Smart Grid Development in Japan

August 25th, 2011

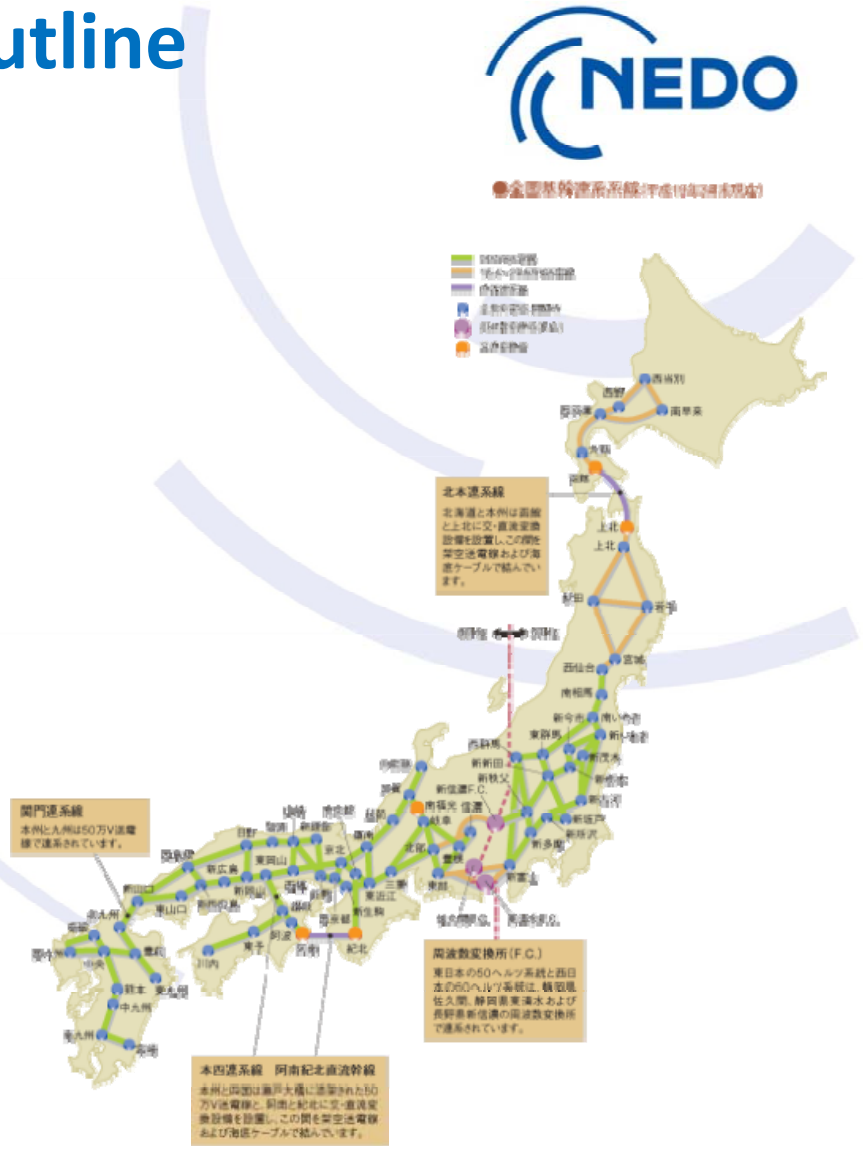
Kazuyuki Takada

NEDO

New Energy and Industrial Technology Development Organization

Japan's Electricity System Outline

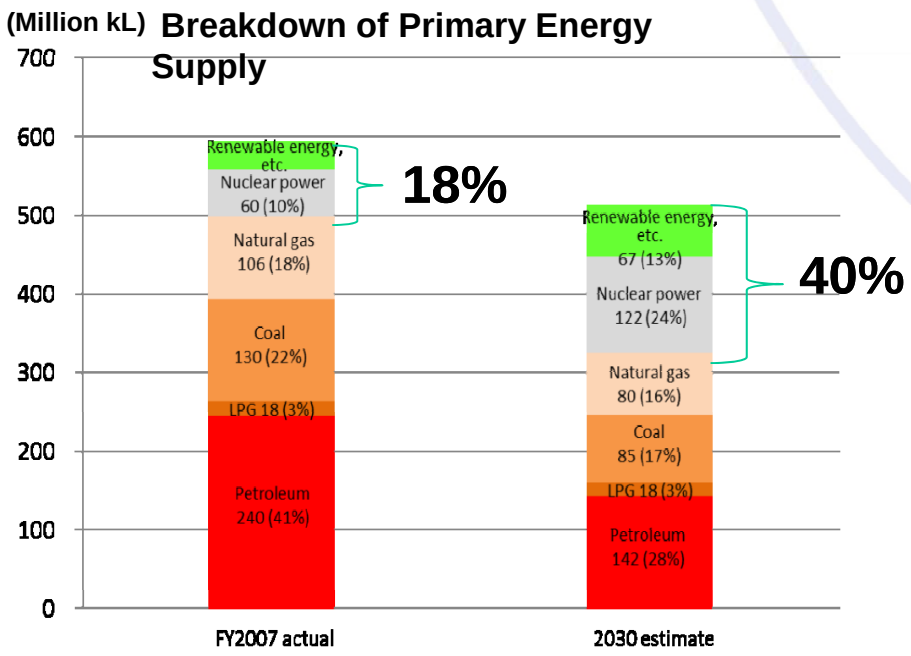
- 10 Vertical Integrated Power Company and PPSs
  - Deregulated above high voltage customers(over 50kW)
  - Average electricity price in household is 20.54 yen/kWh in 2009. (24.81 yen/kWh in 1994)
- Frequency
  - Western part: 60Hz
  - Eastern part: 50Hz
    - Hokkaido(peak demand: about 5.7 GW) is connected by DC line.
- Voltage
  - High voltage distribution line is generally in 6.6kV
  - Household voltage is 100V/200V
    - In regulation 101V +/-6V

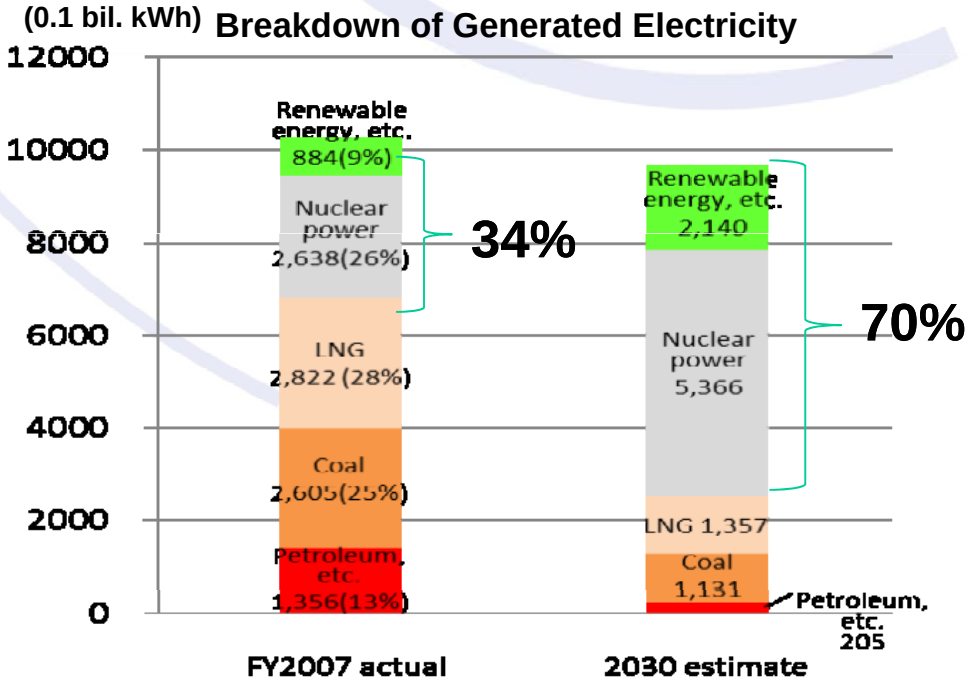


Ambitious Targets Toward 2030

The Japanese government has set ambitious policy targets toward 30% reduction of energy-related CO2 in 2030, compared to the 1990 level. For example,

- ◆Energy self sufficiency: 40% (18% at present)
- ◆Zero-emission power source ratio: 70% (34% at present)





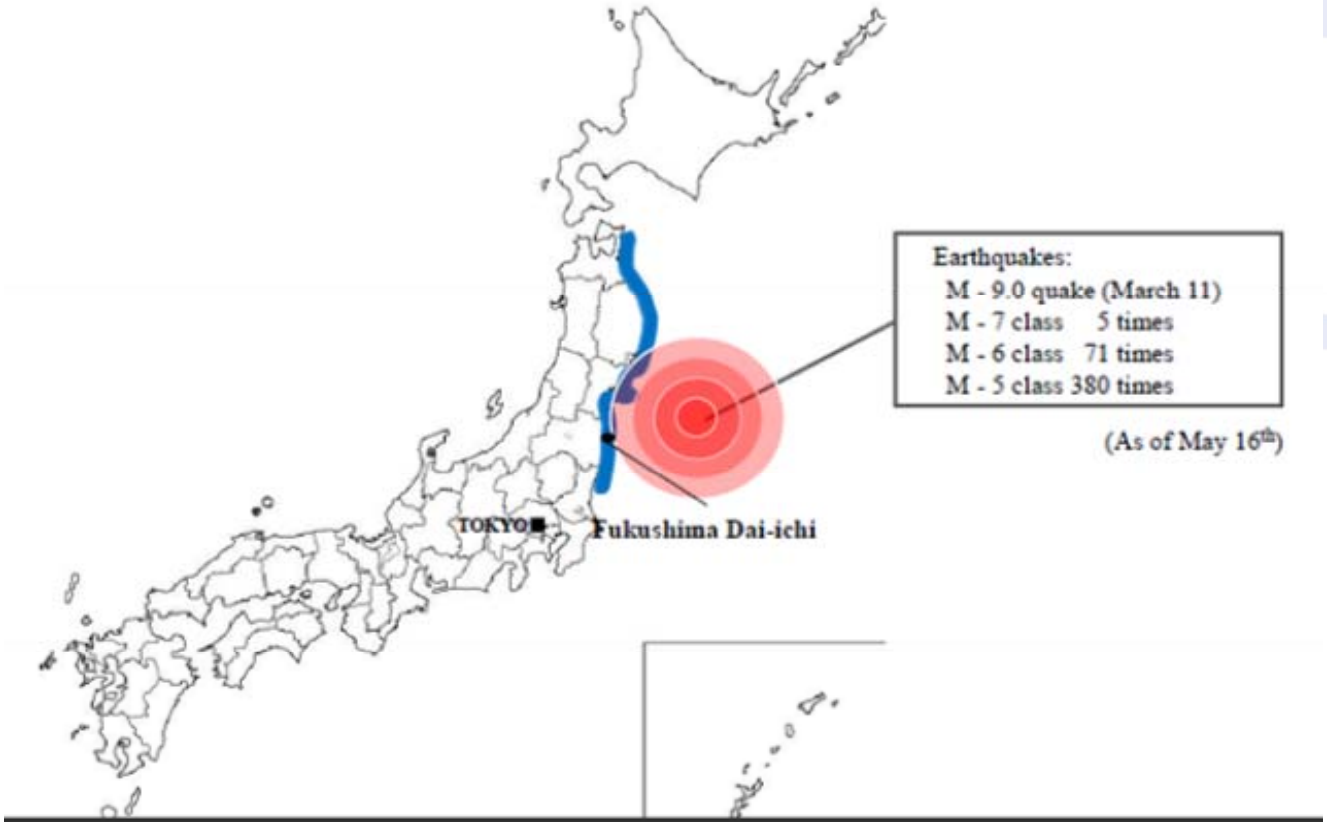
Renewable Energy Promotion Policy in Japan

