# Japanese Experience on Smart Community

September 9, 2014

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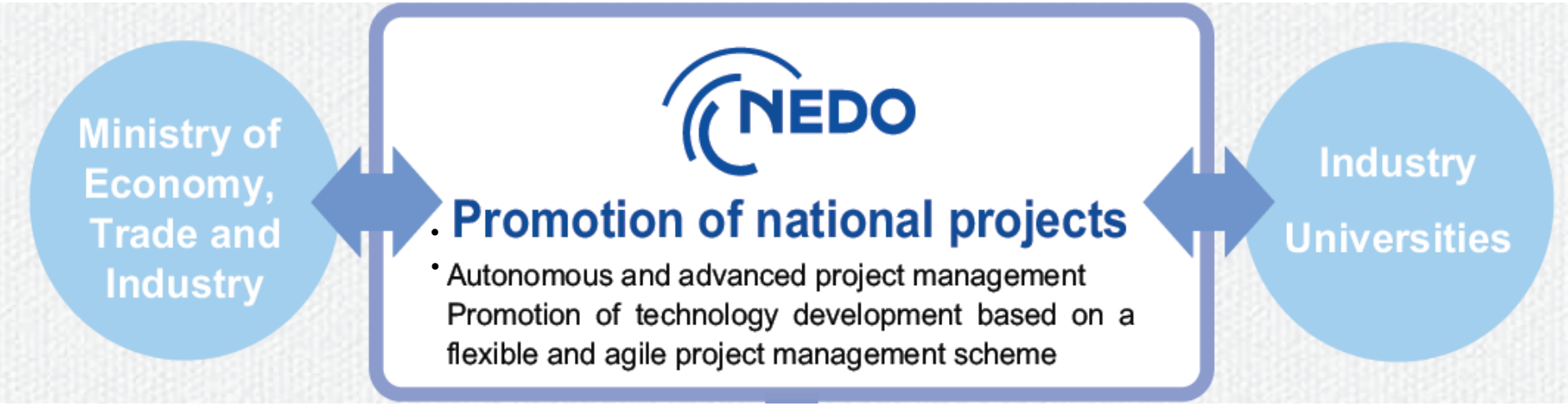
# NEDO's Mission

Japan's largest implementation agency in the area of R&D as well as the diffusion of energy, environmental, and industrial technologies.




Coordination with Policymaking Authorities

Combined Efforts of Industry, Government and Academia

**Budget : Approx. 1.5 billion USD (FY2014)**
**Number of personnel: Approx.800**

# Outline

1. Energy Policy in Japan
2. METI's 4 Demonstration Projects in Japan
3. NEDO's 2 Demonstration Projects in Japan

# Strategic Energy Plan of Japan (Excerpt)

*Chapter 1. Issues related to the energy supply-demand structure in Japan*

*Chapter 2. Basic policy regarding measures concerning energy supply and demand*

Section 1. Principles for the energy policy and Viewpoint of reforms

Safety / Energy Security / Improving Economic Efficiency / Environment Suitability (3E+S)

Section 2. Position of each energy source and policy timeframe

Renewable Energy, Nuclear Power, Coal, Natural Gas, Oil and LP Gas

e.g. renewable Energy

A promising, multi-characteristic and important energy source without greenhouse emissions, which has been introduced as far as possible for three years since 2013 followed by continuous active promotion

*Chapter 3. Long-term measures regarding energy supply and demand to be implemented in a comprehensive and systematic manner*

Section1. Promotion of comprehensive policy toward securing stable supply of resources

Section 2. Realization of an advanced energy-saving society and smart and flexible consumer activities

1. Enhancing energy efficiency in each sector
2. Leveraging demand response that promotes efficient energy supply

Section 3. Accelerating the introduction of renewable energy: Toward achieving grid parity over the mid- to long term

1. Strengthening measures to accelerate the introduction of wind and geothermal power
2. Promotion of use of renewable energy in distributed energy systems
3. Feed-in-tariff system
4. Establishing Fukushima as a center of the renewable energy industry

