Smart Grid Standardization Activities in Japan

Hironori Nakanishi
Director,
Technical Regulations, Standards and Conformity Assessment Policy Division,
Ministry of Economy, Trade and Industry, Japan
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Outline for today

- Current situations
- From Smart Grid to Smart Community
- From R&D to Demonstration
- Contribution to International Standardization
Current situations

- Japan’s situations
- Merit and Demerit of SG
- Interests of industry
- Conversion of discussions
Japan’s situations on Energy and Environment

➢ **Highly reliable electricity supply**
  - No urgent need for improvement now. But …
  - (Power failure time per year / per household: Japan 16min, US 162 min)

➢ **Urgent need for CO₂ emission reduction**
  - 25% CO₂ reduction by 2020 !!
  - Further promotion of energy efficiency
  - Broad introduction of renewable energy
    - 28 GW of PV is needed
    - Feed in Tariff system will be expanded

Deployement of Smart Grid is inevitable!
'Smart grid' is an electricity transmission and distribution grid to promote the stability of electric power supply by using information and communication technology while introducing huge amount of renewable energy.

Once renewable energy, home electrification, EV etc. are introduced, energy supply-demand system will change. There is a potential for the demand side to play an adjustment function role which is currently assumed by energy suppliers.

Energy can be used more efficiently if the demand side manages to distribute power supply locally, i.e. “local production for local consumption”.

**Merit of Smart Grid**

- The storage battery supplies it to the home.
- Use hot water kept warm before.
- Charge a large amount of hot Waters.
- Washing begins automatically.
- The charge begins automatically.
- The storage battery supplies it to the home.

**Example of energy utilization on demand side**

- Large amount of supplies
- It doesn't wash.
- The quantity supplied is a little.
- Charge a large amount of hot Waters.
- Washing begins automatically.
- The charge begins automatically.
'Smart grid' also bring some challenges to the grid, since huge amount of renewable energy is connected to the grid:
- Increase in voltage limit violations
- Increase instability (fluctuation on frequency)
- Uncertainty of balancing

Managing and controlling technology is necessary.
Situations of other countries

- Introduction of Smart Grid differs depending on each country’s situation.
- Networked electric appliances and EV are connected to grid regardless of SG deployment.
  - Vulnerable transmission infrastructure and insufficient investment for new power plants
  - Need for enhancing the reliability of electricity supply through ICT
  - Creation on new business through utilizing demand information

- Set the target of “20-20-20” by 2020
  - Introduction of huge amount of renewable energy
  - Development of EV charging infrastructure
  - Deployment of smart meter for billing and efficient use of energy.

- Rapid growth of energy demand due to economic boom and needs for higher QOL. Construction of energy infrastructure is inevitable.
  - Development of urban city including energy infrastructure such as Tianjin Eco-city.
Interests of Industries

- Discussions on the challenges for power grid
  - Increases in voltage limit violence, frequency instability and uncertainty of balance etc.
  - Smart metering

- Great interests were shown by the industry
  - Expectation to huge potentiality of new business domestically and internationally.

- Standard is the key for complex system such as SG
  - Smart Grid consists of many sub-systems which needs interoperability and common standards.
Contribution to international standardization

- “Study Group on International Standardization for Next Generation Energy Systems” was set up to deliberate road map for Japan’s contribution for international standardization activity in Smart Grid area.
- The road map was released on January 2010.

-Analysis-

- Draw a future-focused total picture
- Identify use case / key systems
- Analyze the strengths / weakness and identify priority areas
- Analyze overseas market

-Road map on Smart Grid standardization-

- Examine a comprehensive smart grid international standardization strategy
- Identify 26 focus areas including control equipment in distributed power supplies and equipment for EV charging infrastructure
- Establish an international standardization roadmap

-Recommendations-

- Contribute to the international standardization activity
- Collaborate with other countries;
  - Collaborate with NIST
  - Exchange information with CENELEC
- Implement policy development;
  - Standardization road map with R&D, pilot projects, and other measures
- Establish private-sector smart grid implementation consortium
From Smart Grid to Smart Community

- Why Smart Community?
- Designing a Smart Community
- Road map toward Smart Community
- JSCA, Institutions for achieving a goal
Why not “Smart Grid” but “Smart Community”? 