- Buyback program was started in 1992. (at 24-25 yen/kWh)
  Only for excess electricity from renewable.
- National RPS was started in 2003.
- Subsidy for residential PV was re-started in 2009. (70,000 yen/kW)
- Buyback program was doubled in November 2009 (48 yen/kWh).
- Feed in Tariff Bill (including Priority Connection Rule for Renewables) submitted by METI. National RPS low will be end after the FIT introduction.
- Priority Dispatching Rule for Renewables will be adapted in near future. (METI's report had issued on Feb. 2011)

CURRENT SITUATION IN JAPAN

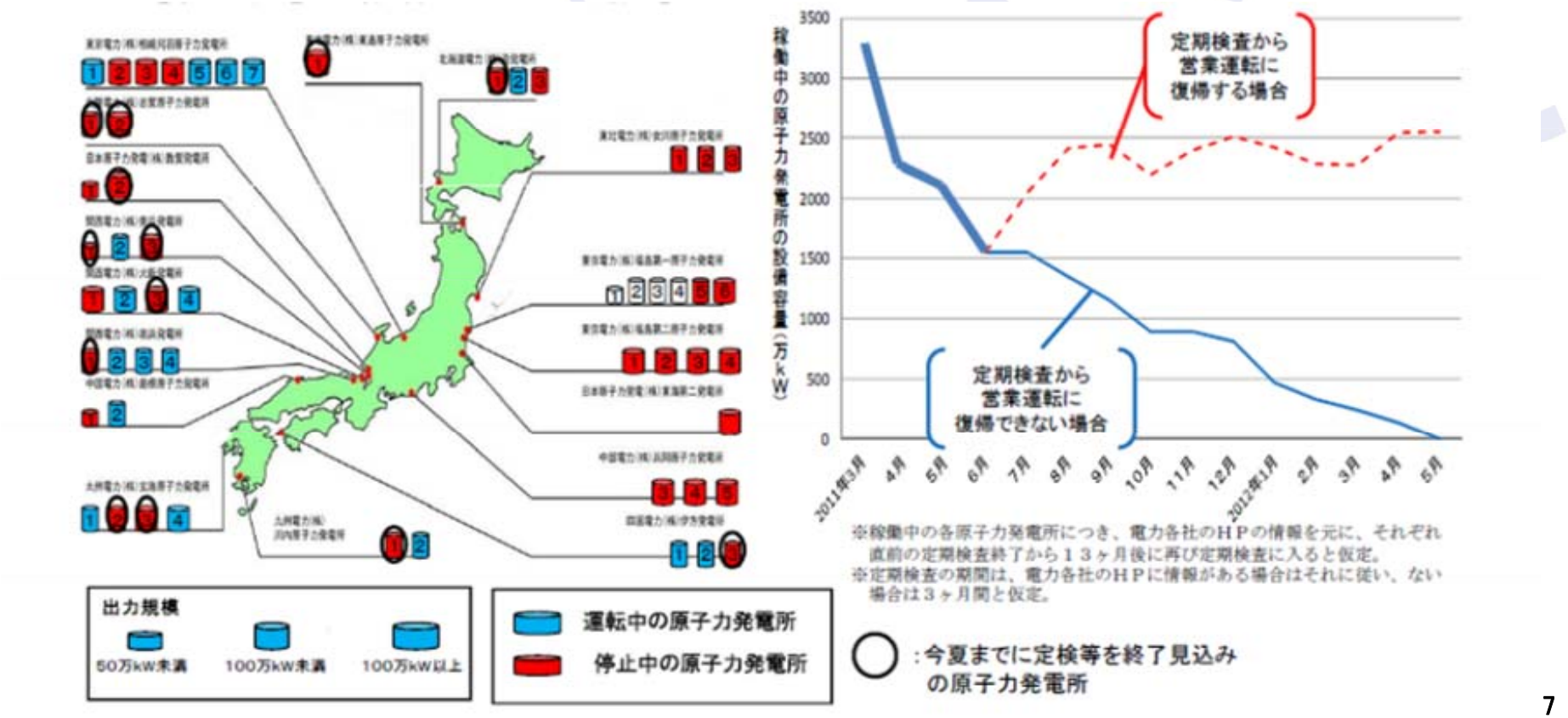
After the Great East Japan Earthquake

March, 11th



After the Great East Japan Earthquake

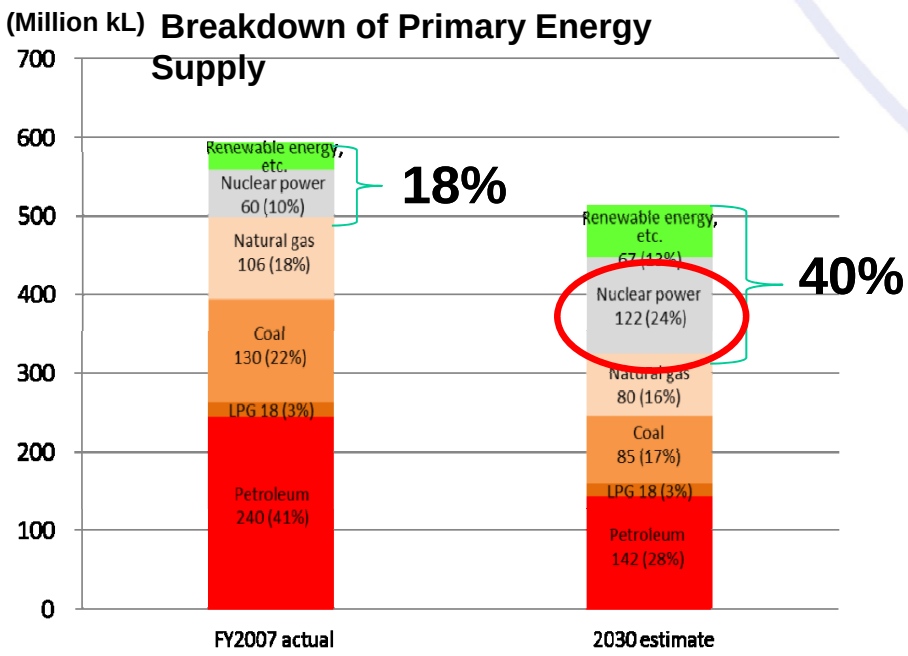
- Currently 50 nuclear power plant units work in addition to the 4 units at Fukushima .
- 3 units at Hamaoka have been shut down due to the request from METI/NISA.
- 30 other units have also been shut down for regular maintenance work.

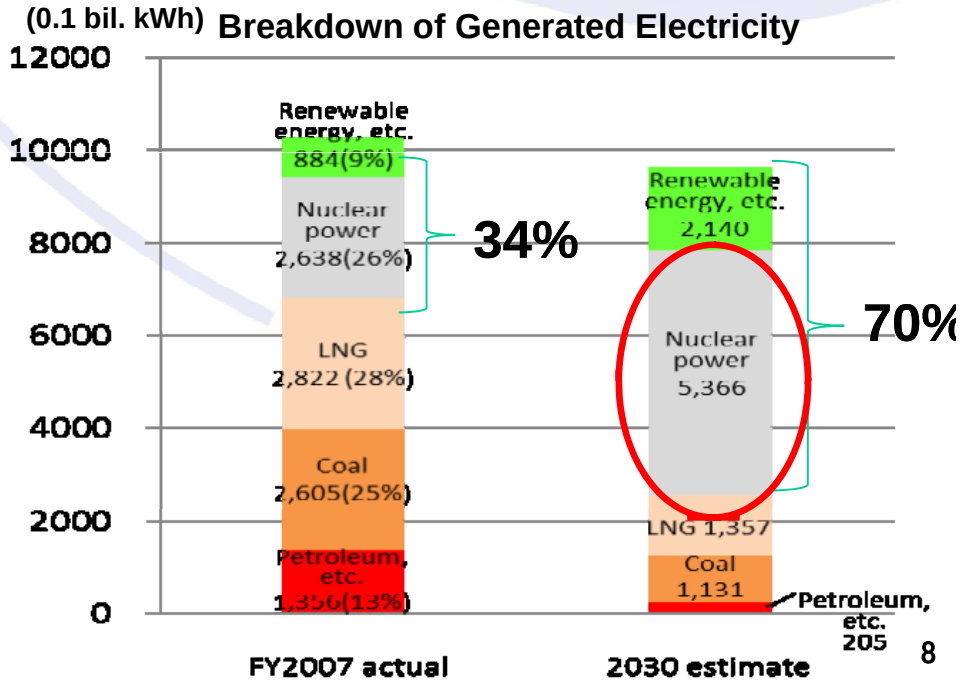


After the Great East Japan Earthquake

"We will engage in drastic technological innovation in order to increase the share of renewable energy in the total electric power supply system to at least 20% by the earliest possible in the 2020s. As a first step for this purpose, we aim to lower the cost of solar power generation to one-third of its current level by 2020 and to one-sixth by 2030. Moreover, we aim to install solar panels on all the roofs of 10 million houses capable of doing so. "

