APEC EGNRET 51, Chang Mai, Thailand

Microgrid system

Energy Management and Storage in Japan

September 13th, 2018

Takao Ikeda
The Institute of Energy Economics, Japan
(IEEJ)

◆Major Demonstration Projects on Microgrid in Japan

◆Major Outcomes from the projects

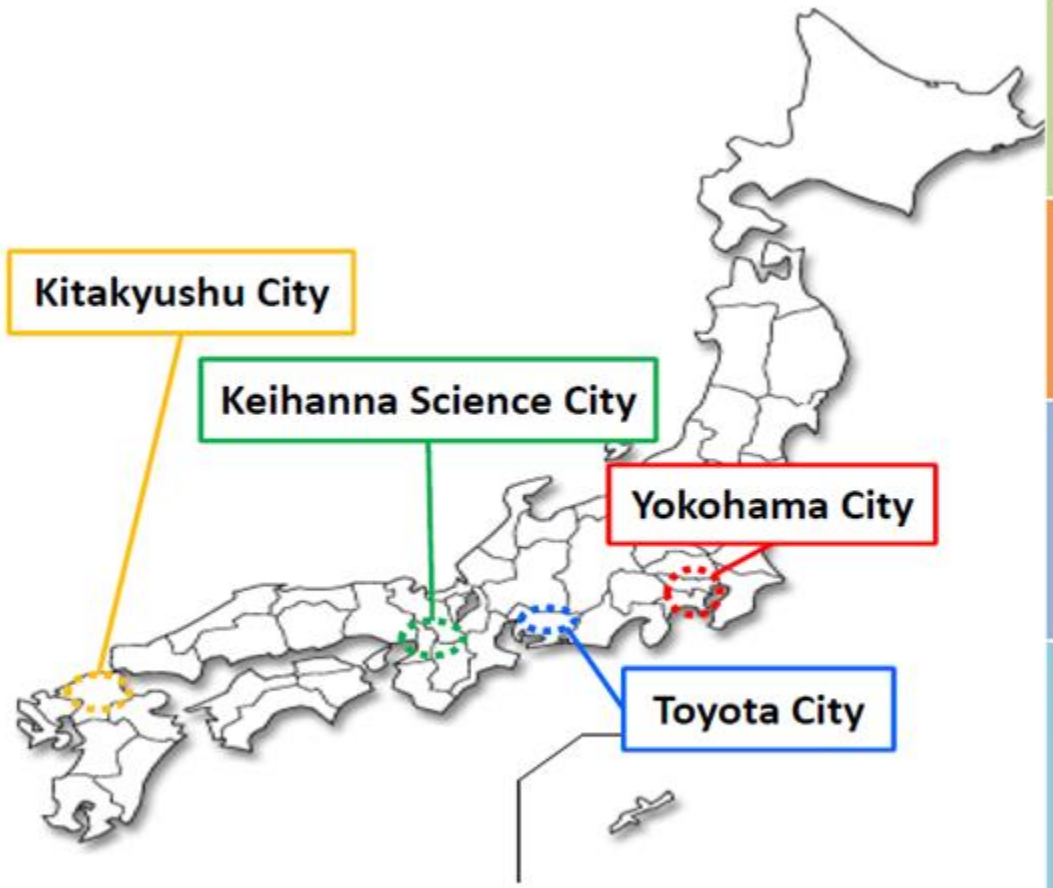
◆Current Situation: Commercialization
and further demonstration

Major Demonstration Projects on Microgrid in Japan

- Demonstration Projects on Smart Community:
  - Smart Community Demonstration Projects in 4 area (FY2010-FY2014)
  - Industrial Smart Community Demonstration Project on “F-Grid” (FY2012-FY2015)
- Major Demonstration Projects on Island Microgrid system:
  - Demonstration Project on deployment of RE in Islands Grids (FY2009)
  - Okinawa Smart Energy Island Infrastructure demonstration (FY2012 -)
  - Oki-Hybrid Project (FY2014-FY2018)
  - Koshiki Island Reused Battery Project(FY2015-2017)
  - Demonstration project for All Island EMS in Miyako Island(FY2011-2017)
- Okinawa-Hawaii Partnership on Clean and Efficient Development and Deployment (2010-2015, 2015-2020)
  - Microgrid Demonstration Project in Maui, Hawaii (FY2011-FY2016)

Smart Community Demonstration Projects

- Smart Community Demonstration Projects in 4 area (FY2010-FY2014)
  - ➢ Various type of residential area in Yokohama, Toyota, Keihanna and Kita-Kyushu
    ---EMS, Demand Response, IT Communications , V2H etc



Yokohama City	Wide-area metropolis Introduction of an energy management system for an existing wide-area metropolis. As the sample number is high (4,000 households), demonstration using a variety of hypotheses is possible.
Toyota City	Separated housing Automatic control of home appliances in 67 households. Secondary cells equipped in vehicles are used to supply energy to households. Approaches for drivers to alleviate congestion.
Keihanna	Housing development Demand response demonstration based on a point system is being implemented for general households (approximately 700 households) where PV or HEMS automatic control has not been introduced.
Kitakyushu City	Designated supply area In an area where power is supplied by Nippon Steel Corporation, a pricing system where the power price fluctuates for 2 hours afterwards in accordance with the state of supply and demand of energy for the day, applicable to 50 business establishments and 230 households, is being implemented.