- Integration of electricity and heat management system is quite important, since half of energy demand is heat.
- Certain amount of energy demand in transportation sector would be merged into electricity demand.
- Our lifestyle should also be changed so as to fully utilize the new energy infrastructure.
- These integrated system is the “Smart Community”.

Energy consumption in house & building:

- **House**
  - Air conditioning (Cooling): 11%
  - Air conditioning (Heating): 17%
  - Hot Water Supply: 31%
  - Kitchen: 8%
  - Power etc: 35%

- **Building**
  - Air conditioning (Cooling): 11%
  - Air conditioning (Heating): 17%
  - Hot Water Supply: 46%
  - Kitchen: 9%
  - Power etc: 46%

Reference: Institute of Energy Economics, Japan

Energy consumption and real GDP of JAPAN:

- GDP (¥trn)
  - Industrial sector: 45.6%
  - Residential/commercial sector: 31.2%
  - Transport sector: 23.2%

- GDP 1973-2007
  - 2.0×
  - 2.5×
  - 1.0×

(Millions of crude oil equivalent kl)

(Fiscal year)
Smart Community
- Designing a future society to come -

Designing a new energy system

- Community Grid – interconnected energy system
  • Managing distributed energy sources (PVs, wind power, fuel cells) in each community to stabilize fluctuation and to make most use of energy produced
  • Utilizing demand response or home storage batteries to absorb excess energy produced in the community, in order to minimize negative impact on the main grid system

- Moving storage device - EV as energy storage
  • Introducing smart charging system at homes in order to absorb fluctuation in the energy system
  • Utilize electric cars as energy storage (G2V & V2G) in the Community Grid to stabilize energy supply (near future)
Smart Community
- Designing a future society to come -

Designing a city

– New transportation system (modal shift)
  • Enabling various type of personal vehicles (including bicycles and small EVs) to run inside the city
  • Introducing environmentally friendly and convenient public transportation system such as LRT (Light Rail Transit) or connectable electric bus
  • Designing organic transportation system which enables smooth transfer from personal vehicles to public transportation and vise versa

– A city coexisted with the nature
  • Redesigning and redeveloping a city to create environmentally friendly but comfortable environment which utilizes natural wind flow, river flow, and sunlight
An Image of “Smart Community”

Control Center for optimizing energy demand/supply
- Maximize the use of renewables, such as PVs, wind power, and micro hydraulic
- In order to absorb fluctuation caused by renewables in the community, share energy with homes and office in the region
- Utilize EV and EB as part of energy infrastructure by managing their location and battery status

Utilize Electric Car As a part of energy infrastructure

Shortage: EV → House
Excess: House → EV

Original Visual Image made by Mitsubishi Heavy Industries

Nuclear Power Plant
Thermal Power Plant

Large Energy Storage

Wind Power

Utilize Natural Wind Flow

Smart House

Micro Hydraulic Plant

Electric Bus (works like LRT when connected)

Power Line Free LRT
LRT with Battery
At the station: Charge to battery
Between stations: Move by battery

LRT: Light Rail Transit

Quick Charging Station
80% charge in 30 minutes

Connected buses will operate like LRT.
Japan’s Smart Community Roadmap

To address the 3Es simultaneously, it is important to realize the best mix of power sources by introducing large-scale RE utilizing storage. This roadmap illustrates a future social system Japan is aiming at, concentrating on regional EMS and lifestyle changes, under such an energy supply structure.

(3E (Environment • Energy Security • Economy))