Address by Prime Minister Naoto Kan of Japan at the Commemoration Ceremony of the 50th Anniversary of OECD (25/05/2011, Paris)





After the Great East Japan Earthquake

The Japanese government has initiated a review process of energy policies in the ***Energy and Environment Council*** : June, 2011
- A ministerial meeting chaired by the Minister of National Policy

[Interim Report July, 2011]

Existing Risk

10% Power Insufficiency at Peak 20% Cost-Up (3 trillion Yen)

Five Principles by the Council

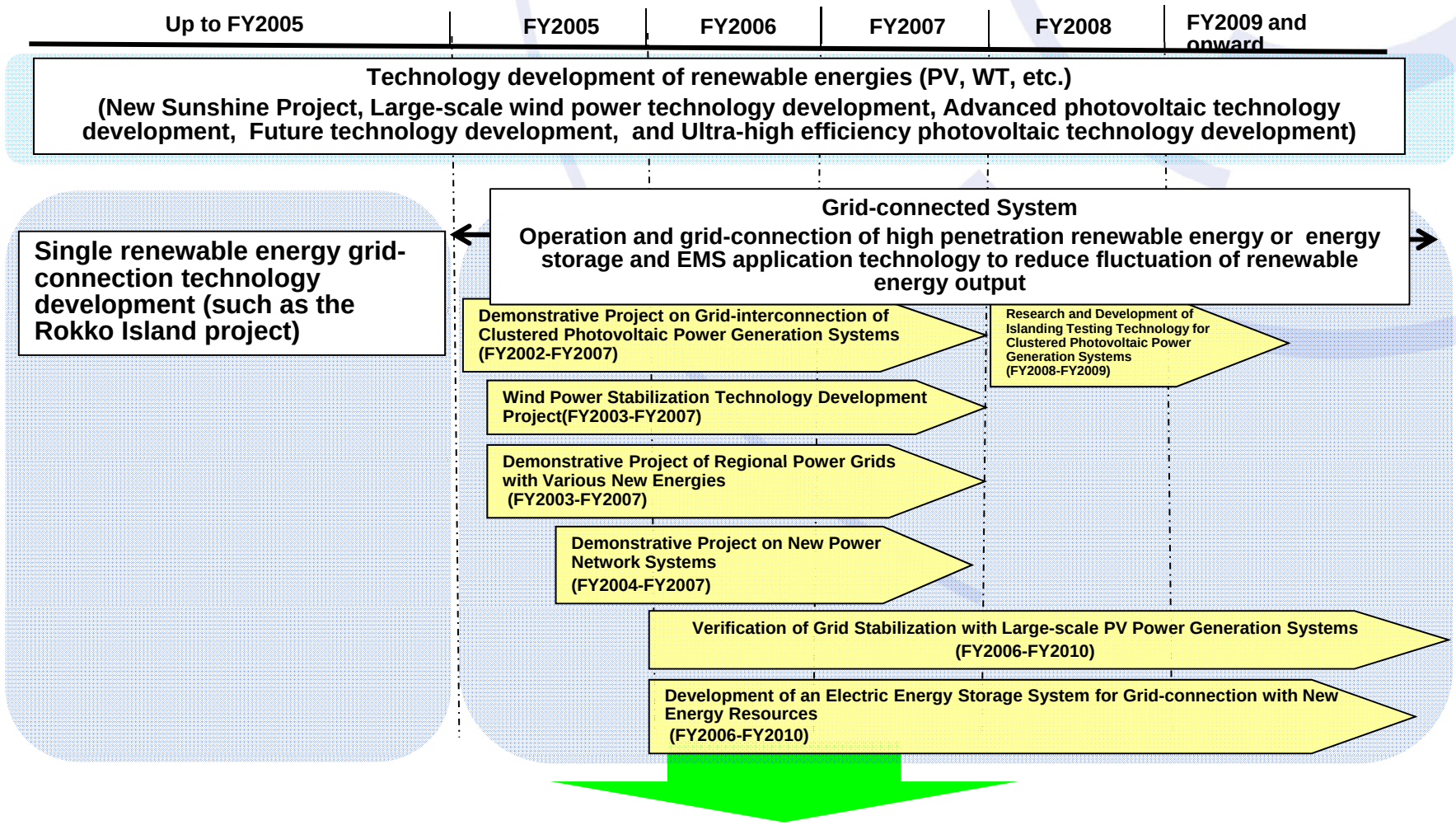
- Minimize both of Power Insufficiency and Cost-Up even if Nuclear shut downs were widespread.
- Avoid Rolling Outage, limiting Power Consumption and easy Price-Up.
- Implement proactive Structural Reform on Energy by supporting overall civic action that is sustainable and reasonable with government support and reviewing regulatory condition. Establish economic and societal mechanism as soon as possible that enables continuous progress on Peak-Cut and Cost-Cut.
- Place the issue of balancing energy demand and supply as a vitalization of economy
- Suggest 3 years road map due to the necessity of civil participation

Action Plan

- ☐ Prioritize Structural Reform on Demand Side =Promote Further Energy Efficiency=
- ☐ Promote an entry into Power Supply Business =Promote Renewables etc.=
- ☐ Power System Reformation
- ☐ Thorough Nuclear Power Safety

EXPERIENCE IN RENEWABLES INTEGRATION

Japanese Experience in Renewabes Integration



Promoting Continuous Efforts to Develop Smart Community Technologies

Grid Connection Test Facility: 1986-1993

Rokko New Energy Test Facility (Kanasai Electricity Power Co.)

First House with Grid connected Rooftop PV in Japan:1992

Grid-interconnection of Clustered PV Power Generation Systems : FY2002 - FY2007

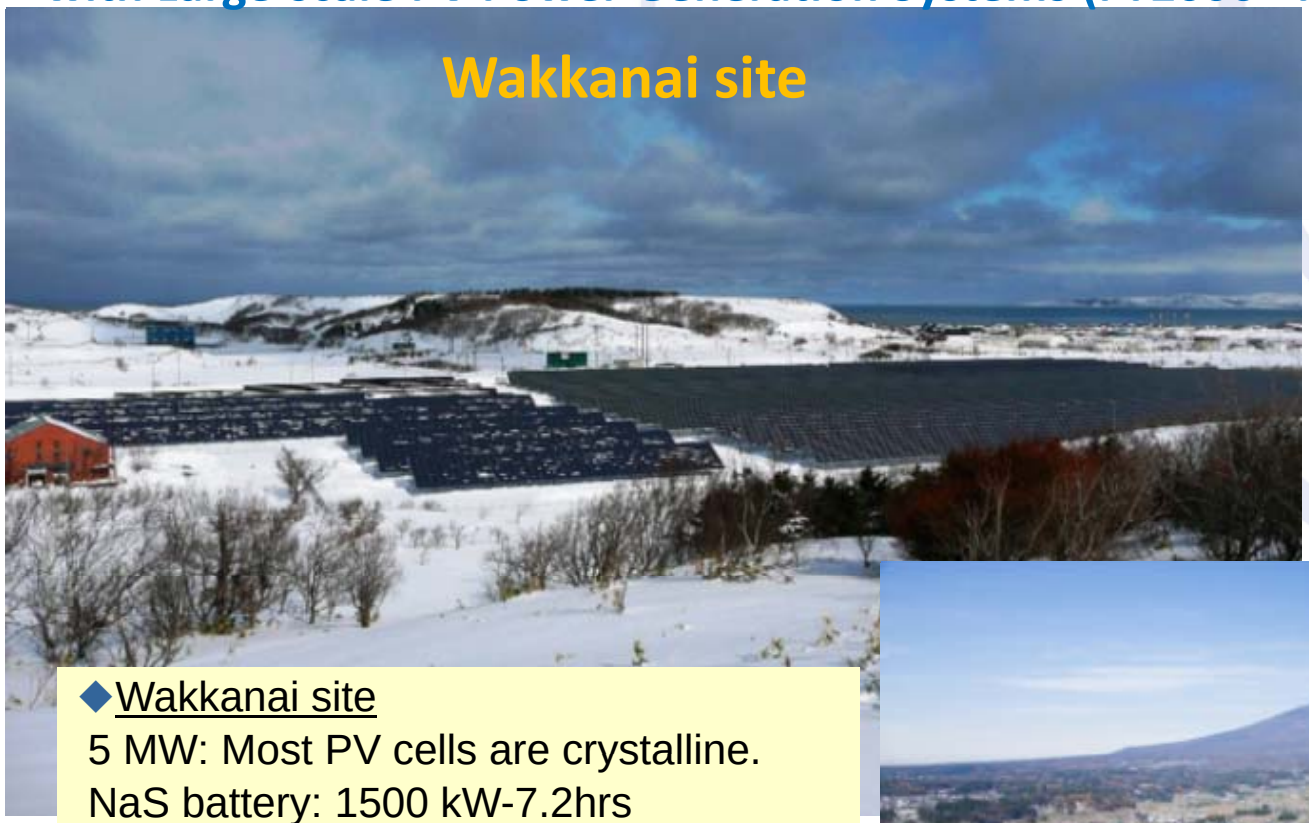
Ota City Demonstration Site

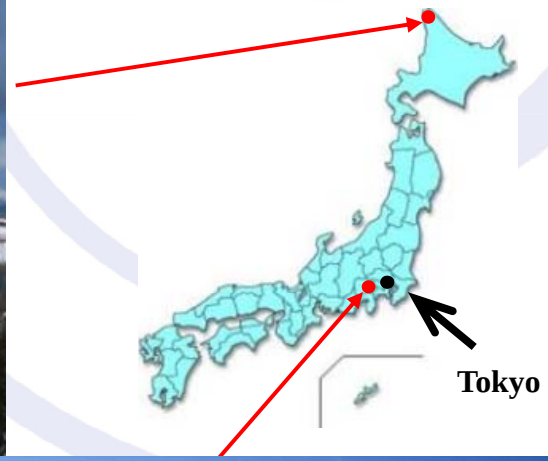
- Development of a new inverter to detect islanding
- Development of battery storage operation and network voltage control
- Development of simulation technologies

Number of PV-equipped houses: 553
Total PV capacity: 2,129 kW
Average capacity per house: 3.85 kW