*Chapter 4. Promotion of strategic technology development*

*Chapter 5. Communication with all levels of the society and deepening of energy-related understanding*

Source: Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry

# Present Status of Introduction of Renewable Energy

■After introducing the FIT scheme, PV (both Households and Mega solar) has increased dramatically.
■Community Energy Management System (CEMS) and Home Energy Management System (HEMS) are the key technologies for efficient use of PV generated electricity.

| Renewable energy generating facilities (type of source) | Before FIT | After FIT |
|---|---|---|
| | Combined total capacity of facilities before July 1, 2012 | Total capacity of newly-approved facilities |
| PV(households) | 4,700 MW | 2,210 MW |
| PV(others) | 900 MW | 7,360 MW |
| Wind power | 2,600 MW | 110 MW |
| Small and medium hydropower | 9,600 MW | 10 MW |
| Geothermal power | 500 MW | 0 MW |
| Biomass power (*4) | 2,300 MW | 90 MW |
| Total | About 20,600 MW | 9,770 MW |

Source: Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry

# Four Major Demonstration Projects by METI (FY2011-2014)

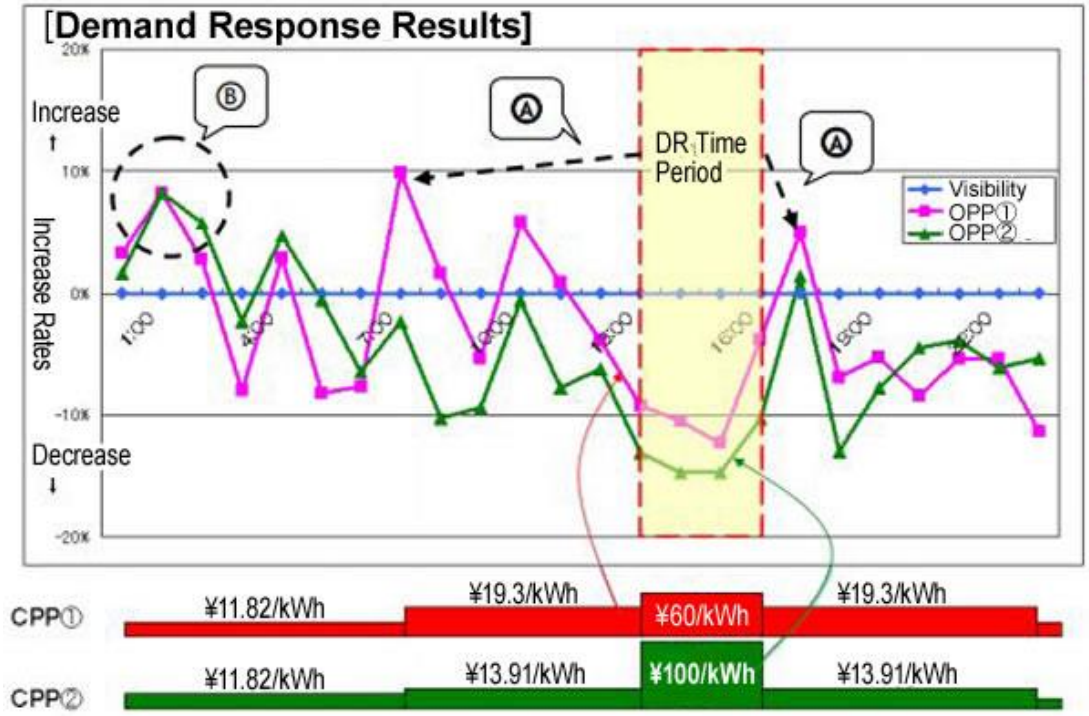
Starting in FY2011, large-scale smart community demonstration projects have been ongoing in 4 regions across Japan that constitute representative examples of various patterns, based on participation by many residents, local governments, and corporations.

