Overview of Smart Grid Projects and Prospect in Japan

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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 (FY2015)
Number of personnel: Approx.800

Outline

1. Energy Policy in Japan
2. METI's four Demonstration Projects in Japan
3. NEDO's two Demonstration Projects in Japan
4. Introduction of Japan Smart Community Alliance

Japan's Energy Policy Shift

1970s (Oil crises (1973, 1979))

Energy Security

- Ensure energy security by reducing oil dependence and introducing alternative energy

1980s

- Promotion of enegy conservation

(Demand for economic structural reform)

1990s

Energy Security + Economic Efficiency

- Ensuring economic efficiency of energy through power and gas reforms

(Adoption of Kyoto Protocol (1997))

Energy Security + Economic Efficiency + Environment Compatibility

- Promoting introduction of alternative energy and greater energy conservation

2000s

(Enforcement of Kyoto Protocol (2005), Intensification of competition for natural resources)

Energy Security + Economic Efficiency + Environment Compatibility

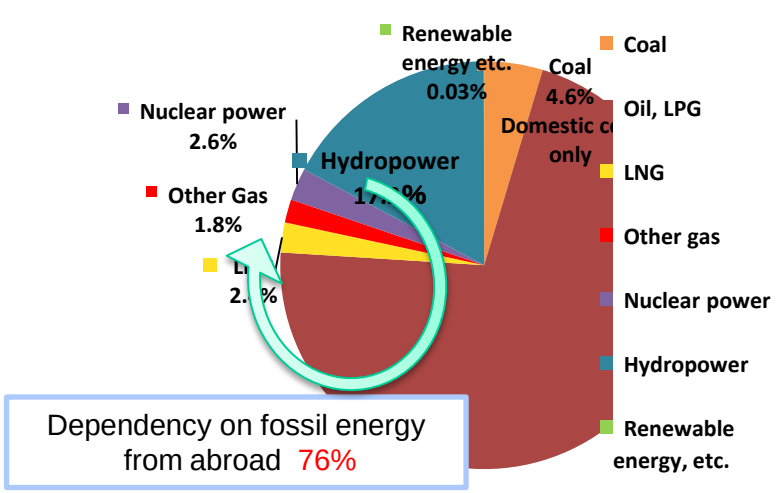
Securing Natural Resources

- Expansion of non-fossil energy introduction (renewable energy and nuclear power)
- Strengthening resource diplomacy

Current Strategic Energy Plan (April 2014)

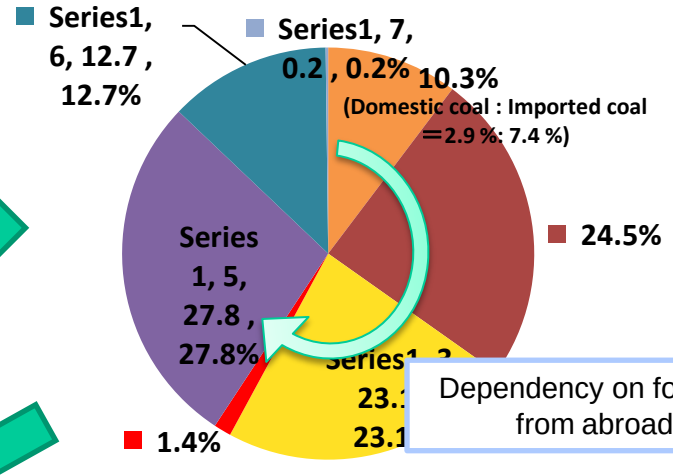
Change in Japan's power source composition

Dependency on fossil energy from abroad currently stands at approximately 88% (FY2012), which is higher than during the first oil crisis (approximately 76%).