Verification of Grid Stabilization

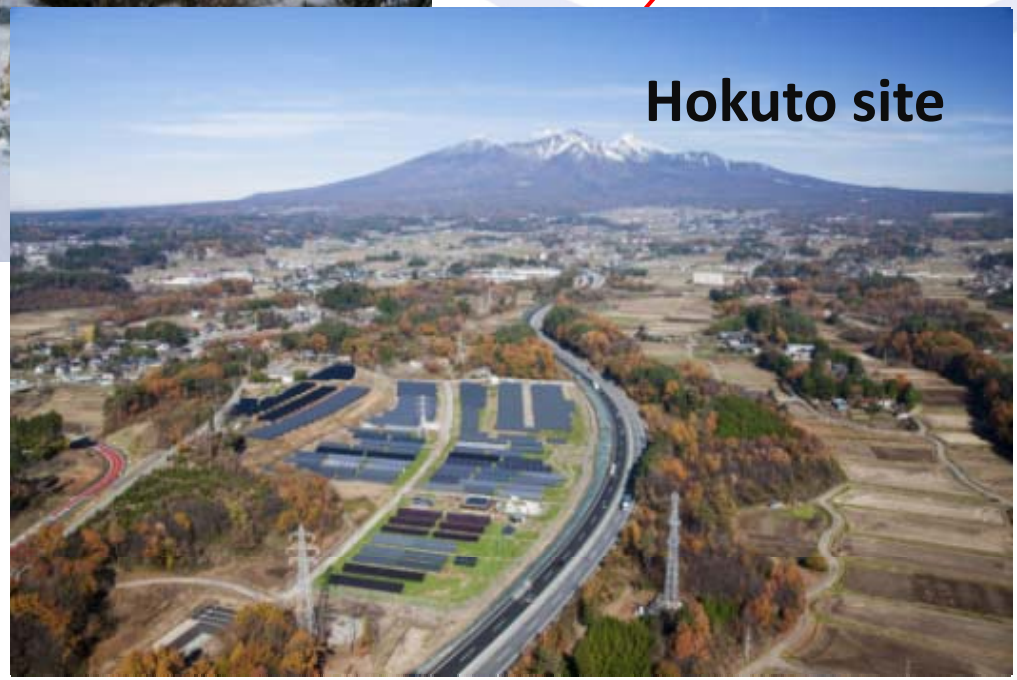
with Large-scale PV Power Generation Systems (FY2006 - FY2010)





◆Wakkanai site
5 MW: Most PV cells are crystalline.
NaS battery: 1500 kW-7.2hrs

◆Hokuto site
1.8 MW: 27 types of PVs



- Technology development to reduce voltage fluctuation with battery
- Development of a new inverter suitable for mega-solar plant
- Testing various types of PV modules

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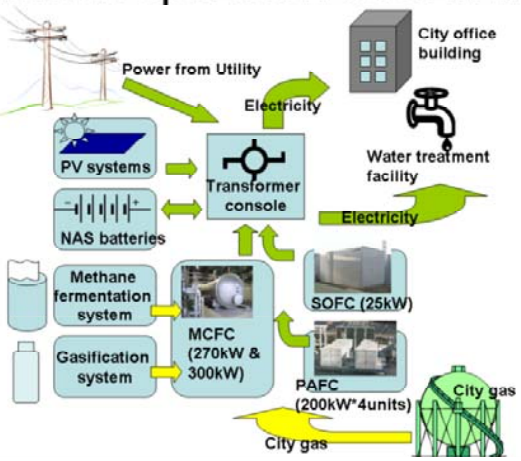
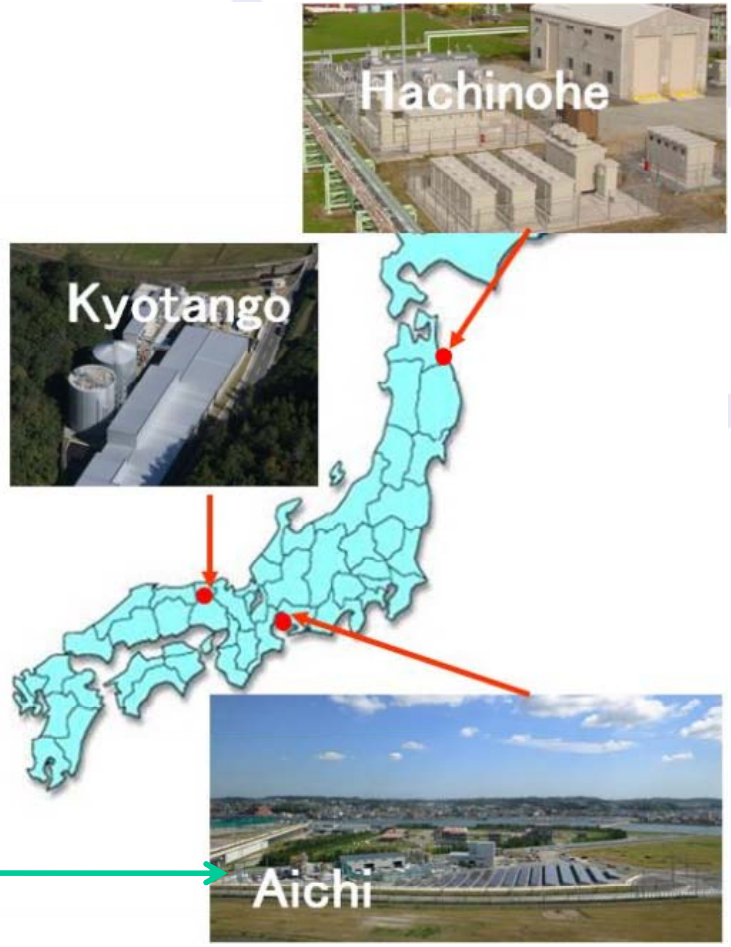
Regional Power Grids

Verification of Grid Stabilization with Large Scale PV Power Generation Systems

(1)Creating energy supplying system from new energy economically. (Also, this system should be less influence of fluctuation of output from new energy to power system.)

(2)Measuring power quality and other data such as operation cost In the systen

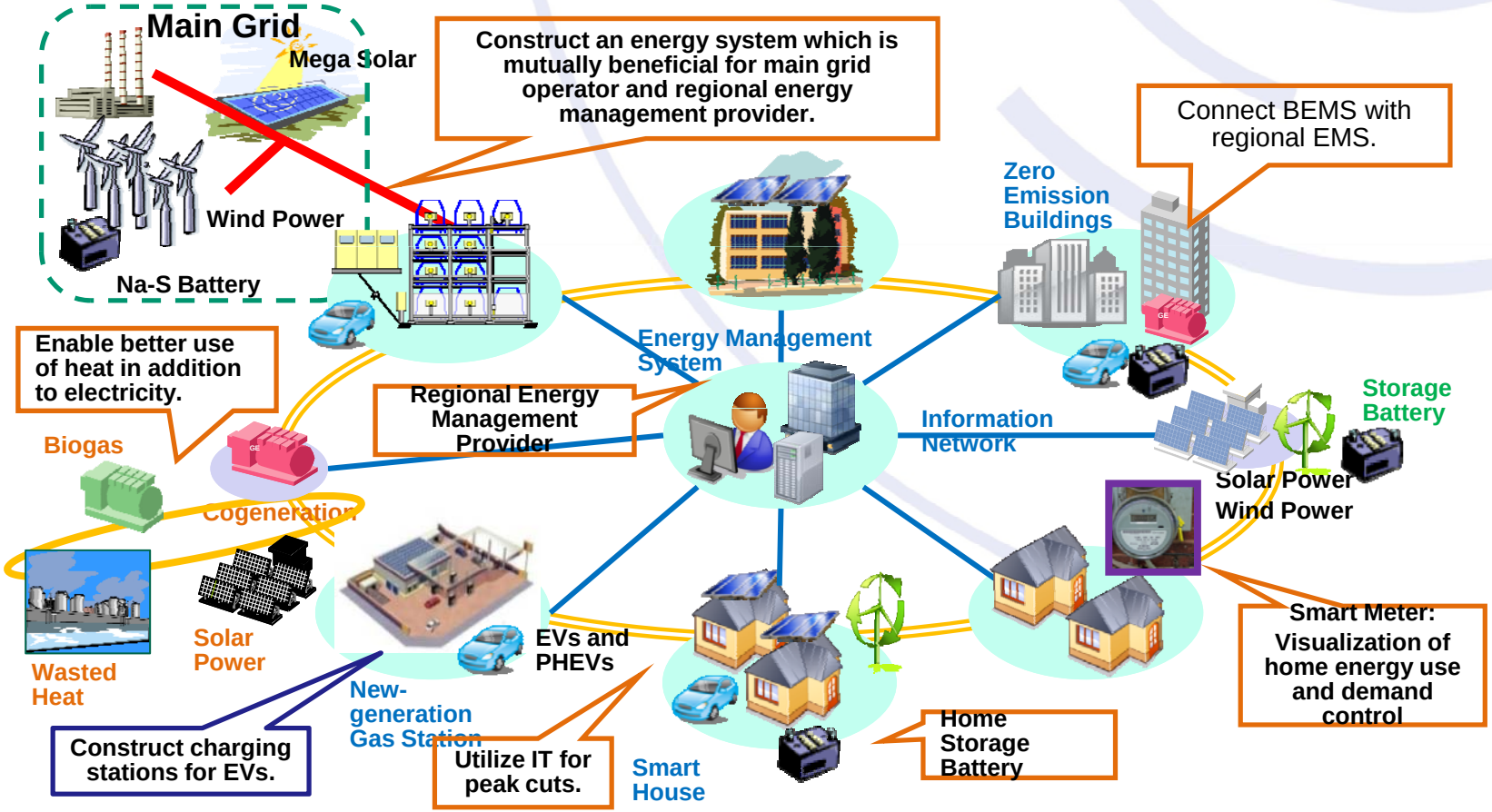




ON GOING ACTIVITIES IN JAPAN

Japan's Smart Community and smart grid Goal

More convenient, reliable and greener system
by means of IT through coordination and cooperation
Between energy suppliers and demand side users.



Japan Smart Community Alliance

Japan
Smart Community Alliance

NEDO

JSCA carries out various work for the development of roadmaps or dissemination of information to achieve international standardization and strengthen collaboration among a wide range of relevant people and organizations.

