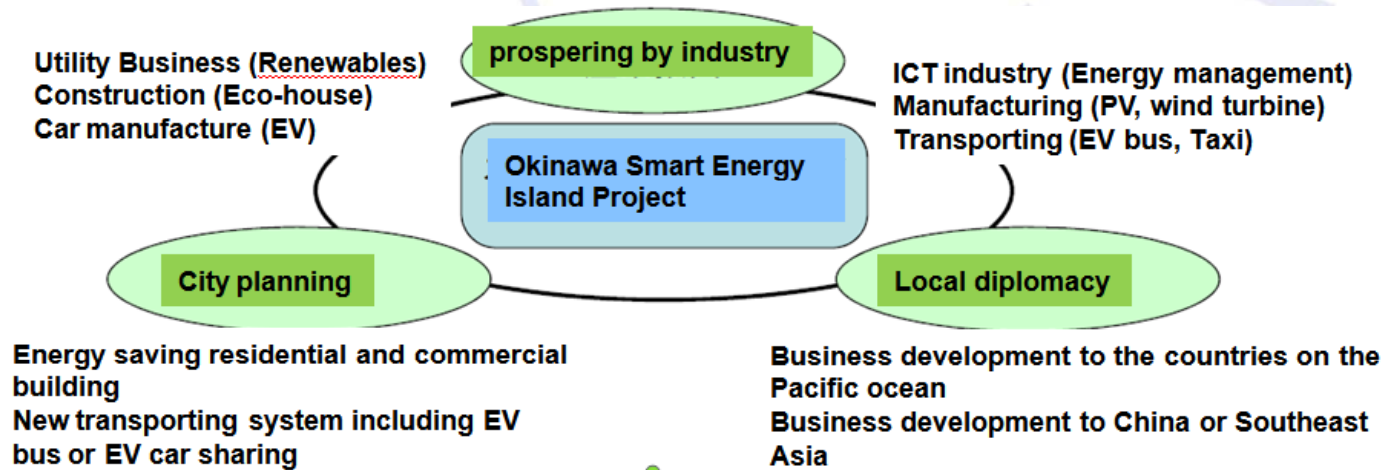


# Okinawa Smart Energy Island Project



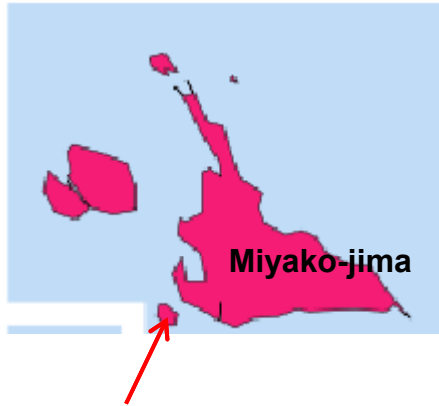
Period: FY2011–FY2014 : By the furtherance of Cabinet Office of Japanese Government

Purpose: Through the demonstration of subtropical island smart grid, it builds a base prospering by industry of Okinawa. Also, the result should be reflected to city planning of Okinawa and local diplomacy.

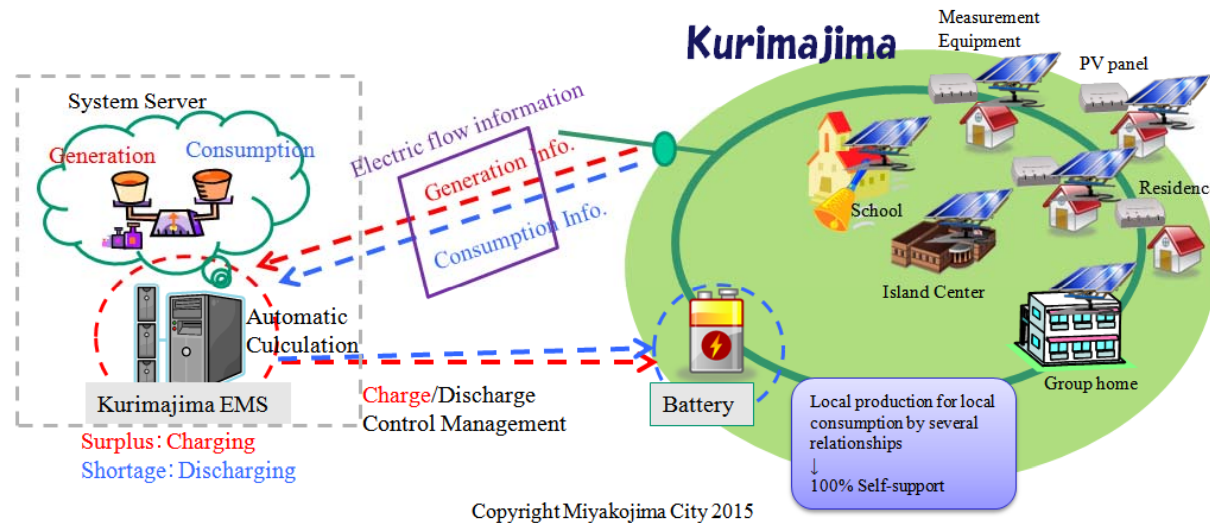


Okinawa Prefecture

# Okinawa Smart Energy Island Project : Development of Pilot Project for All-Miyako Island Energy Management System



Kurima-jima



## 【Outline】

To contribute to secure energy security and reduce CO2 emission by construction of model utilizing maximum utilization of renewable energy, “Island Model utilizing 100% Renewable Energy” supplying all energy by renewable energy will be realized by utilizing existing wind in Miyakojima with new solar and battery installed into customer.

【Period】2011 fiscal year ~ 2016 fiscal year

Refer to Miyakojima-City



100kW SCiB battery storage system



**THANK YOU FOR ATTENTION**