| | Control of a single sector (household) only | Integration and control of multiple sectors |
|---|---|---|
| **Highly dependent on the system** | **Keihanna**<br>**- Housing complex category -**<br>Energy consumed at business buildings, universities and 900 households is visualized, and non-essential and non-urgent electricity is reduced. In addition, incentives such as eco-points if energy is saved are also given. | **Yokohama**<br>**-Wide-area metropolitan category –**<br>-Demonstration of mutual complementation of control by large storage batteries, Community energy Management System or CEMS and large-scale systems in three areas (business, housing complex and detached houses) |
| **Less dependent on the system** | **Toyota**<br>**- Individual housing category -**<br>Implementing demand side management in 67 newly built houses. Gathering data on batteries and installation of optimum chargers are verified by demonstration how to use the next-generation vehicles in everyday lives. | **Kitakyushu**<br>**- Regional major urban area category -**<br>Demonstration is conducted in the special supply area for a steel company. Smart meters are placed at all consumers within the area and dynamic pricing, which changes electricity rate in accordance with demand-supply situation, is implemented. Considering the steel works as a backbone system, role sharing with the system is demonstrated. |

# Demonstration in Yokohama City

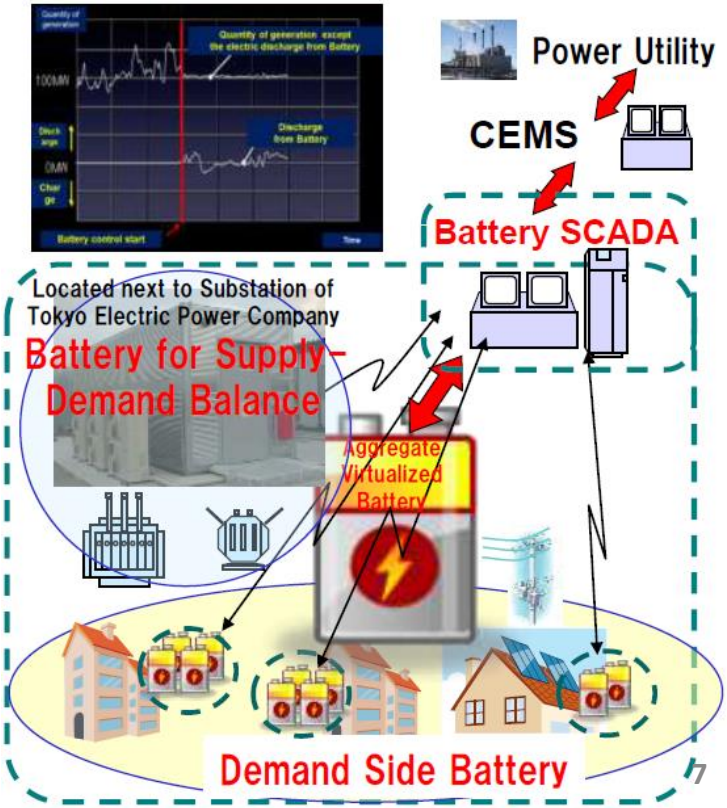
## Demand Response

- The YSCP implemented Japan's largest ever DR verification experiment targeting 1,200 households in fiscal 2013.
- It Achieved a Maximum Peak Demand Reduction Rate of 15.2%.




## Battery SCADA

- Reduce imbalance between renewable generation power and unstable demand in community by virtual battery



# Demonstration in Toyota City (Smart Houses)

- In demonstrations conducted in Toyota City, 67 smart houses equipped with solar panels, fuel cells, Heat Pump, Home battery, plug-in hybrid vehicles, electric vehicles, etc. are being constructed.
- Demand response demonstration of awarding of points has been initiated from 2012. It achieved 18.7% $CO_2$ reduction .