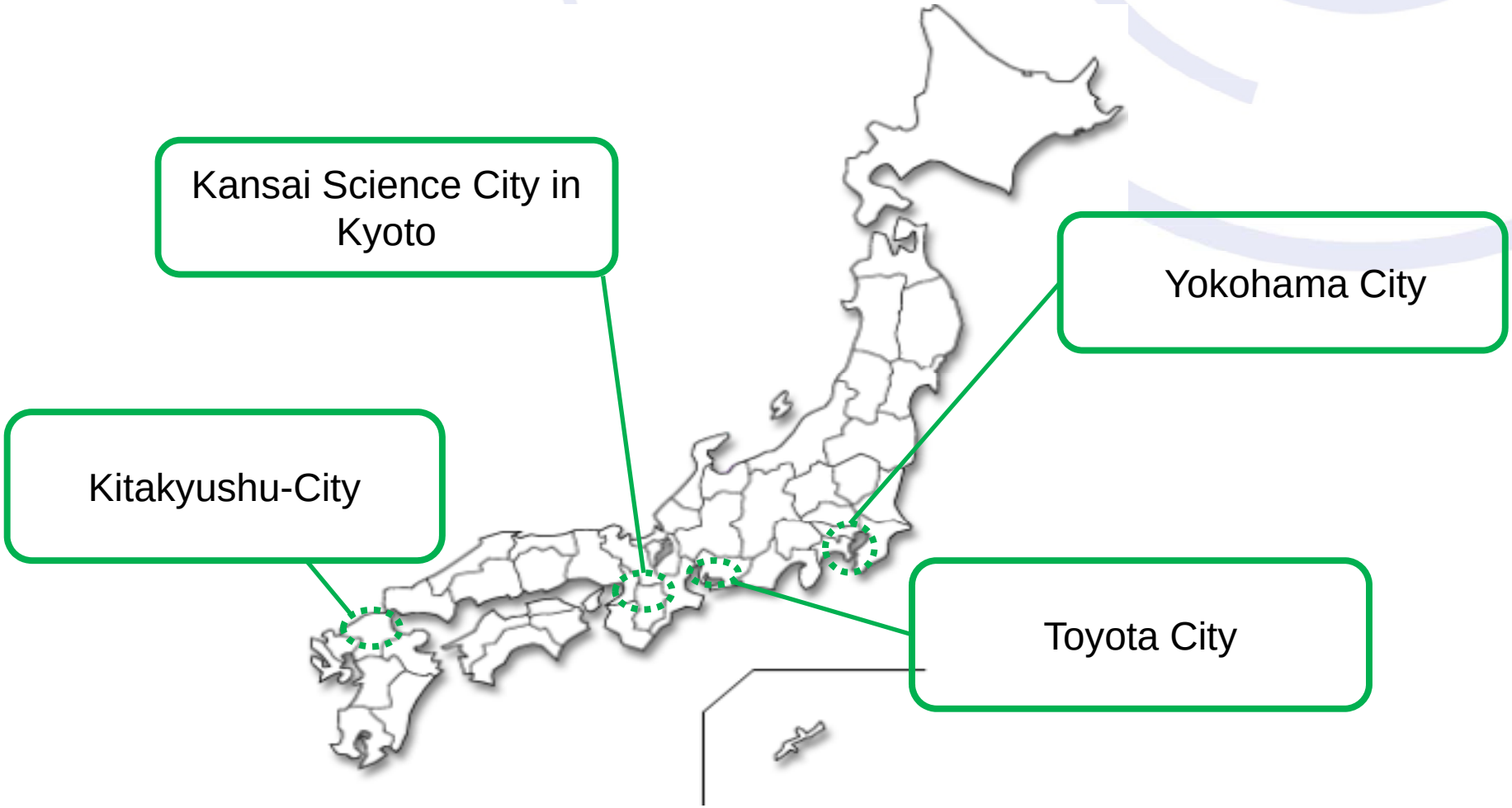
Members: 646（As of August, 2011 ）

Established: April, 2010

JSCA is a public-private organization, consists of a broad range of Japanese organizations and companies, including electric power, gas, automobile, information and communications, electric machinery, construction and trading industries as well as the public sector and academia.

Large Scale Pilot projects on Smart Grid and Smart Community in Japan

- 4 sites were selected by Japanese Government : April, 2010
- METI as well as other Ministries (communication, environment, agriculture and forestry) conduct Smart Grid related projects in those areas.



Yokohama City, Kanagawa

Large-scale Demonstration in a Large City

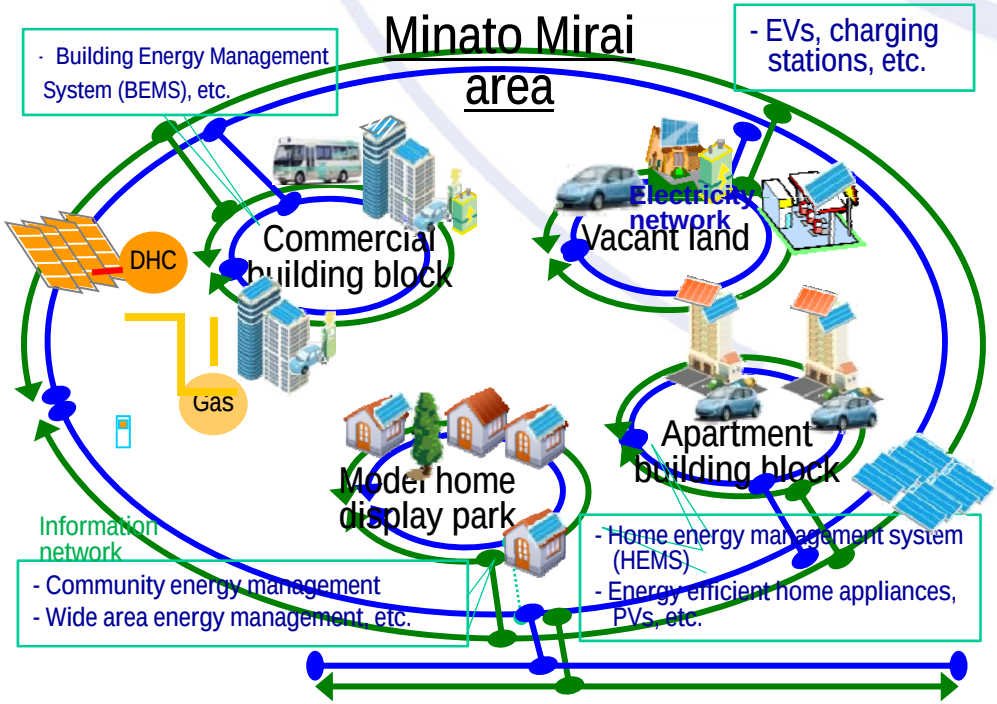
Conducted by METI

CO2▲30% by 2025（from 2004）

- EMS integrates 3 different areas (suburbs ,urban , apartment area)
- Demand Response with HEMS and BEMS
- 27 MW Renewables including 7MW PV
- 4000 Smart houses, 2000 EVs

TOSHIBA Leading Innovation >>> accenture

Tokyo Gas NISSAN Panasonic MEIDEN



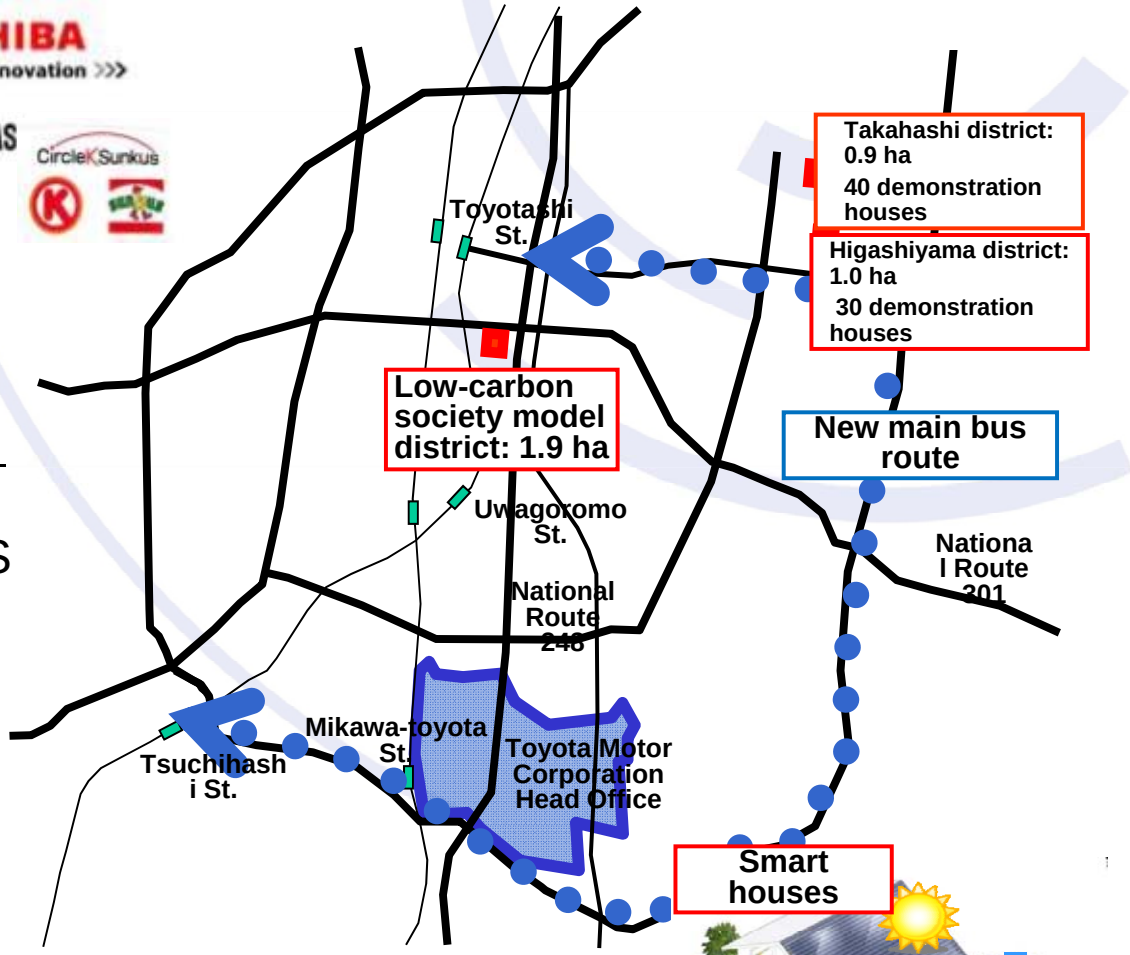
Toyota City, Aichi

Community-based Demonstration in a Provincial City

Conducted by METI

CO2▲30% by 2025（from 2005）

- EMS integrates different areas
- Demand Response with HEMS at 70 houses with PV, FC and heat pump
- 3100 EVs, V2H, V2G
- Establishment of a low-carbon transport system by ITS