<table>
<thead>
<tr>
<th>Today - Year 2020</th>
<th>2020 - 2030</th>
<th>2030 -</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relation between regional EMS and entire grid</strong></td>
<td>■ Solar panel prices will decrease significantly due to large-scale introduction of panels to houses as well as commercial buildings.</td>
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<tr>
<td></td>
<td>■ Measures to maintain the quality of electricity while the large-scale introduction of PV will be carried out mainly for the grid side. Storage cells will be installed at substations.</td>
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<td>■ As regional EMS are further demonstrated, technology and know-how will be accumulated.</td>
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<td>■ The cost of storage cells will go down due to technology development and demonstration.</td>
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<td>■ Due to a decline in PV prices, more PV systems will be installed at houses.</td>
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<td>■ Regional EMS, which contribute to effective use of RE generated at houses, will become more important.</td>
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<tr>
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<td>■ Regional EMS will be realized as storage cells become cheaper and are further disseminated.</td>
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<td>■ Distribution and transmission networks that enable two-way communication between demand side and grid side will be actively established.</td>
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<td>■ Cost competitiveness of RE will improve as fossil fuel prices increase by more than double. Use of RE will be prioritized and nuclear power will be used as a base.</td>
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<tr>
<td></td>
<td>■ EMS that can provide an optimized balance in terms of economy and security between regional EMS and grid will be established.</td>
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<td></td>
<td>■ EMS that creates demand by charging EVs at the time of excessive RE, and supplies energy to grid at high demand, will be used.</td>
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<tr>
<td><strong>Houses</strong></td>
<td>■ Remote reading using smart meters will start.</td>
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<td></td>
<td>■ HEMS is will be disseminated. Some houses will install home servers. Demand response demonstration will start.</td>
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<tr>
<td></td>
<td>■ Demonstration of EVs will start.</td>
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<tr>
<td></td>
<td>■ HEMS and regional EMS will be integrated. All power generated at houses will be used optimally.</td>
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<tr>
<td></td>
<td>■ Various services using home servers will be disseminated.</td>
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<tr>
<td></td>
<td>■ EVs will be used for power storage as well.</td>
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<tr>
<td></td>
<td>■ A fully-automated HEMS will be realized.</td>
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<tr>
<td><strong>Buildings</strong></td>
<td>■ ZEB introduction will start. ZEB: Zero Emission Building</td>
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<td>■ ZEB will be realized at new public buildings.</td>
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<td></td>
<td>■ ZEB will lead to a greatly reduced level of emissions for all new buildings as a group.</td>
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Japan Smart Community Alliance

- The “Japan Smart Community Alliance,” a public-private consortium, consists of a broad range of Japanese organizations, companies, has founded in April 2010.
- It carries out various work for development of roadmaps or dissemination of information to promote international standardization, and strengthening collaboration.

Members as of September 14, 2010:
- Utilities
- Developers
- Manufacturers
- Institutions

JSCA has members from the electric power, gas, automobile, information and communications, electric machinery, construction and trading industries as well as the public sector and academia.
This working group will identify domestic and global smart grid trends and JSCA will then share such information with international organizations. It will also study and develop strategies to support Japanese companies in their international deployment activities.

With the aim of achieving international smart grid standardization, this working group will facilitate practical activities in different areas. Collaborative activities with organizations in Europe and the United States will also be carried out.

This working group will prepare a roadmap for smart grid technology development. In addition, it will promote technology development as part of a social system by developing a scenario for a next-generation society in which smart grid-related technologies have been disseminated.

With a view to early commercialization of smart house technologies, this working group will review an information infrastructure (platform) that will enable visualization and monitoring of home energy use evaluation as a basic consumer service.
From R&D to Demonstrations

- Technological Progress
- Plan for Demonstration Projects
- Four Regional Demonstration Projects
- International collaborative Projects
Toward Demonstration Projects

- Development of individual renewable energy and technology for grid connection
  - 2005; so many R&D projects

- Development of grid connected system and verification of grid stability
  - 2002 – 2010; grid connected system

- Demonstration Pilot project at community level
  - Small scale 2005 - 2011
  - Large scale 2010 - ;
    Next Generation Energy & Social System Demonstration (4 cities)
Smart Community Related Experience

<table>
<thead>
<tr>
<th>Period</th>
<th>Technology</th>
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<tbody>
<tr>
<td>Up to FY2005</td>
<td>Demonstration Project on Grid-interconnection of Clustered PV Power Generation Systems (FY2002-FY2007)</td>
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<tr>
<td>FY2005</td>
<td>Wind Power Stabilization Technology Development Project (FY2003-FY2007)</td>
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<tr>
<td>FY2006</td>
<td>Demonstrative Project of Regional Power Grids with Various New Energies (FY2003-FY2007)</td>
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<td>FY2007</td>
<td>Control of Clustered PV voltage</td>
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<td></td>
<td>Development Project of Electric Energy Storage System for Grid-connection with New Energy Resources (FY2006-FY2010)</td>
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<tr>
<td></td>
<td>Verification of Grid Stabilization with Large-scale PV Power Generation Systems (FY2006-FY2010)</td>
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Technology development of renewable energies (PV, WT, etc.)
Technology Demonstration Project