Solar panel (3.2 kW)

Fuel Cell

Eco Cute (370L)
$CO_2$ Air to Water Heat Pump

Exterior

Home battery (5kWh)

Charging stand
(supports V2H)

# Demonstration in Toyota City (V2H, FC Bus)

Utilize electricity from the vehicle for non-driving use in the emergency time as well as in the ordinary time.

## PHV

- V2H with interconnected operation in the ordinary time, and V2L for home appliances use in the emergency time

Provide electricity directly to home appliances

Home appliances

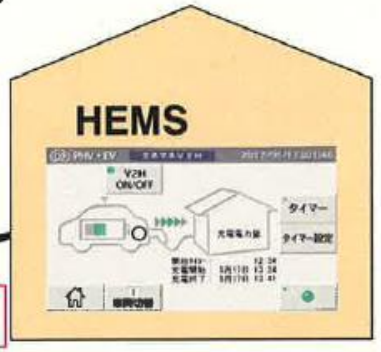

V2L; Vehicle to Load

Max Power:1.5kW

Discharge from PHV to Home

AC

Max Power:1.5kW




## FC Bus

- Provide electricity to the evacuation facility (e.g. a gymnasium) in case of emergency from FC bus

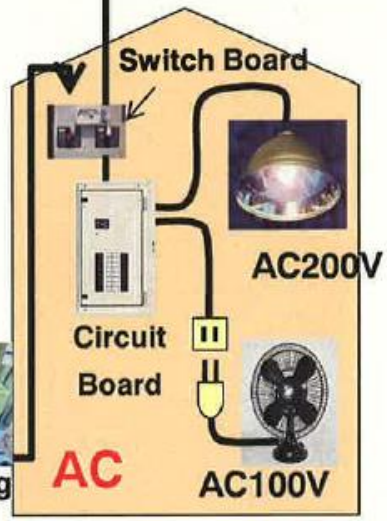
FC Bus

Max Power:9.8kW

Discharge from FC bus to the facility

DC

Power Receiving equipment




Source: Toyota

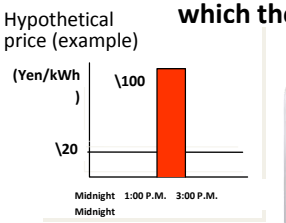
# Demonstration in Keihanna (Large-scale Demand Response)

- In 3 municipalities in Keihanna Science City, large-scale demand response demonstration was initiated in summer 2012, targeting approx. 700 households.
- Peak cut effect resulted approx. 20%.

## DR design

- Implemented for 3 months during the summer and the winter.
- Before each season, a fixed amount per household (7,000 yen) is granted.
- The peak period amount of "used amount x unit price" is collected during the peak hours of 1:00 to 4:00 PM on weekdays (6:00 to 9:00 PM during the winter).
- The premium unit price is 20 yen for regular weekdays, and either 40 yen, 60 yen, or 80 yen during CPP.
- The condition for CPP during last summer consisted of "arbitrary days where the forecast on the previous day is 30° C or higher," occurring 5 times for each unit price for a total of 15 times.

**E-mail notification stating that the following day is a day on which the hypothetical pricing is applied**



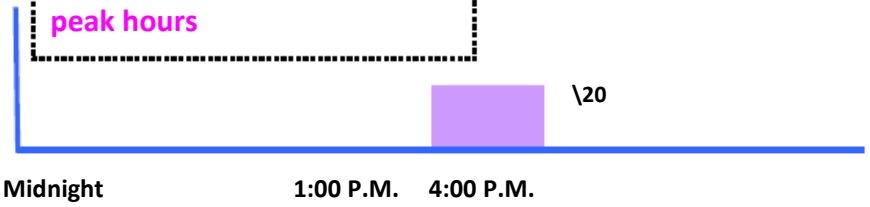




***CPP = Critical Peak Pricing**

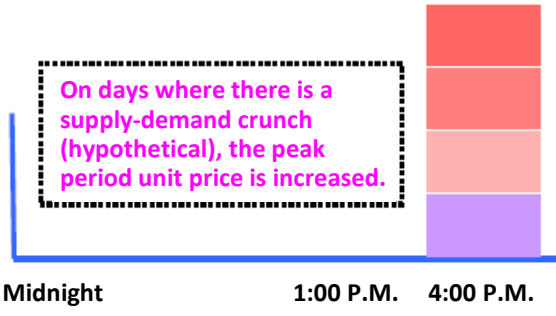
**Summer weekdays: Not put into motion**