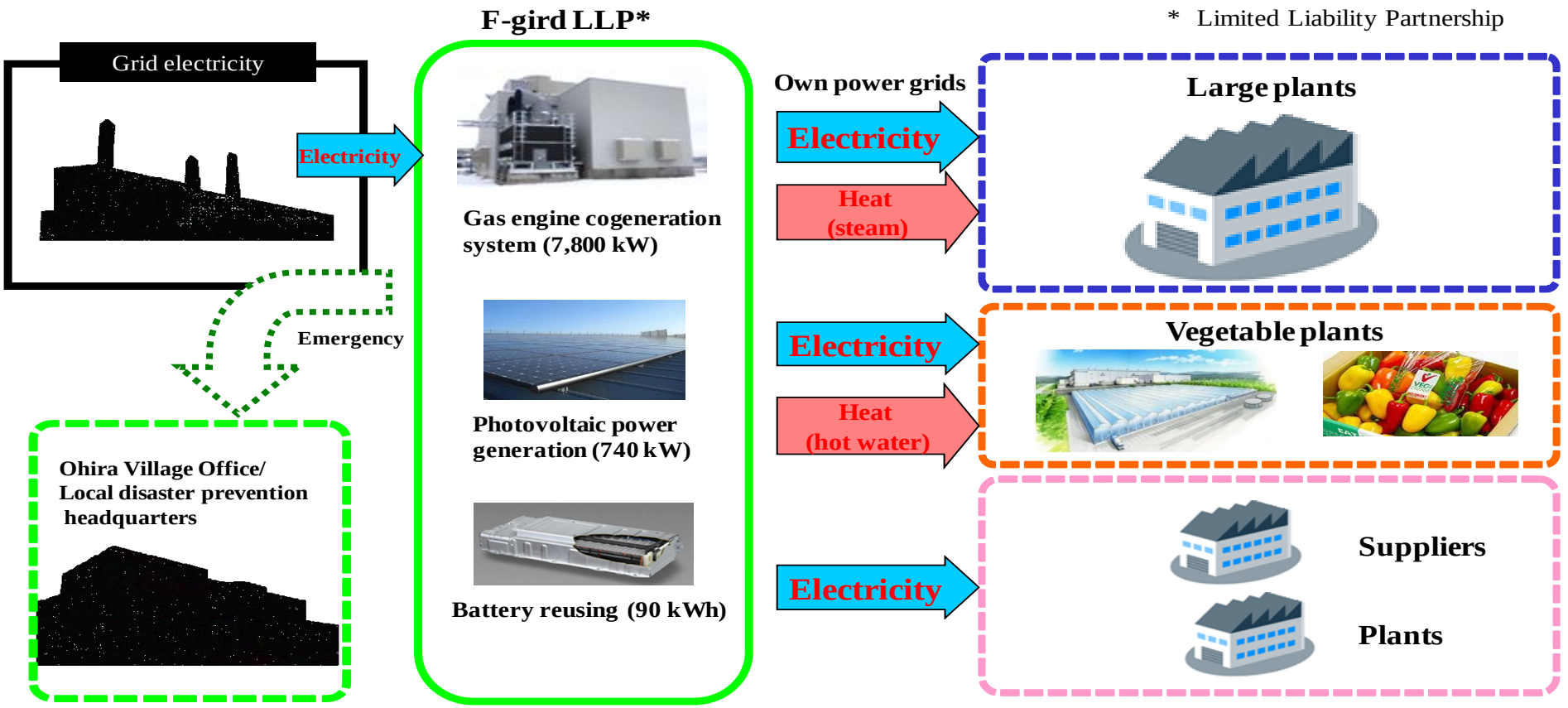
Industrial Park Microgrid system demonstration Project

➢ Industrial Smart Community Demonstration Project on “F-Grid” (FY2012-FY2015)

Industrial Park and adjacent area in near Sendai

--- PV+CGS, EMS, Vehicle related Battery (PHEV, 2nd handed Battery from Vehicle)

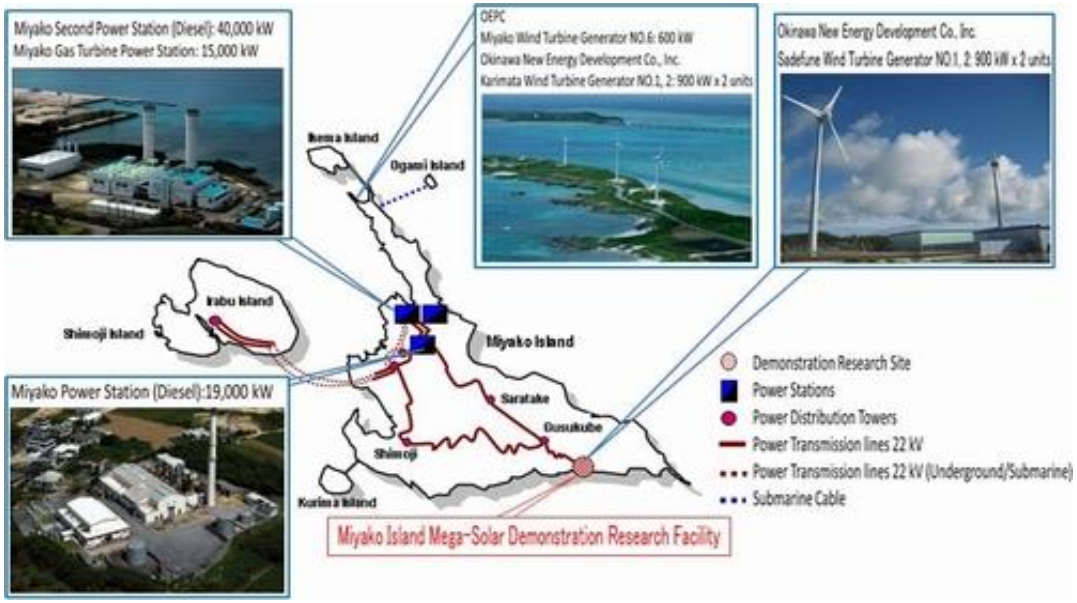
*Key Technologies are based on above Toyota and Kitakyushu smart Community Projects