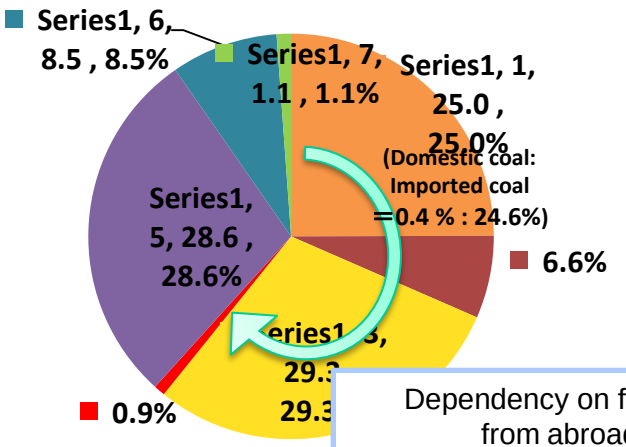
Dependency on fossil energy from abroad 76%

FY1973 (During the 1973 oil crisis)



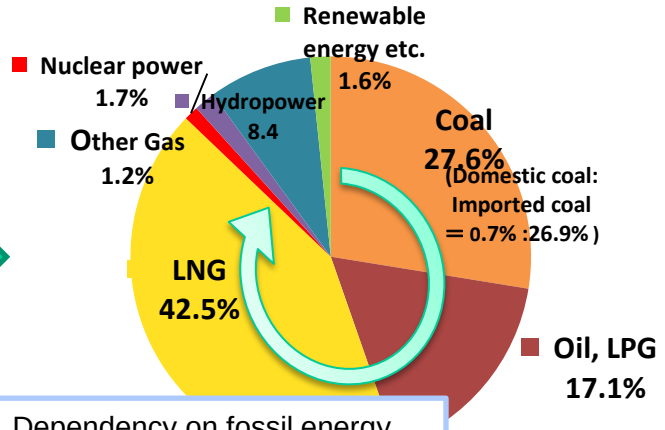
Dependency on fossil energy from abroad 57%

FY1991 (During the Gulf War)



Dependency on fossil energy from abroad 61%

FY2010 (Before the Great East Japan Earthquake)



Dependency on fossil energy from abroad 88%

FY2012 (the latest definitive figures)

* Prepared on the basis of "Overview of power source development." Calculated % using power generation amount. "Other gas" mainly consists of city gas, natural gas, and coke-oven gas, which are used for mixed-fired use by general electricity utilities. In addition, "other gas" includes "dependency on fossil energy from overseas" (approximately 88%, approximately 76%).

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	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)

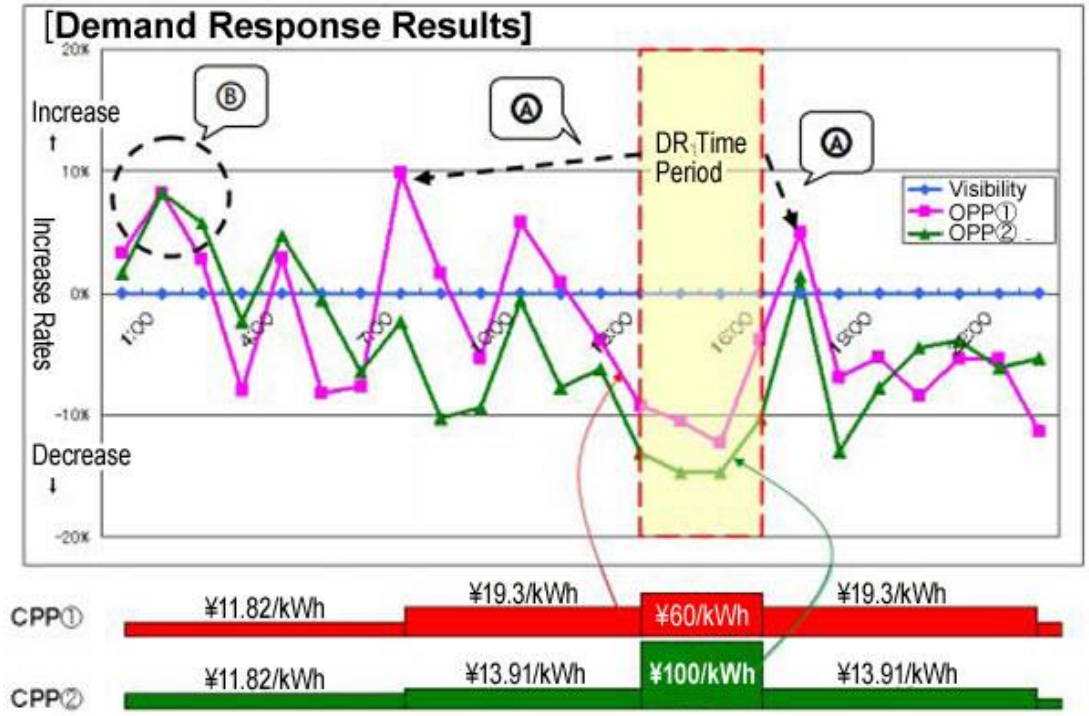
Starting in FY2011, large-scale smart community demonstration projects had been conducted in 4 regions across Japan that constitute representative examples of various patterns, based on participation by many residents, local governments, and corporations.