**On regular weekdays, a fixed unit price is applied during peak hours**




**Summer weekdays: Put into motion**

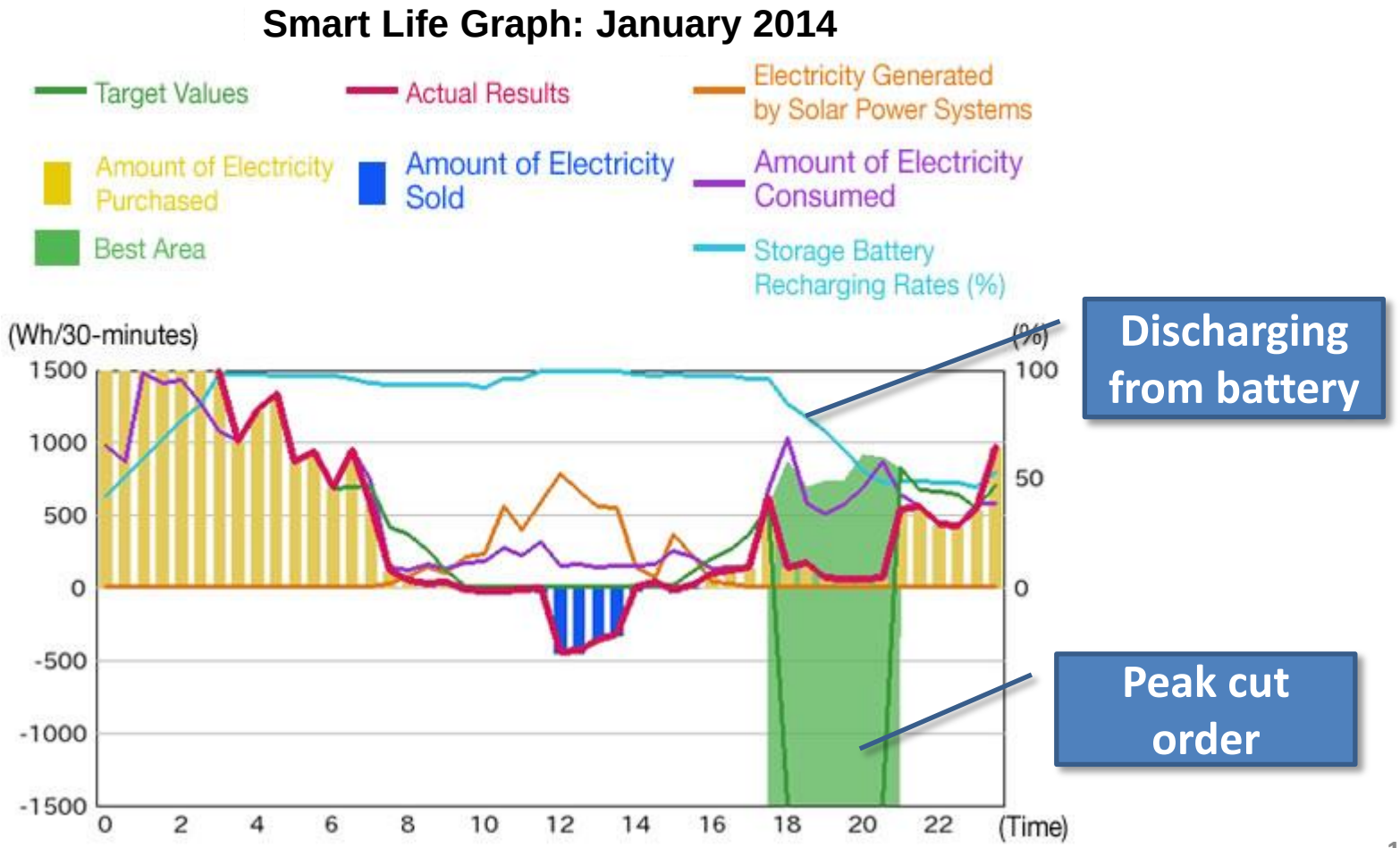
**On days where there is a supply-demand crunch (hypothetical), the peak period unit price is increased.**