Island Microgrid Demonstration Projects

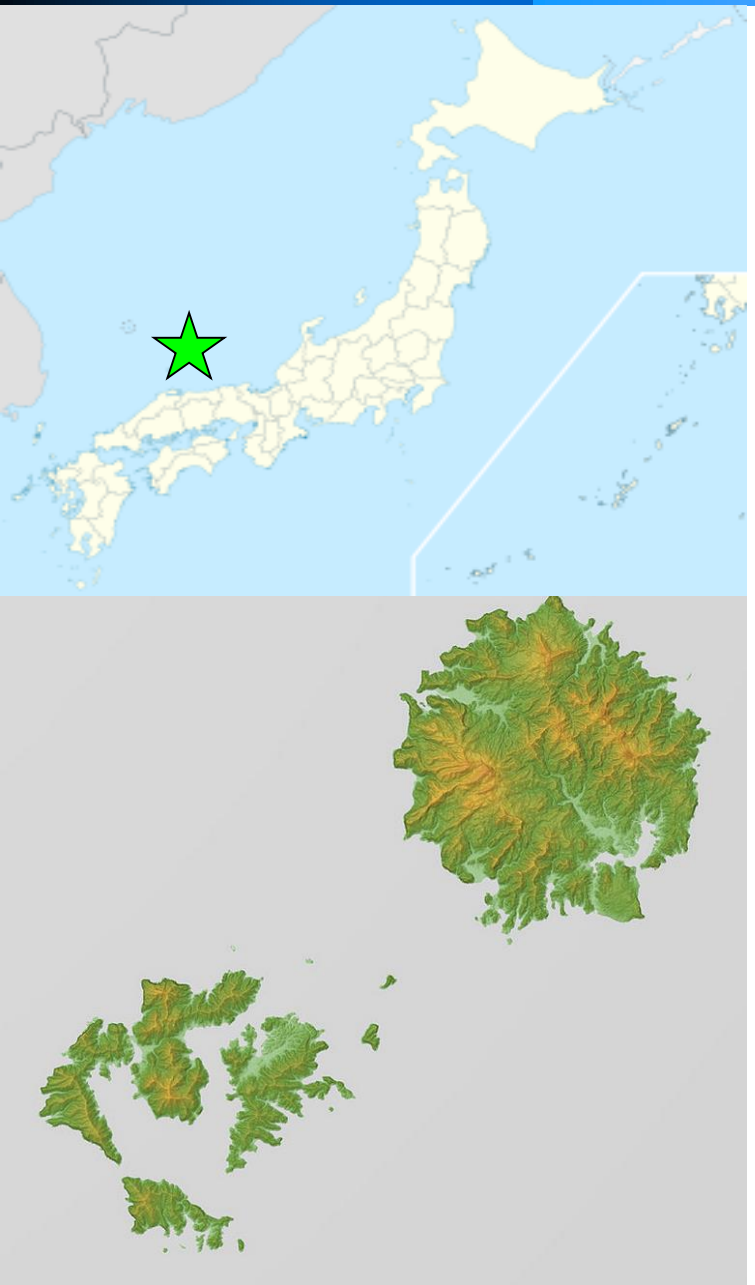
- Demonstration Project on deployment of RE in Islands Grids (FY2009)
- Okinawa Smart Energy Island Infrastructure demonstration Projects(FY2011 -)
  South-West Islands of Japan incl. Miyako, Yonaguni, Kitadaito, Tarama etc.
  -- Renewable Energy(PV and Wind) and Battery, PCS

- Demonstration project for All Island EMS in Miyako Island(FY2011-2017)
  ---Demand in FY2011 : 22MW(winter)-52MW(summer)
  ---Total RE facilities in FY2015 :28.5 MW (PV: 23.7MW, Wind 4.8MW)



Island Microgrid Demonstration Projects

Oki Hybrid Project: Hybrid Battery demonstration at Oki Islands Micro Grid)



<Major Purpose>

- Stabilization of the power quality in Oki Islands Micro Grid
- CO2 reduction through the replacement of Diesel Power Generation by renewable energy

<Oki Hybrid Battery System demonstration Project>

- NAS Battery:4.2 MW/25,200kWh
- Lithium Ion Battery：2MW/700kWh
- EMS

<Current Situation and Target of Oki Islands>

- **Minimum Electricity Demand：Approx. 10MW**
- Current Power Plant：
  - Saigo Thermal Power Plant : 25.32 MW(Diesel)
  - Kuroki Thermal Power Plant: 7.38MW(Diesel)
  - Wind Power:1.8MW
  - Small Hydro:0.3MW (0.1MW, 0.2MW)
  - Approx 3MW of Renewable Energy in Total

- **Renewable Energy Installation** in the near future
  - PV: 5.5MW (2MW, 1.5MW, 1.5MW, 0.5MW)
  - Wind Power: 2MW
  - Approx. **11MW** in Total