	Control of a single sector (household) only	Integration and control of multiple sectors
Highly dependent on the system	**Keihanna** **- Housing complex category -** 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** **-Wide-area metropolitan category –** -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** **- Individual housing category -** 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** **- Regional major urban area category -** 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

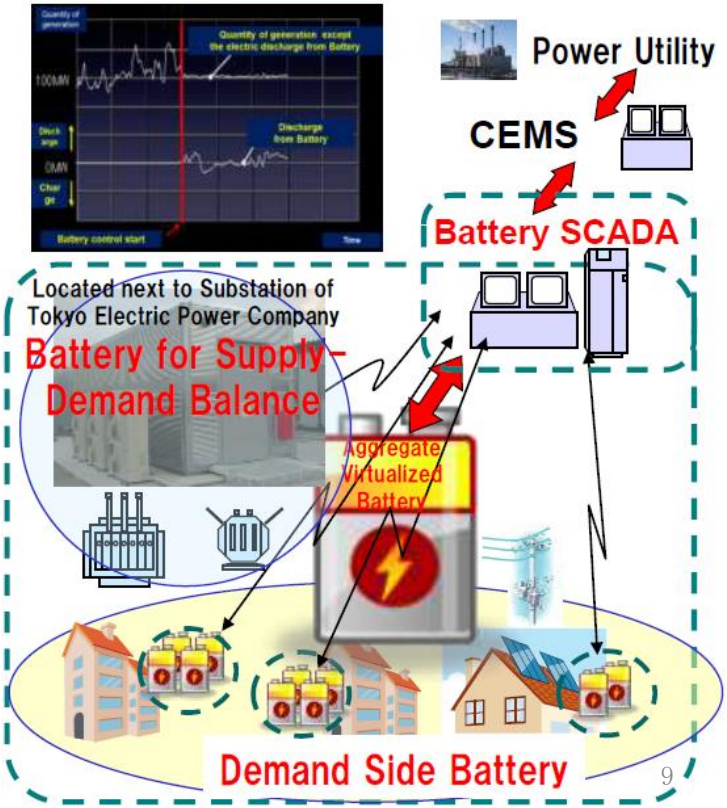
Demand Response

- 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. were constructed.
- Demand response demonstration of awarding of points had 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

Home battery (5kWh)

Charging stand
(supports V2H)

Demonstration in Toyota City (V2H, FC Bus)

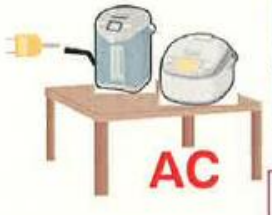
Utilize electricity from the vehicle for non-driving use in the emergency time as well as in the ordinary time.