**On days where the special pricing is put into motion, the unit price increases to one of those on the left (notification is provided regarding the unit price beforehand)**

# Demonstration in Keihanna (HEMS and Solar)

- Results of Verification Experiments Involving 14 Households into which HEMS and Solar Power Generators have been Installed.
- 51% Reduction in CO2 Emissions and a 62% Reduction in Peak Demand Achieved



# Dynamic Pricing in Demonstration for Kitakyushu

- The site for this project is a special supply area that uses the power lines operated by Nippon Steel Corporation. A natural gas co-generation power plant in which Nippon Steel Corporation has invested, is used as the main power supply source, and it is supplied in combination with renewable solar-generated and wind-generated electrical power
- Dynamic pricing was initiated in summer 2012. Prices were changed in accordance with the state of supply and demand as based on information related to supply and demand of power that was aggregated in CEMS, and notification regarding power pricing was sent to each customer beforehand.

## Introduction of new energy

● **Town mega solar generation**

● **Kitakyushu hydrogen town - Fuel cell**

## Introduction of energy-saving system over entire community

● **Introduction of BEMS* and FEMS* smart meters meeting demand**

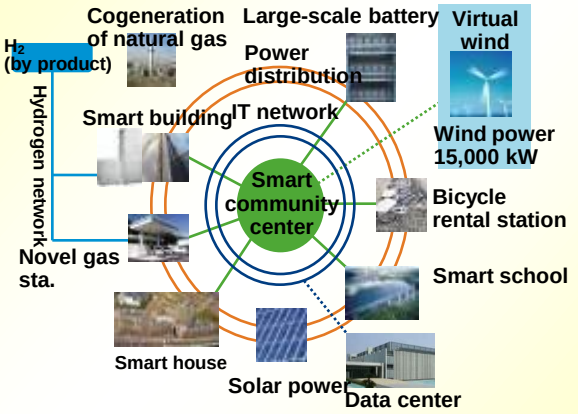
**Smart office** **Smart data center** **Smart factory**

### Creation of regional society such as next-generation transportation system

- **Large-scale introduction of EVs**
- **Use of small vehicles using fuel cell**
- **Coordination with public transportation system and community buses**

## Building regional energy management system

● **Regional brownout system**




● **Introduction of smart meters**

● **Eco-Point system for carbon offset**

*BEMS: Building Energy Management System *FEMS: Factory Energy Management System

# Results of Demand Response Demonstration in Kitakyushu

■ From the results of demand response demonstration, peak cut effects of 20% and energy-saving effects are statistically confirmed. A review is ongoing regarding reflection of these results in reform of power regulations.

## Kitakyushu City

Results of the FY2012 demonstration trials (number of sample cases: 180)

| | Summer (June to September) | | Winter (December to February) | |
|---|---|---|---|---|
| Electricity price (*1) | Peak cut effect | Statistical significance (*3) | Peak cut effect | Statistical significance (*3) |
| Time of Use (TOU) | - (*4) | - (*4) | - (*4) | - (*4) |
| CPP= 50 yen | -18.1% | 5% level | -19.3% | 1% level |
| CPP= 75 yen | -18.7% | 5% level | -19.8% | 1% level |
| CPP= 100 yen | -21.7% | 1% level | -18.1% | 1% level |
| CPP= 150 yen | -22.2% | 1% level | -21.1% | 1% level |