Ota City Demonstration Site

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

Demonstration Project on Grid-interconnection of Clustered PV Power Generation Systems (FY2002-FY2007)

Wakkanai Demonstration site

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

Verification of Grid Stabilization with Large-scale PV Power Generation Systems (FY2006-FY2010)
Future Plan for Smart Community Related Projects

- Power system countermeasures for high penetration of distributed renewable energy
- Islanding power system demonstration
- Evaluation of renewable energy high penetration
- Load leveling equipment demonstration
- Optimal control for future grid demonstration
- Distributed energy optimization project
- Model project for natural gas application
- Next-generation high efficiency residential house project
- Demonstration of smart building
- Smart EV charger project
- Japan-New Mexico smart grid demonstration Project
- Next-generation energy and social system demonstration Projects in Japan (Four Cities)
- Japan-European country smart grid demonstration Project

Collaboration among projects
Technology development for a smart community
Demonstration of a Next-Generation Energy and Social System

- Need to gather actual data and create a system to manage them.
  - make the entire region, including local industry, citizens, and local government, involved in the project so as to allow systems to be as real as possible.
  - visualize CO2 reductions in residential / commercial and transport sectors.
  - establish complementary relationship between the utility grid and the regional energy management system in a demonstration.

Upper systems
- Mega Solar
- Wind generation
- Na-S battery

Create a power supply system that creates a complementary relationship between a utility grid and a regional energy system

Presence of a project leaders to organize players

Establish technology for integrated management of electricity and heat

Biogas
- Cogeneration
- Solar power generation
- Waste heat

Establish a regional energy management system

Next-generation car

Build charging infrastructure

Reduce peak demand (oil thermal power) by using IT

Energy Management System

Verify the locations to install storage batteries (distribution station or each home)

Set installation standards for lithium storage batteries based on demonstration data

Use smart meters to visualize power consumption and control demand
Smart Community Projects
– Four large scale pilot projects started in 2010 –

**Kyoto Keihanna District**
(Kyoto Prefecture, Kansai Electric Power, Osaka Gas Power, KANSAI SCIENCE CITY, Kyoto Univ.)
CO2 20%:houses, 30%:transportation (from 2005)
- ‘Smart tap’ which visualizes energy consumption controls home energy usage.
- ‘Electric power virtual coloring’ technology actualizes total home energy management.

**Yokohama City**
(Yokohama City. Toshiba, Panasonic, Meidensha, Nissan, Accenture, etc.)
CO2 30% by 2025 (from 2004)
- Energy management system which integrates HEMS, BEMS, EV
- PV (27000 kW) Use of heat and unused energy
- 4000 Smart houses, 2000 EVs

**Kitakyushu-City**
(Kitakyushu City, Fuji Electric, GE, IBM, Nippon Steel) CO2 50% (from 2005)
- Real-time management in 70 companies and 200 houses
- Energy management by HEMS, BEMS
- Energy system which integrates demand-side management and high energy system.

**Toyota City**
(Toyota City. Toyota, Chubu Electric, Toho Gas, Toshiba, Mitsubishi Heavy, Denso, Sharp, Fujitsu, etc.)
CO2 20%:houses, 40%:transportation
- Use of heat and unused energy as well as electricity
- Demand response with more than 70 home 3100EV, V2H, V2G
Contributions to International Standardization

- Initiatives for International Cooperation
- Overseas project deployment
- Standardization activity around the world
- Contributions toward international standards
Initiatives for International Cooperation

- **Project base**
  - Each technology was proven at the research project level.

- **Local deployment**
  - Micro Grid project
  - Smart Community project
    - Still its impact is limited.

- **Global deployment**
  - Western countries
  - BRICs
    - Contribution to the world through cooperation
Due to rapid growth of developing countries, they have high demand for infrastructure development such as electricity, water, railway, and road. Many projects including smart grid or infrastructure development in the future.
Overseas Deployment of Smart Community

- Overseas demonstrations are planned in parallel with domestic projects.
- JSCA has been organized to promote domestic and overseas Smart Grid projects.
- Different types of systems will be developed:
  - Urban type (Domestic projects and New Mexico project),
  - Remote island type (Okinawa-Hawaii project),
  - Emerging country type (India).