Kansai Science City in Kyoto

Conducted by METI

Demonstration of New Technologies in a Provincial City

CO2▲30%by 2030（from 1990）

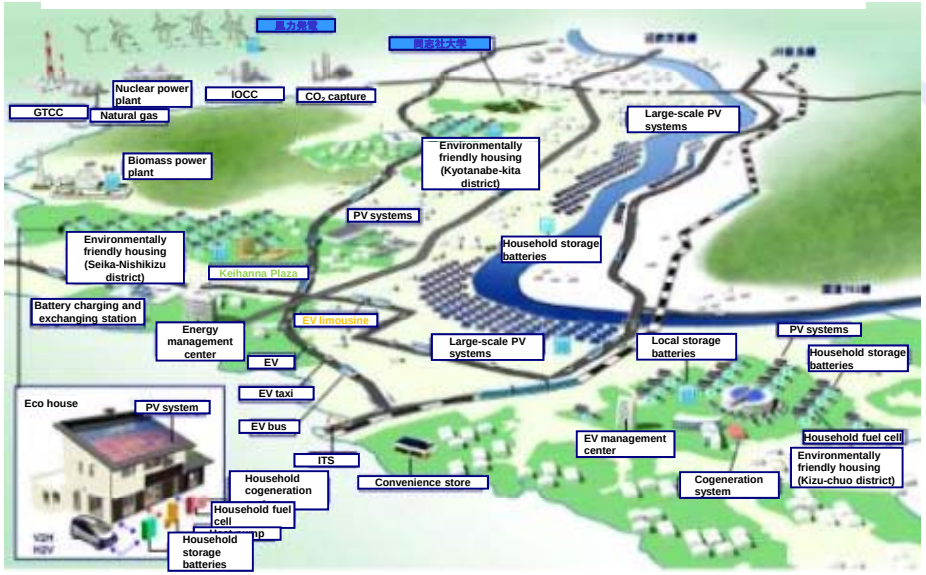
- ‘Smart tap’ which visualizes energy consumption control home electronics energy usage.
- ‘Electric power virtual coloring’ technology actualizes total home energy management system.

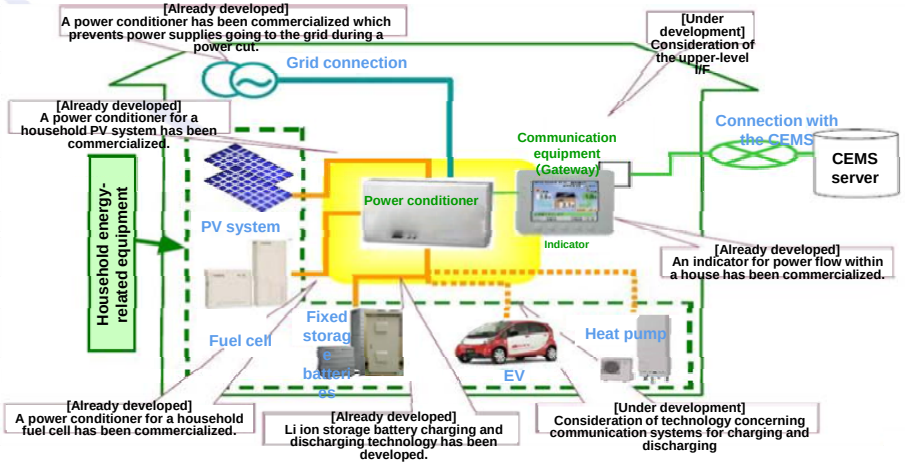
京都府 Kyoto Prefecture Web Site　関西電力　大阪ガス GROUP

MITSUBISHI Changes for the Better　三菱重工　OMRON

Kansai Research Institute

Future Look of the Kansai Science City





Kitakyushu City, Fukuoka

Demonstration in a Special Zone in an Industrial City

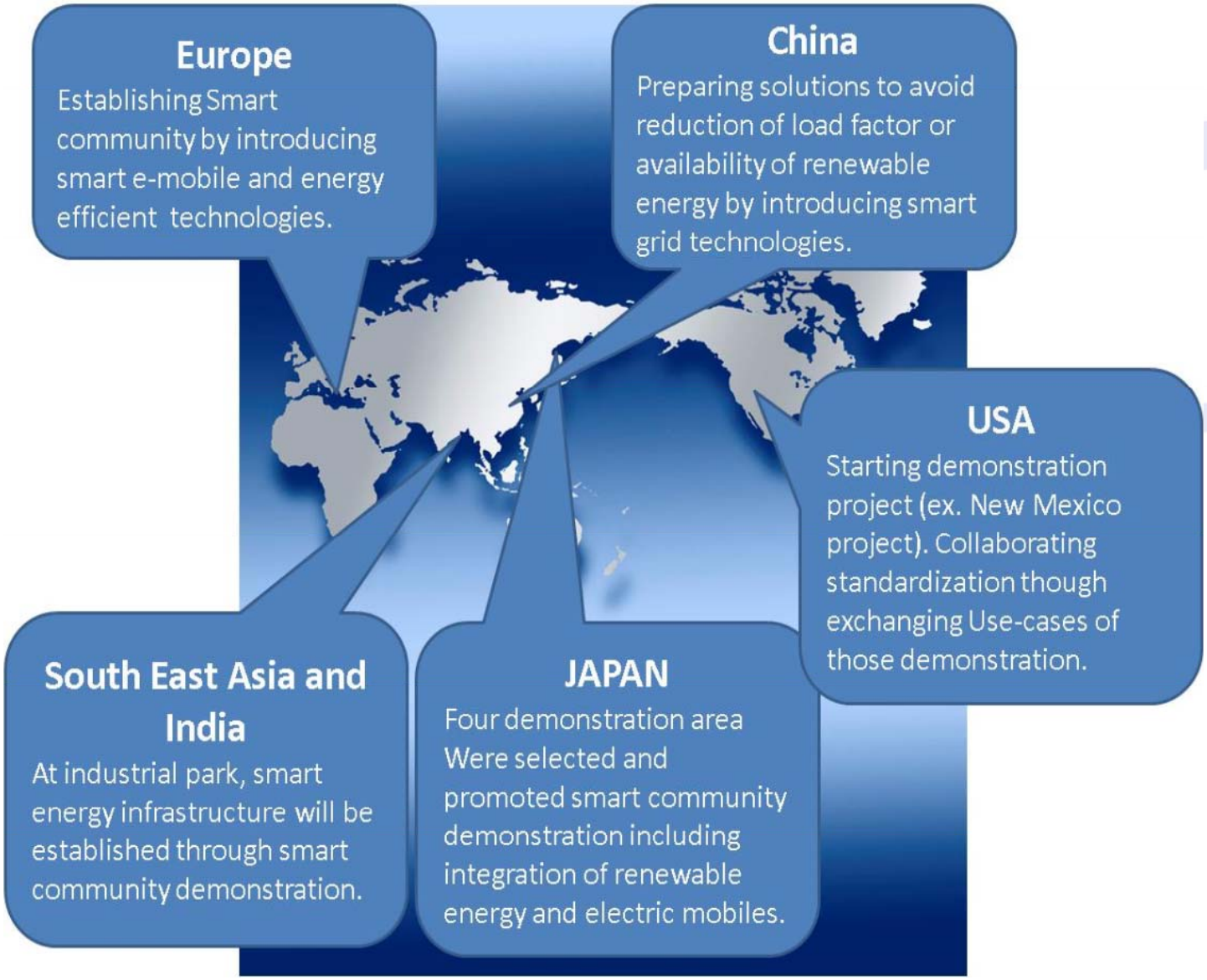
Conducted by METI

北九州市 imagination at work intel
新日本製鐵 富士電機
NTT西日本 YASKAWA IBM

CO2▲50%（from 2005）

- 70 companies and 200 households using smart meters HEMS , BEMS
- Real-time pricing and demand control
- City block energy management through a regional energy saving station
- Development of communities and transport systems based on energy infrastructure

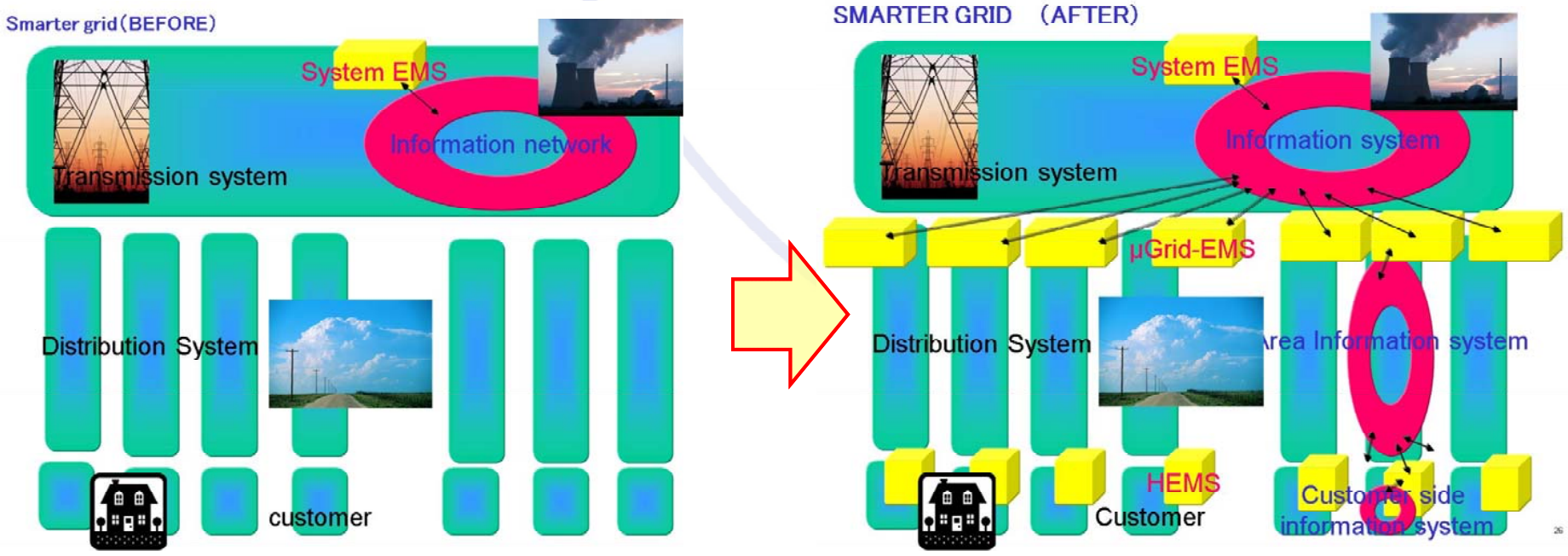
International Smart Community Activities