## Keihanna Science City

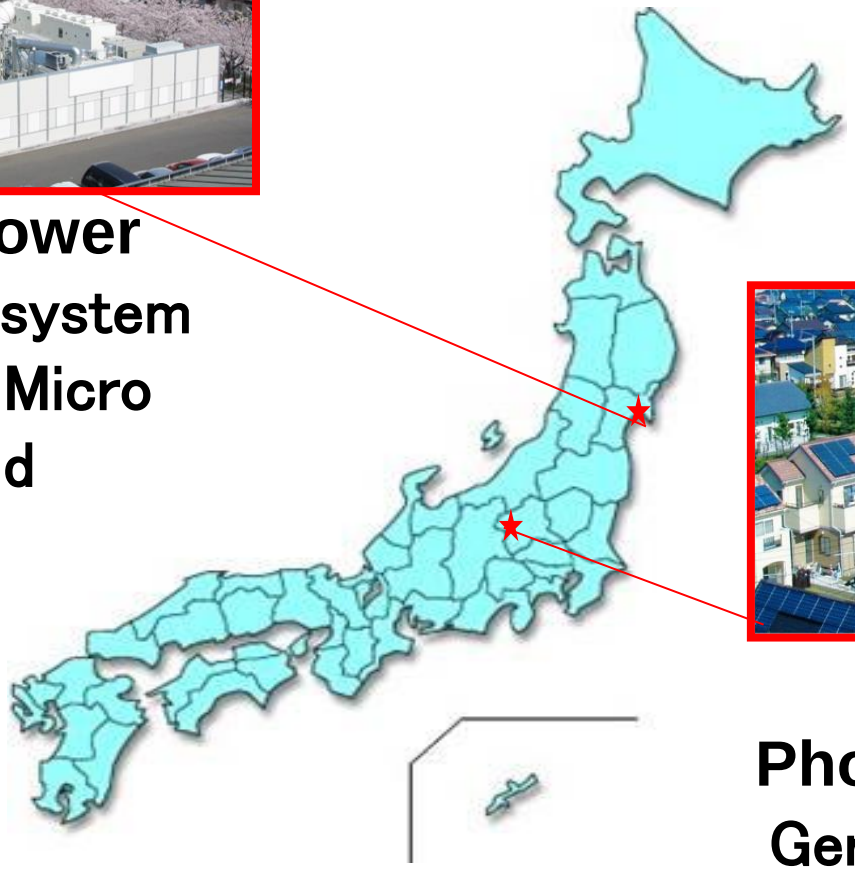
Results of the FY2012 demonstration trials (number of sample cases: 681)

| | Summer (July to September) | | Winter (December to February) | |
|---|---|---|---|---|
| Electricity price (*2) | Peak cut effect | Statistical significance (*3) | Peak cut effect | Statistical significance (*3) |
| TOU (premium: 20 yen) | - 5.9% | 1% level | -12.2% | 1% level |
| CPP (premium: 40 yen) | - 15.0% | 1% level | -20.1% | 1% level |
| CPP (premium: 60 yen) | -17.2% | 1% level | -18.3% | 1% level |
| CPP (premium: 80 yen) | -18.4% | 1% level | -20.2% | 1% level |

Source: Results of the statistical demonstration conducted by Dr. Takanori Ida, professor, Kyoto University, Graduate School of Economics, Dr. Ryuichi Tanaka, associate professor, National Graduate Institute for Policy Studies, and Dr. Ito , fellow, Stanford Institute for Economic Policy Research