Island Microgrid Demonstration Projects

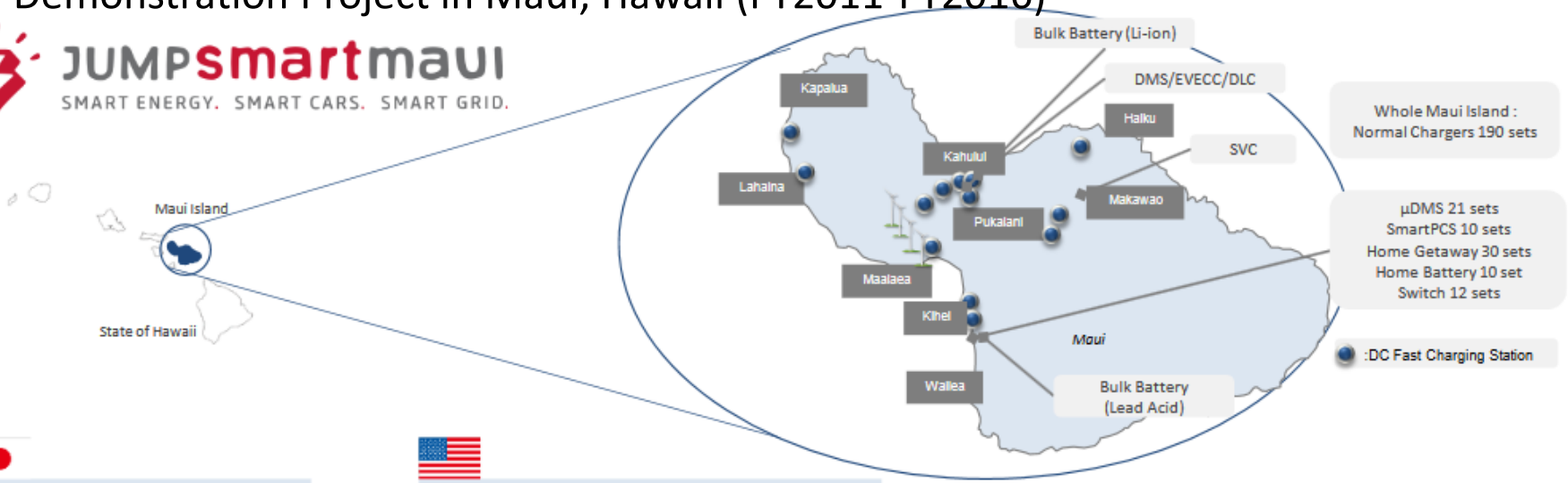
Reused Battery Project at Koshiki Island

- Demonstration Project on reused EV battery in Islands Grids in Koshiki jima Island which population is about 5,000
- Establish “Koshiki Island Energy Storage Center” with 0.8MW batteries from 36 EVs
- This energy storage center is using 2nd handed battery which finished their 1st life as EV battery
- Economically reasonable than new battery product & gaining residual value for used battery of retired EV

Island Microgrid Demonstration Project in Maui, Hawaii Under Japan-U.S. Cooperation on Clean Energy Technologies

- Okinawa-Hawaii Partnership on Clean and Efficient Development and Deployment (2010-2015-2020)
  - ✓ Grid Stabilization(Development of Microgrid System)
  - ✓ Clean Transportation
  - ✓ Energy Efficiency in Buildings
  - ✓ Renewable Energy Technologies
  - ✓ People-to-People Exchange
- Microgrid Demonstration Project in Maui, Hawaii (FY2011-FY2016)

JUMPsmartmaui
SMART ENERGY. SMART CARS. SMART GRID.



- NEDO
- Hitachi
- Mizuho Bank
- Cyber Defense Institute

- Maui County
- MEDB (Maui Economic Development Board)
- MECO (Maui Electric Company)
- HNEI, Univ. of Hawaii
- UHMC, Univ. of Hawaii etc…

Purpose
- Renewables (Wind and Solar) friendly EV charging
- Reduce fossil fuel consumption and its dependency
- Mitigate investment cost for absorbing fluctuation by Renewables

EV management	Fast EV Charging Station
	EV Charging Management
	V2G program
Activity on distribution substation level	Control of distributed storage batteries
	Voltage regulation of distribution grid (SVC)
Activity on LV grid level	Voltage regulation of distribution grid (Smart PCS)
	Direct Load Control (DLC)

◆Major Demonstration Projects on Microgrid in Japan

◆Major Outcomes from the projects

◆Current Situation: Commercialization
and further demonstration

Major Outcomes from the Projects: CEMS (Community Energy Management System)

- CEMS can act as small size LDC in the community from the view point of technology.
- Much demonstration project focused on Demand Response and visualization of the information

Function in CEMS demonstration project		Status in demonstration projects
Forecast	RE power supply, Demand	○ : Demand and RE power supply are forecasted by weather forecast and demand in the past
Management	Power supply management	△ : Only simulation (Difficult to manage the actual power plants for demonstration purpose)
	Electricity Sharing in the community	△ : Only some cases demonstrated due to distribution grid availability
	Demand management	○ : Demonstrated by demand response
Information collection	Collection of electricity usage, RE power output	○ : Information are collected through each EMS (HEMS, BEMS etc) and others
Operation plan for supply and demand		△ : Operation plan was focused in demand side
Information offering	Visualization of various information	○ : Information of supply and demand in the community are showed in HEMS and others

Major Outcomes from the Projects: Demand Response

■ Variety of demand response projects are demonstrated

	Display of Electricity Price	Display of Electricity Price + Recommendation (consultuing)	Display of Electricity Price + Automated Control
TOU Time Of Use	Keihanna	Keihanna	Yokohama
CPP Critical Peak Pricing	All 4 areas	Keihanna, Toyota	Yokohama, Toyota
RTP Real Time Pricing	Toyota	Toyota	Toyota