KEY DISCUSSION OF SMART GRID

The point at issue of the smart grid (1)

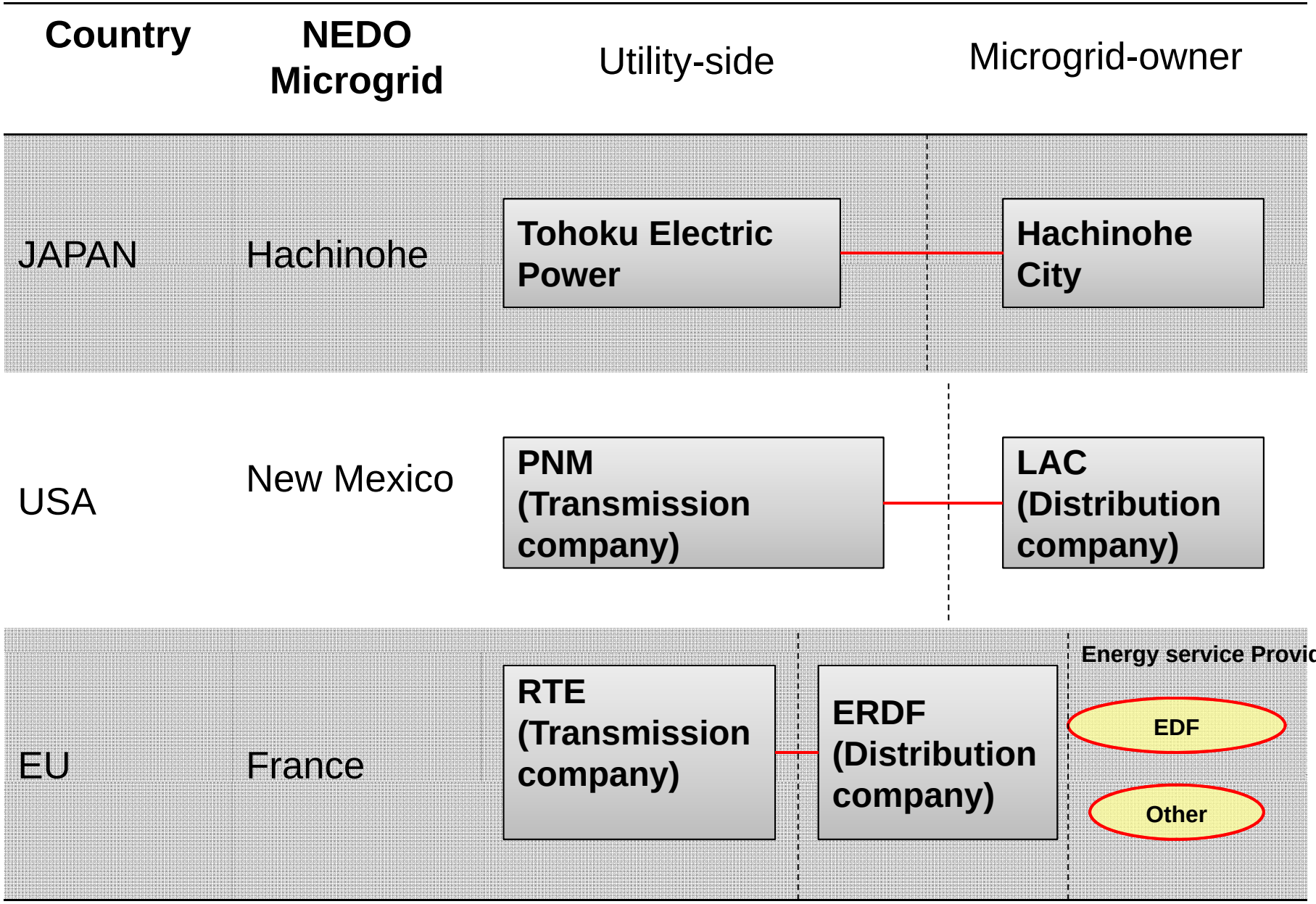
(1) It is not completed by installing Smart Meter and AMI.
EMS is also very important element on smarter grid.
This role of this EMS is influenced by difference of regulation.



Japanese experience on Micro-grids

Country	Utility	NEDO Microgrid	Microgrid-owner
JAPAN	Mostly integrated	Hachinohe Aichi	Microgrid owner – Demand side
USA	Wholesale deregulated (Not completely deregulated on the retail side)	New Mexico Hawaii	Microgrid owner – Distributed Utility
EU	Fully deregulated (Both wholesale and retail)	Lyon (France) Malaga (Spain)	Microgrid EMS is separated into two different types (regulated utilities, competitive utilities)