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



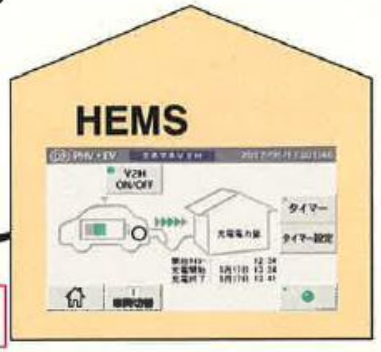
V2L; Vehicle to Load

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

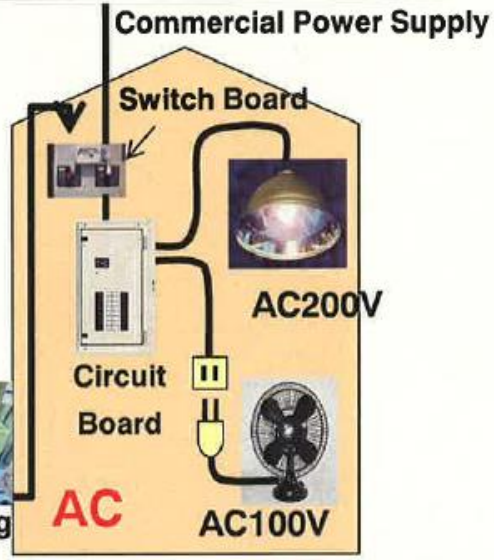
FC Bus

Max Power: 9.8kW

Discharge from FC bus to the facility

DC

Power Receiving equipment



Source: Toyota

Demonstration in Keihanna (Large-scale Demand Response)

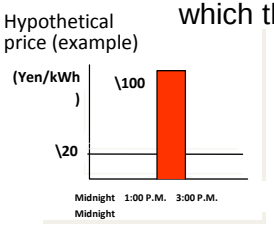
- In three municipalities in Keihanna Science City, large-scale demand response demonstration was initiated in summer 2012, targeting approx. 700 households.
- Peak cut effect resulted approx. 20%.

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 degrees Celsius or higher,” occurring 5 times for each unit price for a total of 15 times.