■ About 20% demand can be reduced on a continuing basis.
■ Higher price does not always mean higher reduction

Kita Kyushu	2012(Summer)	2012(Winter)	2013(Summer)
CPP = JPY50	-18.1%	-19.3%	-20.2%
CPP=JPY75	-18.7%	-19.8%	-19.2%
CPP=JPY100	-21.7%	-18.1%	-18.8%
CPP=JPY150	-22.2%	-21.1%	-19.2%

Keihanna	2012(Summer)	2012(Winter)	2013(Summer)
TOU(+JPY20)	-5.9%	-12.2%	-15.7%
CPP(+JPY40)	-15.0%	-20.1%	-21.1%
CPP(+JPY60)	-17.2%	-18.3%	-20.7%
CPP(+JPY80)	-18.4%	-20.2%	-21.2%

Other Outcomes from the Projects: Smart Community

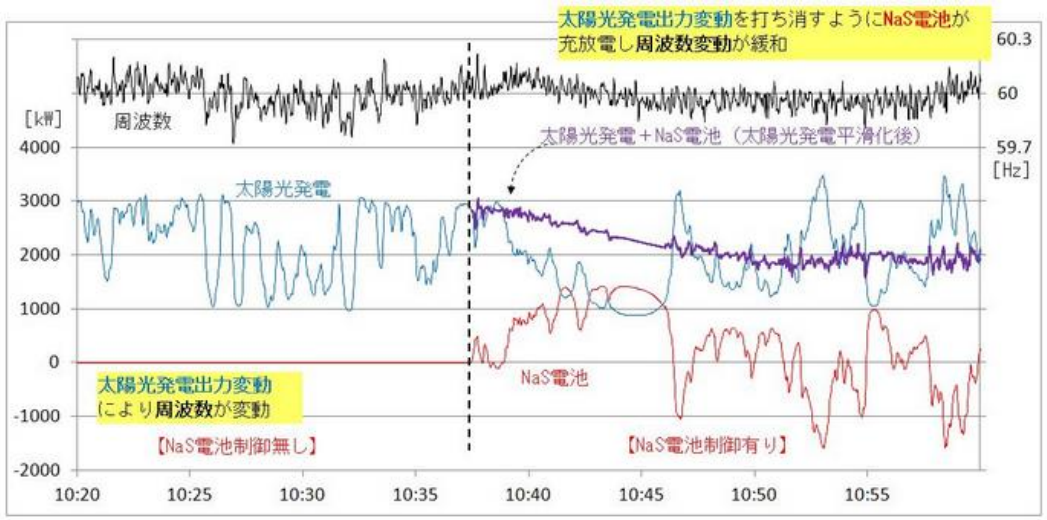
- Communication for Smart House :ECHONET Lite
  - Established Communication protocol for smart house (ISO/IEC standard)
    IT communication protocol between HEMS and home appliances
    (https://echonet.jp/spec_v112_lite_en/)

- Communication for automated Demand Response
  - Based on US OPEN ADR
  - Will be used for VPP demonstration projects (Energy Resource Aggregation)

- Multiple Battery aggregation system
  - “Battery SCADA system” was demonstrated Yokohama Smart City Project
  - Aggregate multiple batteries from utility grid size to home size

- V2H guideline
  - Guideline for charge/discharge system from xEV (Yokohama/Toyota)
  - FCV to House is also demonstrated based on this guideline (Kita Kyushu)

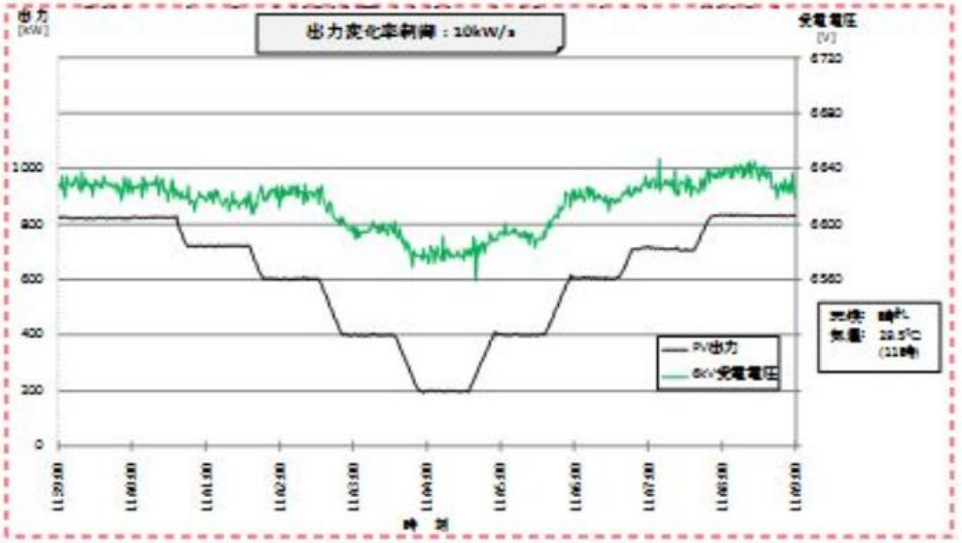
Major Outcomes from the Island Microgrid Projects: Battery and PCSs



- NAS Battery in Miyako Island
  Charge and discharge from Battery counteracts to output fluctuation from PV power generation

- PCS in Abe Mega Solar in Okinawa
  PCS controls power output from PV.