# NEDO's Projects in Japan 2005 - 2010

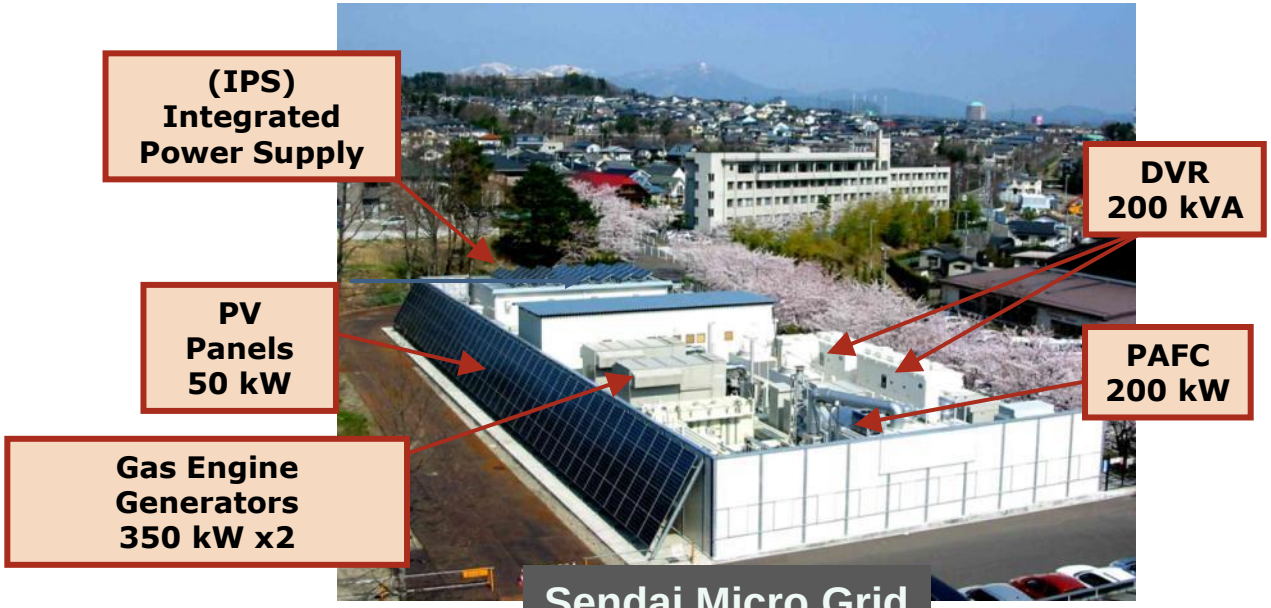
New power network system Sendai Micro Grid



Clustered Photovoltaic Power Generation Systems in Ohta city

# Sendai Micro-grid

- Constructed as a 4-year demonstration project (FY2004–2007)
- Technical feature = MPQM (Multiple Power Quality Microgrid)
  - Desirable power quality varies from customer to customer.
  - MPQM enables power supply by different levels of power quality according to each customer's needs within the area.



Sendai Micro Grid

# Clustered Photovoltaic Power Generation Systems in Ohta city

## Establishing an Islanding Detection Method

FY2002–FY2007
Demonstrative Project on Grid-interconnection of Clustered Photovoltaic Power Generation


Established islanding detection method can be applied to clustered PV systems

**Development of function to detect unintentional islanding by "step injection of reactive power"**

FY2008–FY2009
Development of anti-islanding test procedure for high penetration of PV


PCS and measurement systems

FY 2010–
Japan-US smart grid demonstration project in New Mexico
・Collaborative research with Sandia National Lab on anti-islanding and FRT

# Challenges for Smart Community

1. Insufficient promotion of social understanding and interest in Smart community
   - Necessity for public awareness campaign
   - Necessity for user's perspective, such as residents and communities
   - Necessity for quantitative merits to ease acceptance of users
2. Lack of key players to conduct projects in local area
   - Necessary to have a promoter to adjust stakeholders' interest and endorse projects
   - Necessary to have participations of expertise from energy industry
3. Difficulties in establishing business models due to the high cost of equipment and systems
   - Insufficient revenue stream other than FIT, and difficult to secure DR incentive sources
   - Required to create added value for non-energy
4. Ambiguous application of regulations for energy circulation
   - Necessary to establish verification of DR effect and trading rules


http://www.nedo.go.jp/english

Thank you very much
for your kind attention!