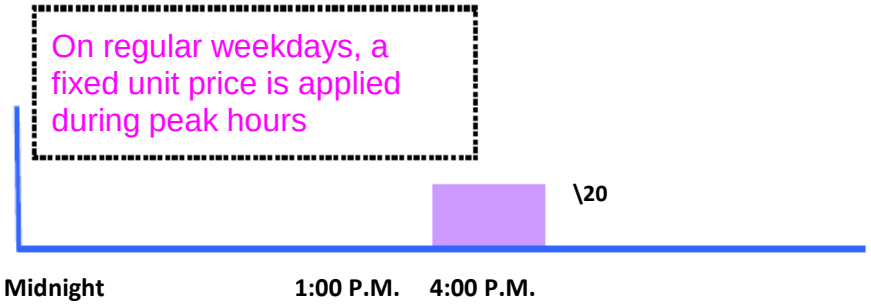
*CPP = Critical Peak Pricing

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



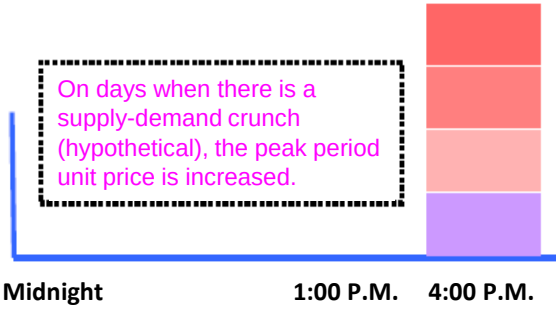
Summer weekdays: Not put into motion

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



Summer weekdays: Put into motion

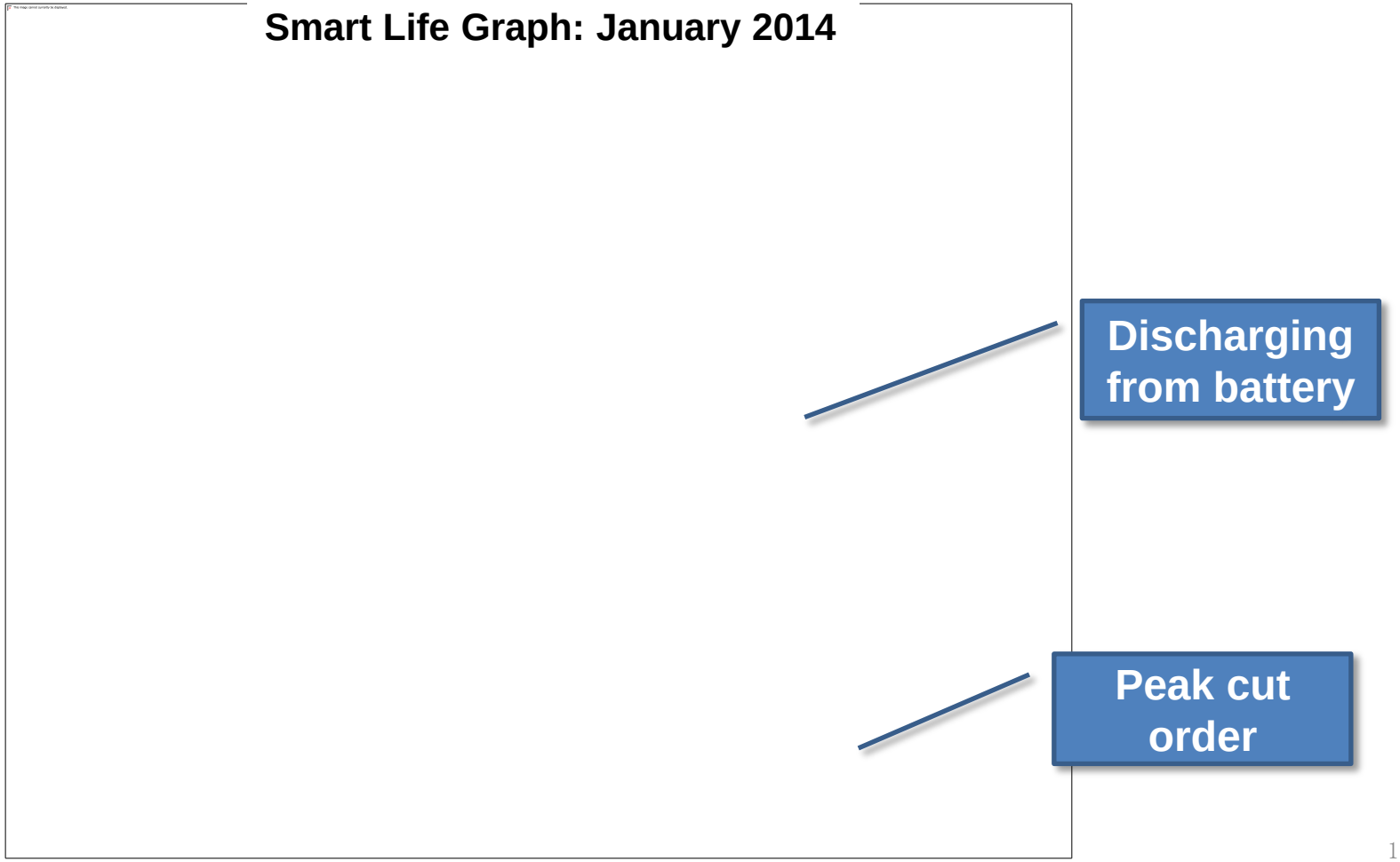
On days when there is a supply-demand crunch (hypothetical), the peak period unit price is increased.



On days when 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

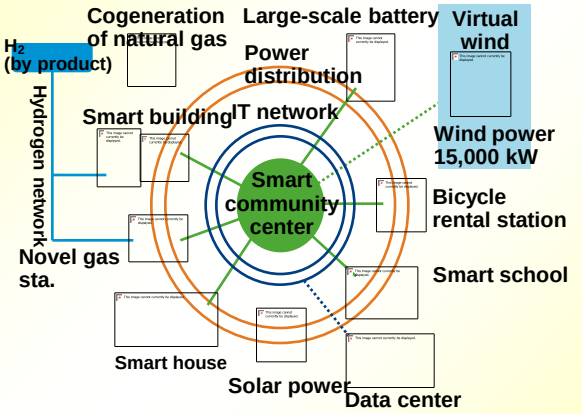
Smart office Smart data center Smart factory

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 were statistically confirmed. A review is ongoing regarding reflection of these results in reform of power regulations.