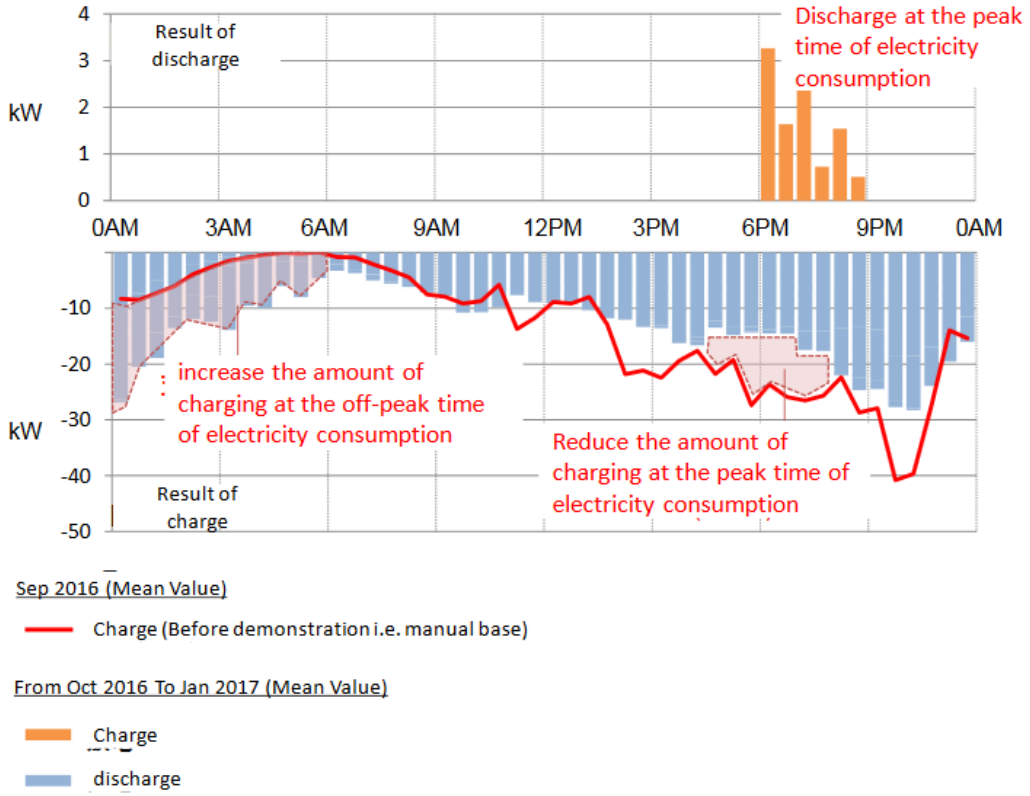
By utilizing this function, management of rapid out put fluctuation from PV is demontstrated



(Source) Kyushu Electric Power Company

Major Outcomes from Microgrid Demonstration Project in Maui

- Major outcomes
  - ➢ Effective usage of surplus renewable electricity by shift of charge timing(peak shift)
  - ➢ Frequency control by demand side load management
  - ➢ Alleviation of voltage rise in lower distribution network
  - ➢ Increase EVs and chargers which are necessary for the project
  - ➢ “Duck curve” countermeasure by EV utilization



(Source) http://www.nedo.go.jp/content/100864936.pdf

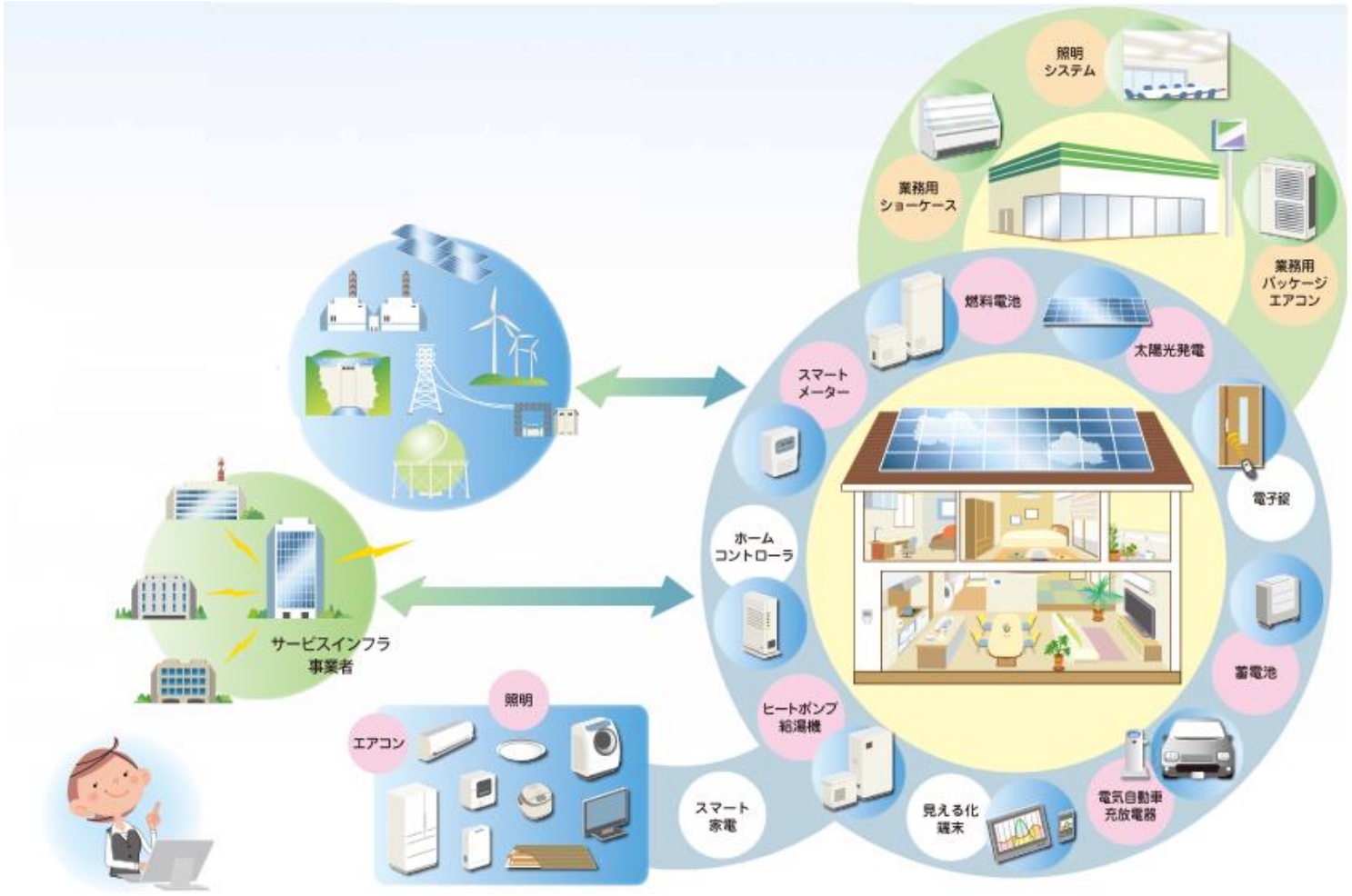
◆Major Demonstration Projects on Microgrid in Japan