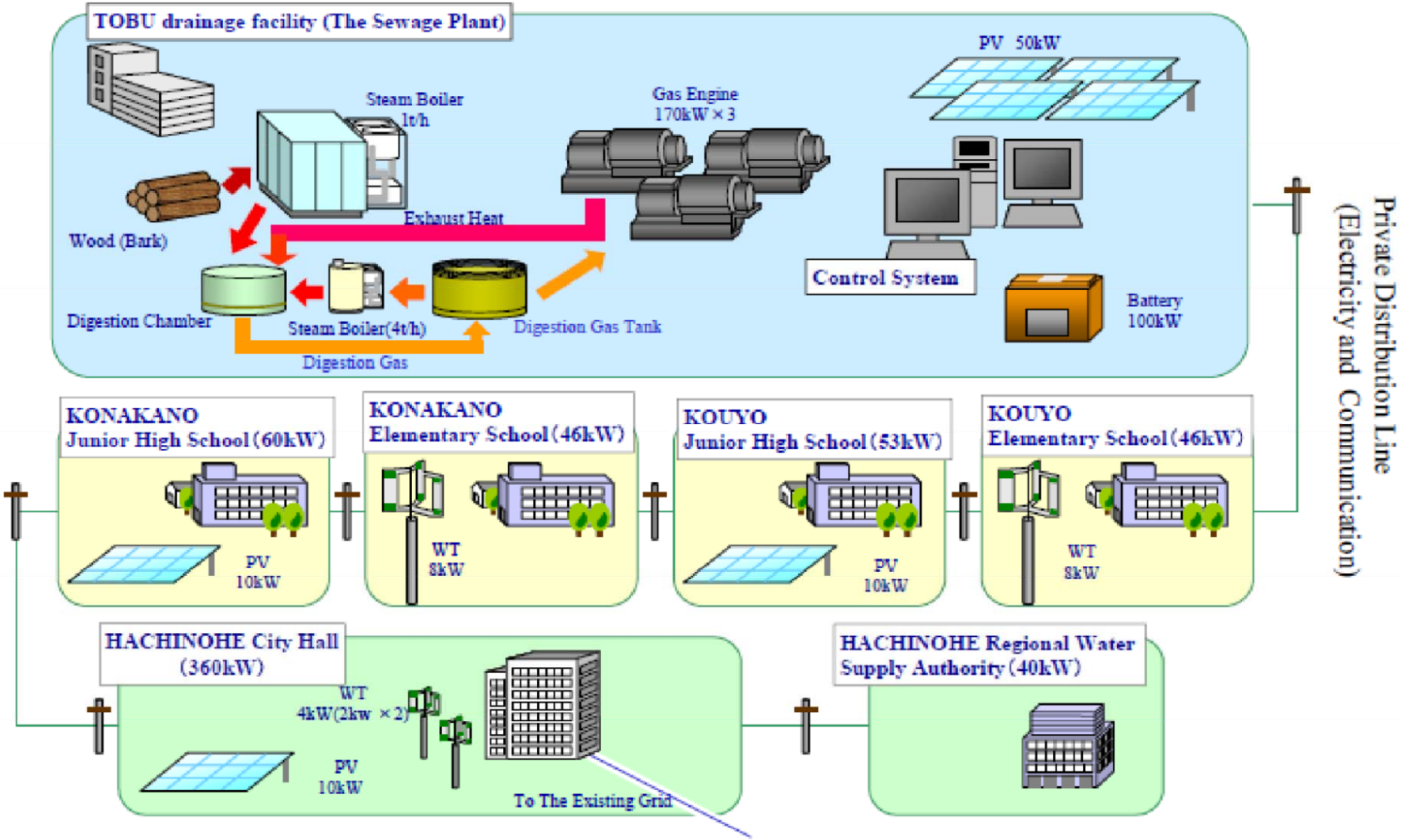
Specific Micro grid Activities



Hachinohe Project

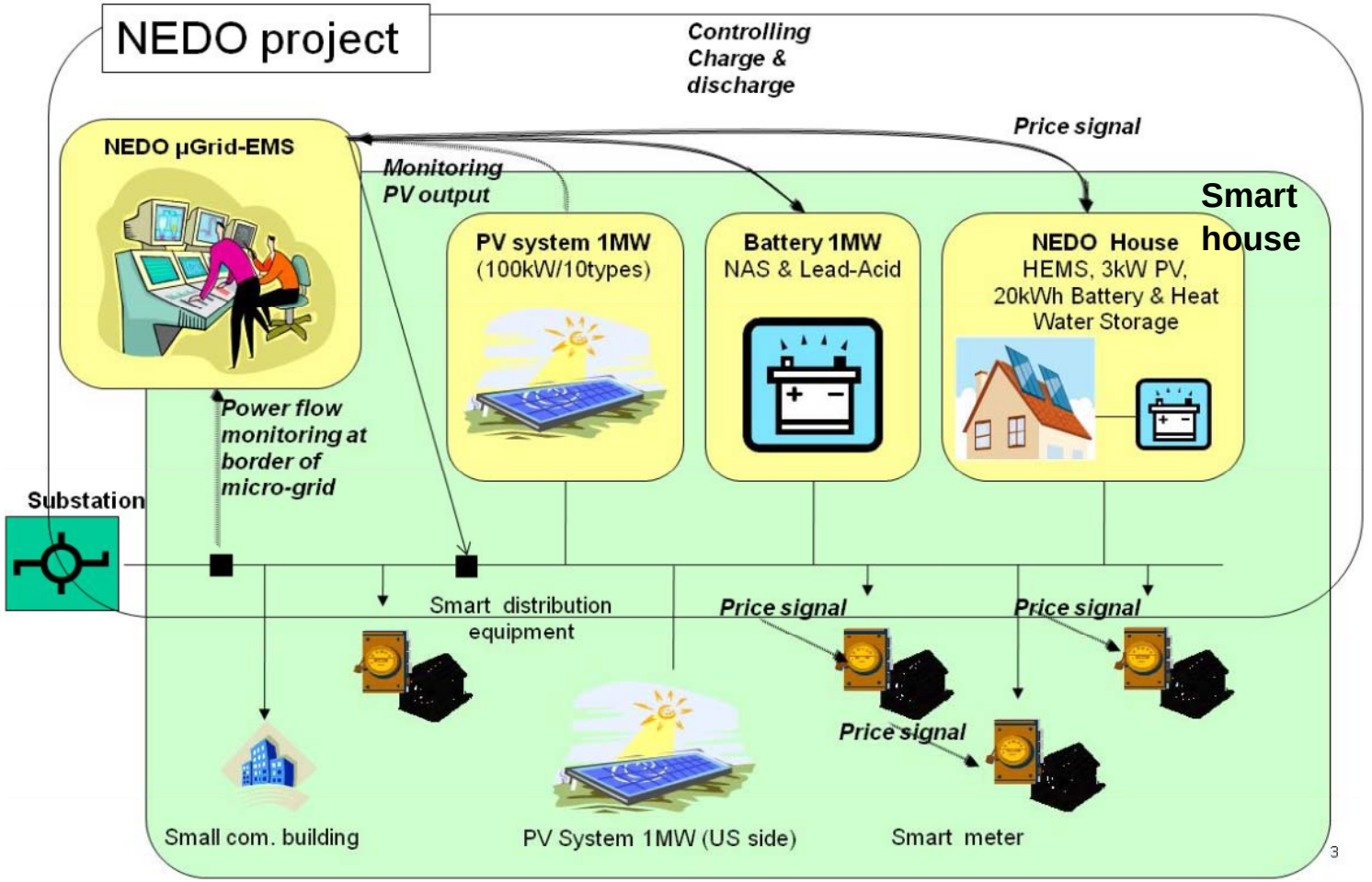
Demonstration Project for Regional Power Grids Utilizing Various New Types of Energy

Mitsubishi Research Institute,
Mitsubishi Electric, Hachinohe City



Micro grid Demonstration in Los Alamos

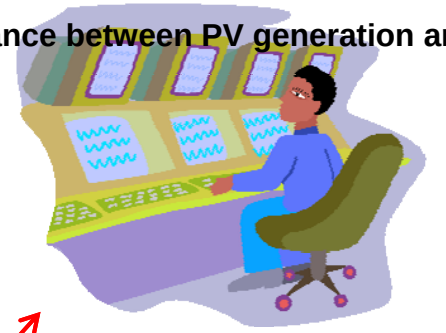
Demonstration of concentration power storage or home demand response



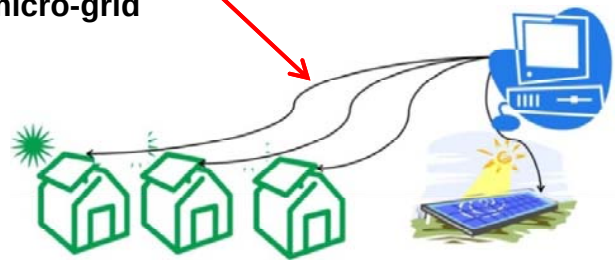
- ✓ **Concentration PV generation and power storage cells w of about 2 to 5 MW will be installed on distribution lines.**
- ✓ **Absorption experiments on PV output fluctuation will be conducted by using various PV introduction efficiencies obtained by changing grid formation.**
- ✓ **A distribution network with high operability will be installed and demonstrated by introducing smart distribution equipment (distribution equipment with IT functions).**

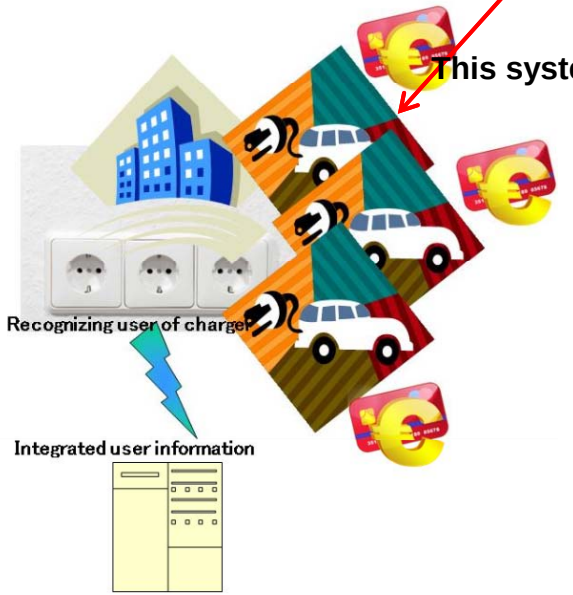
Contents of Task2 in Lyon project

- Local management system
  - Trying to keep balance between PV generation and EV charging



This system consists virtual micro-grid





- PV remote management system includes:
  - Generation monitoring
  - Synchronization of PV generation and EV charging
  - Fault detection

- EV charging system includes:
  - Billing management system
  - Charger authentication
  - Car sharing service

The point at issue of the smart grid (2)

(2) Application of smart meter differs in different regulation circumstance.

In completely deregulated market, application of smart meter may focus on dynamic profiling rather than getting demand response.

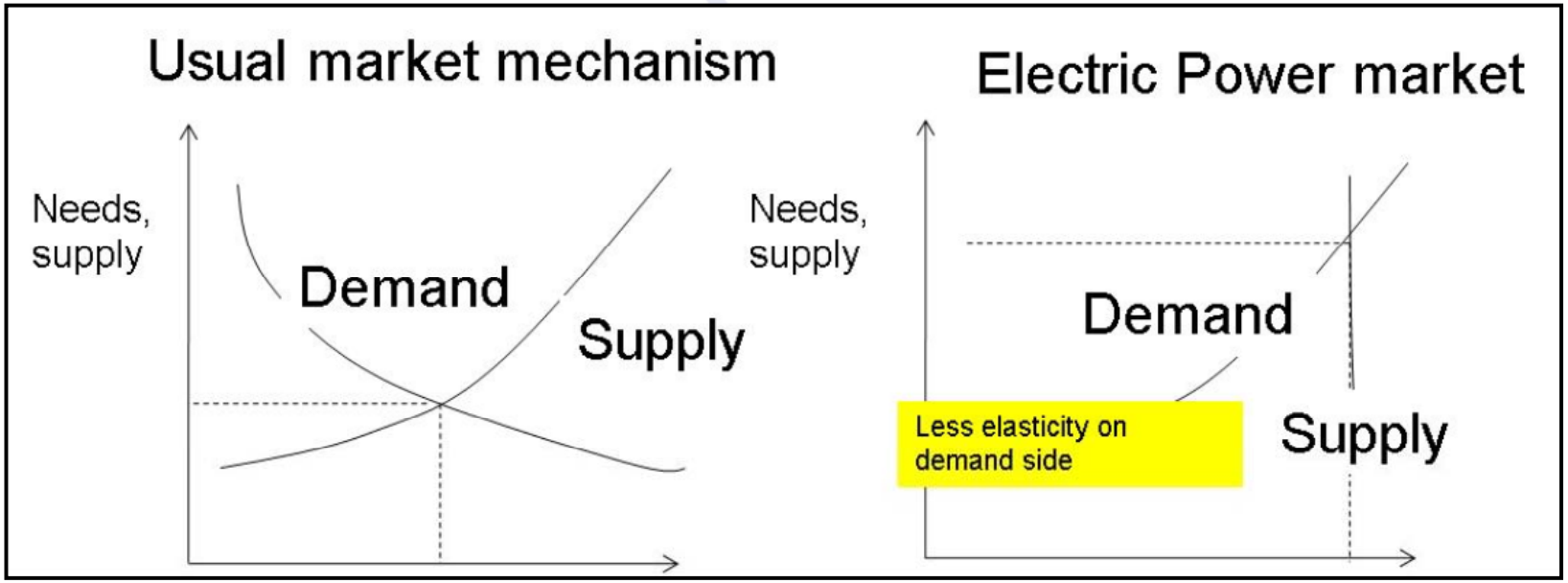
To reap the full benefits of demand response, sophisticated HEMS system is necessary at demand side.

Difficulty of trading renewable energy on market

At the demand side of electric power market has less price elasticity. This is the reason, demand response is desired.

However increasing of renewable energy (such as PV and wind) is also decrease price elasticity at supply side.

To keep market mechanism on electricity, we need to add inventory mechanism by adding energy storage.



The point at issue of the smart grid (3)

(3) Electric vehicle is moving demand. Recognition ICT system is needed where EVs are charged in town.

Charging in nighttime may be not desired way, if renewable energy generators (especially PVs) are increased.

Synchronizing renewable generation and EV charging is the best way to reduce CO2 emission by vehicle.

At home, 3434 is fixed.

At town, consumer is mot fixed.
Therefore, recognition system is needed to identify user.

Thank you for your attention

Kazuyuki Takada
Deputy Director
Smart Community Department
NEDO

Kazuyuki Takada is Deputy Director for Smart Community Department, NEDO, focusing on developing and disseminating Smart Community related technologies based on Renewable Energy with collaborating worldwide.
He has been Representative for NEDO Washington DC Office until June, 2011. He has managed Cellulosic Ethanol Production Technology Development Program until August 2008 as well as various Japanese national R&D projects after joining NEDO in April, 1997.
He received a Bachelor of Engineering degree in Resource Engineering, and a MBA in Technology Management from Waseda University.