Kitakyushu City

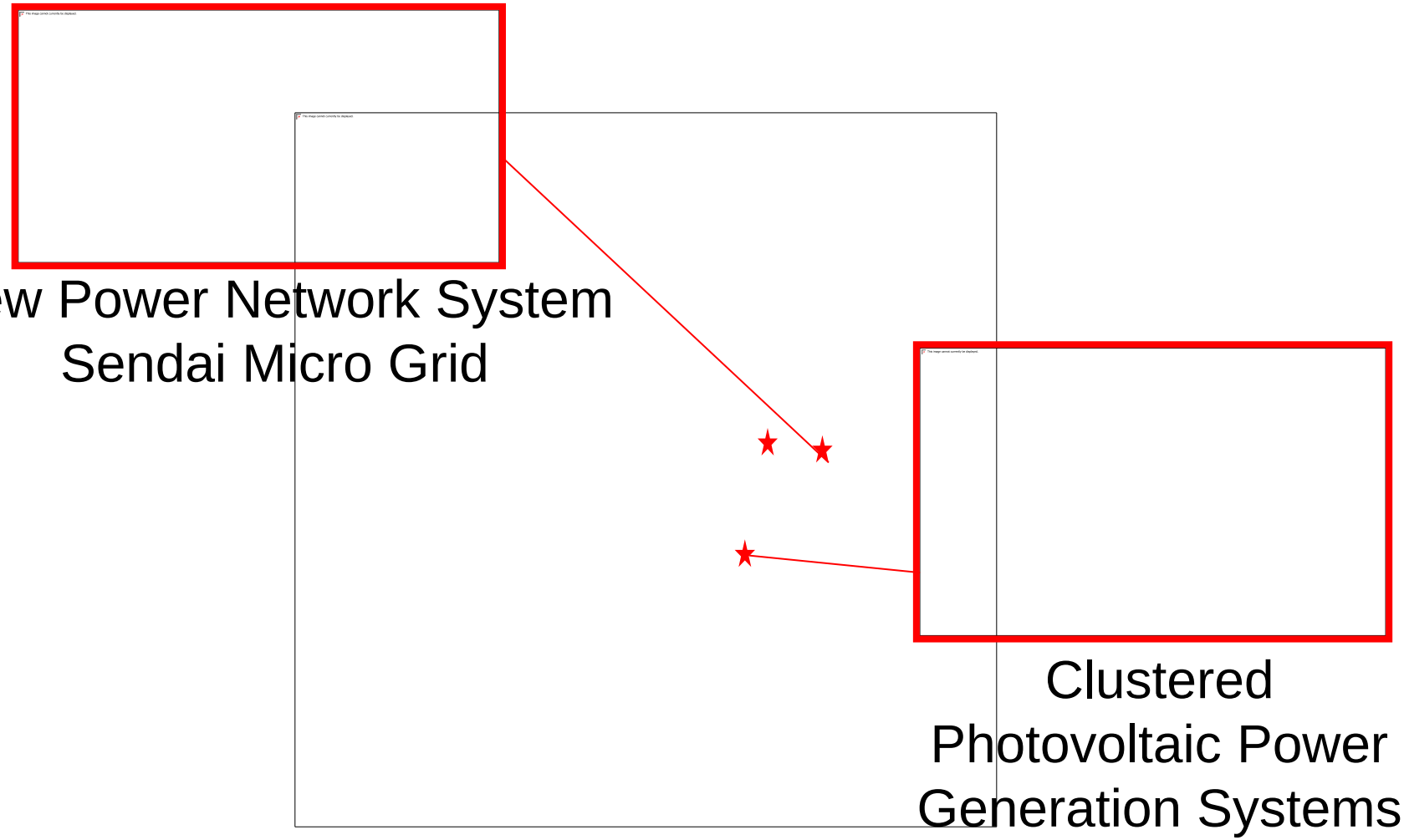
Results of the FY2012 demonstration trials (number of sample cases: 180)