◆Major Outcomes from the projects

◆Current Situation: Commercialization
and further demonstration

Commercialization : Smart House and HEMS

- Home appliance manufactures and Internet Providers etc. provide HEMS for sales
- Housing manufactures provide “smart house” for their production line up



https://echonet.jp/wp/wp-content/uploads/pdf/General/Download/1705_ECHONET_j_web.pdf

Commercialization : Smart Community

- Commercialization of Smart Communities have already started

- Japanese government (METI) prepare the smart community cases as of June, 2017
  (http://www.meti.go.jp/press/2017/06/20170623002/20170623002-1.pdf)

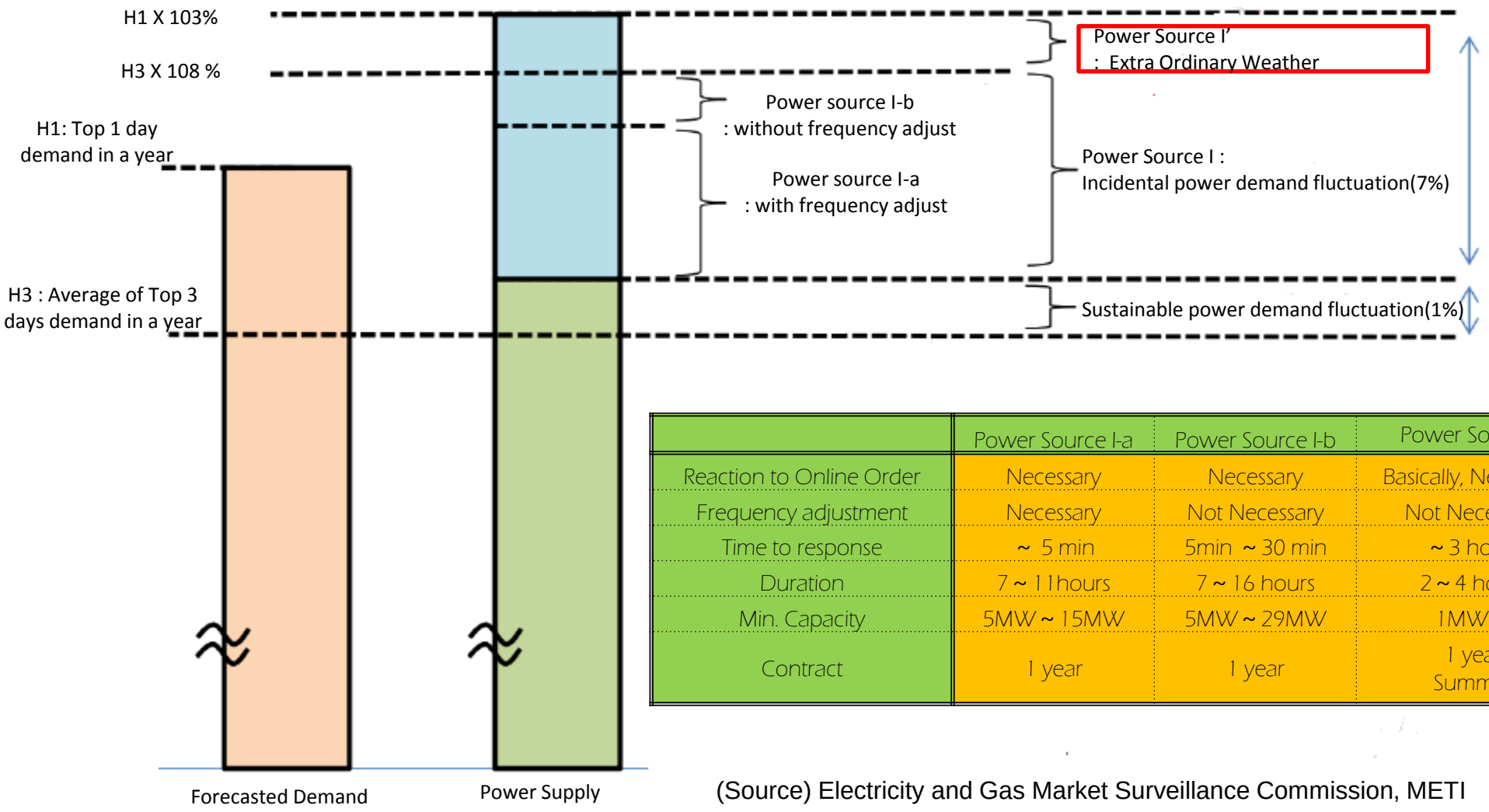
- Site visit of EGNRET 49 in Tokyo is one of the smart community case (Shibaura 2chome)