Keihanna Science City

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

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

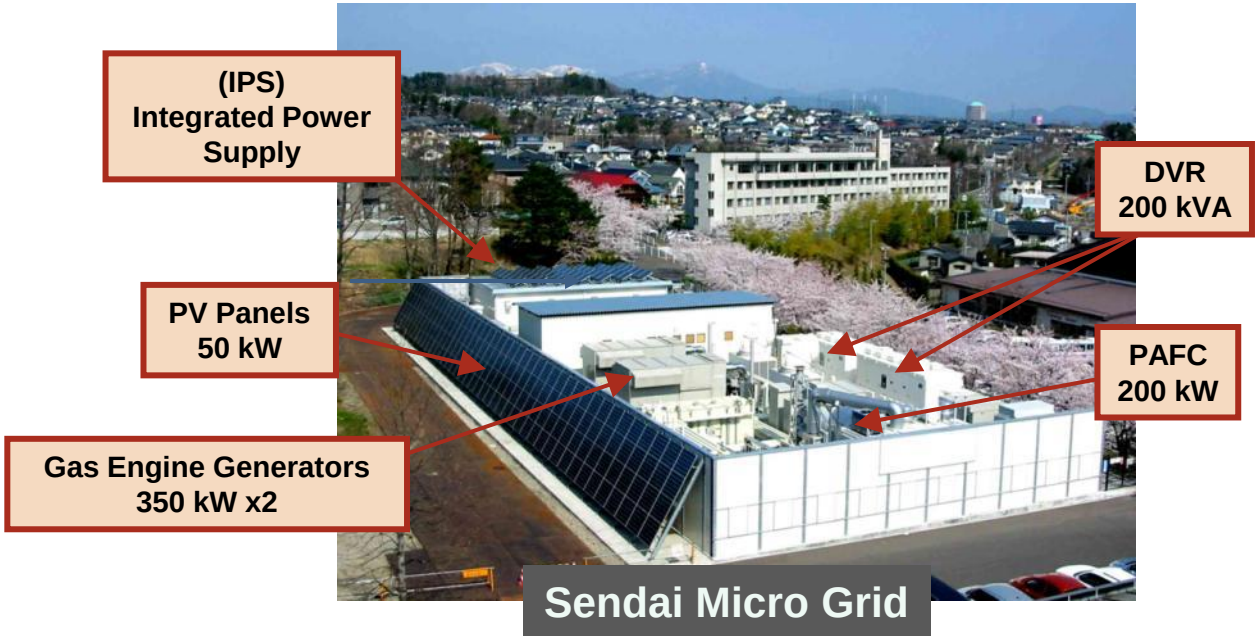


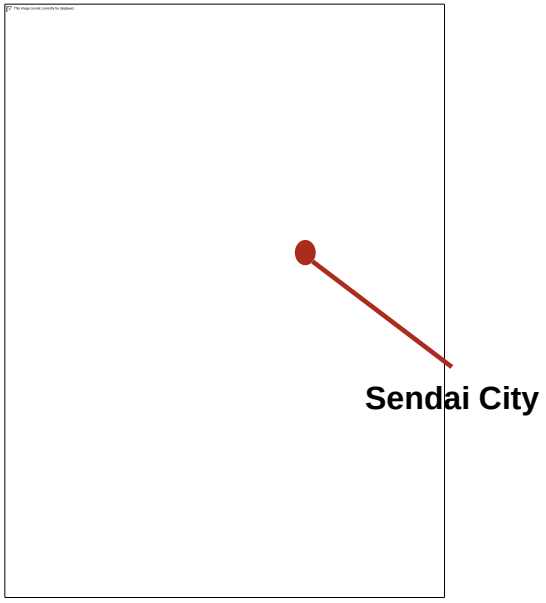
New Power Network System
Sendai Micro Grid

Clustered
Photovoltaic Power
Generation Systems
in Ota 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.





Clustered Photovoltaic Power Generation Systems in Ota City

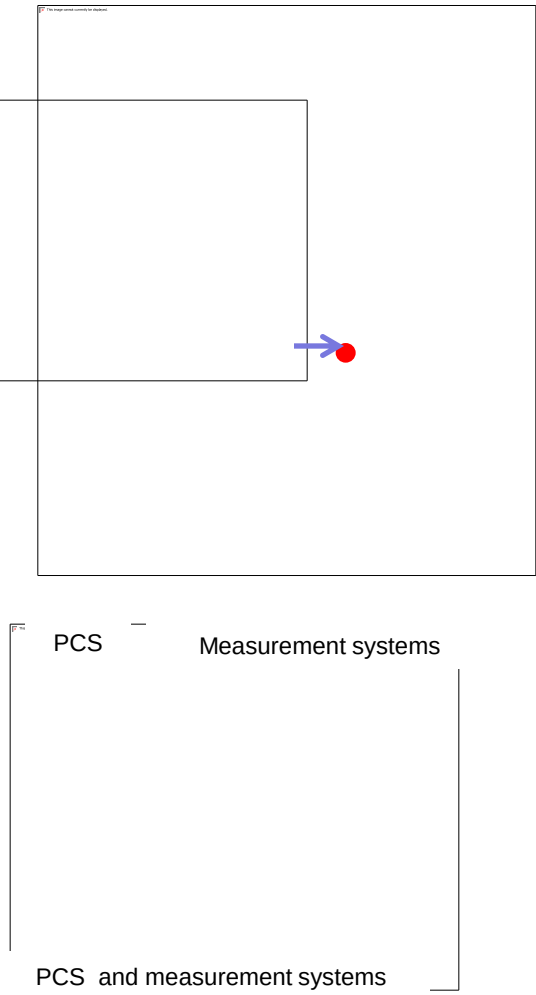
Establishing an Islanding Detection Method

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



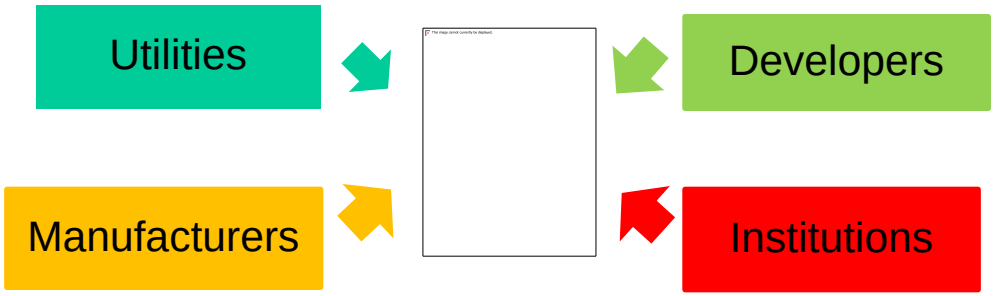
FY2010–FY2014
Japan-US smart grid demonstration project in New Mexico
・Collaborative research with Sandia National Lab on anti-islanding and FRT

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

Japan Smart Community Alliance

Established: April, 2010



Members: 281 (As of May 2015)
Electric power, gas, automobile, information and communications, electric machinery, construction and trading industries as well as the public sector and academia

President: MITSUBISHI ELECTRIC
Board: Hitachi, ITOCHU, JGC, Kansai Electric Power, NIPPON TELEGRAPH AND TELEPHONE, Panasonic, SHIMIZU, Tokyo Gas, TOSHIBA, TOYOTA MOTOR
Secretariat: NEDO

- Steering Committee
  - International Strategy Working Group
  - International Standardization Working Group
  - Roadmap Working Group
  - Smart House & Building Working Group

https://www.smart-japan.org

Overseas Collaboration

Secretariat

Member

Public Framework

Private Framework

Member

MOU

Governmental Framework
with 25 countries/regions

Industrial Framework
with 18 countries/regions

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

Thank you very much
for your kind attention!