- Smart City Shioashiya “Solar-Shima” is also one of the smart community case in Japan which were awarded in “2017 The 3rd ESCI Best Practices Awards Program” associated with EWG53

http://esci-ksp.org/project/shioashiya-japan/

Commercialization of Demand Response

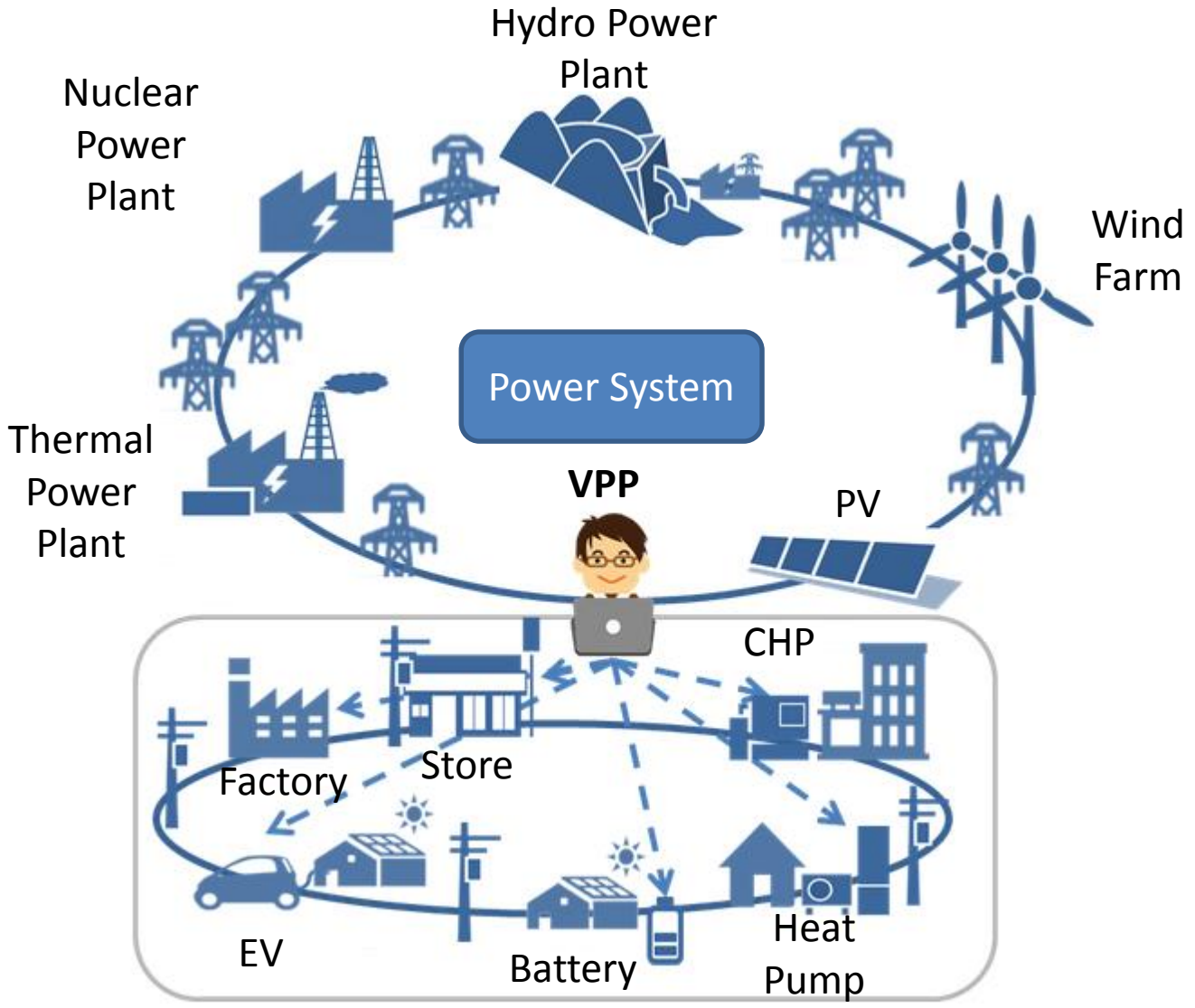
- ✓ Power Grid companies call for bid for Power Source I(I-a I-b), I'
- ✓ ***About 70% of power source I' is supplied by Demand Response***



	Power Source I-a	Power Source I-b	Power Source I'
Reaction to Online Order	Necessary	Necessary	Basically, Necesarry
Frequency adjustment	Necessary	Not Necessary	Not Necessary
Time to response	~ 5 min	5min ~ 30 min	~ 3 hours
Duration	7 ~ 11hours	7 ~ 16 hours	2 ~ 4 hours
Min. Capacity	5MW ~ 15MW	5MW ~ 29MW	1MW ~
Contract	1 year	1 year	1 year Summer

(Source) Electricity and Gas Market Surveillance Commission, METI

Further Demonstration Project : VPP (Virtual Power Plant)



Thank you for your attention!