Japan - China
The ‘Smart Community’ Plan includes not only energy project but also water, recycle, transportation system projects.

Japan - India
The ‘Smart Community’ Plan materialized after prime minister visit in Dec 2009. JETRO-DMICDC has concluded a MOU. (Mitsubishi, Hitachi, Toshiba, JGC and other major companies have joined)

Japan - U.S ( New Mexico )
High-level technological tests by the United States National Research Institute and NEDO. About 31 companies (Toshiba and Kyocera etc.) are participating. (Total investment is about 7 billion yen.)

Japan (Okinawa) - US ( Hawaii )
Japan - U.S. Clean Energy Technologies Action Plan (November 2009)
Evaluate the achievements of clean energy projects in both islands to enable the islands to be energy independent, including micro-grid projects, etc.
Standardization activities around the world

**U.S.**
- U.S. DoC/NIST announced in January 2010 the NIST framework and roadmap on developing plans for smart grid interoperability standards
- Identified 75 standards requiring special or additional study and 15 Priority Action Plans
- “Smart Grid Interoperability Panel (SGIP)” was established by governments and private sectors to support NIST’s activities in November 2009

**Europe**
- Set up a smart grid taskforce in 2009 to put together recommendations and a roadmap by 2011 and establish related European standards
- CEN/CENELEC/ETSI created joint “Focus Group on Smart Grid” in May 2010

**IEC**
- Arrangement for IEC smart grid-related standards. Japan is represented by Professor Goda, Kyushu University.
  - ISO/IEC/JTC1
  - IEC TC57
  - IEC TC8
  - SG 3: Smart Grid
    - Set up a special work group on smart grids
    - Activities focused on creating standards intended to realize interconnectivity and interoperability between power ICT systems
    - Make a use-case of electric power distribution and coordinate relevant TCs
  - SG 4: LVDC Distribution Systems

**IEEE**
- Japan is represented by Mr. Tomita, Univ. of Tokyo, Mr. Nakamura, Kanto Electric Association, Mr. Kushiki, Panasonic
- Released report on electric energy efficiency, including smart grids, at the IEC general convention in Oct. 2009.

**SCC21**
- P2030: Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System, and End-Use Applications and Loads
  - Scheduled to issue a standard within four years
Study Group on SG Standardization

“Study Group on International Standardization for Next Generation Energy Systems” was set up in Aug. 2009. (Chairman; Dr. Akihiko Yokoyama, Tokyo University)

It was planned to deliberate road map for Japan’s contribution to international standardization activity in Smart Grid area.

The road map, which includes 26 focus areas, was released on January 2010.

Japan Smart Community Alliance (JSCA) was founded to support activities including international standardization. Many programs and projects to be managed under JSCA.
Contribution to International Standardization

-Analysis-

- Draw future-focused whole picture
- Identify Use Case / Key Systems
- Analyze Strength/weakness and identify focus areas
- Analyze overseas market

Road map on Smart Grid standardization

- Examine a comprehensive smart grid international standardization support activity
- Identify 26 focus areas including control equipment in distributed power supplies and equipment for EV charging infrastructure
- Establish an international standardization roadmap

-Recommendations-

- Contribute to the international standardization activity
- Collaborate with other countries:
  - Collaborate with NIST
  - Exchange information with CENELEC
  - Joint project with Asian countries
- Implement policy coordination:
  - Standardization activity with R&D, pilot projects, and other measures
- Establish private-sector smart grid implementation consortium
Japan’s approach to international standardization

The Study Group engaged in a thorough debate from the macro to the micro on:

1. Developing a big picture of the smart grid
2. Defining seven business fields that make up the big picture
3. Identifying the key systems in which Japan is interested
4. Selecting 26 focus areas from the key systems, where Japan can contribute to international standardization
5. Studying standardization strategies for the priority areas

Seven fields:
- Wide-area situational awareness (WASA) in transmission systems
- Demand response
- System-side energy storage
- Demand-side energy storage
- Electric vehicles
- AMI systems
- Distribution grid management

(1) Big picture on smart grid

(2) Break down into 7 fields

- Distribution grid management
- Electric vehicles

(3) Identify the key systems

- Power conditioner for distributed power
- Quick charger

(4) Select 26 focus areas

- Power conditioner
- Quick charging station coupler

(5) Standardization topics

- I/F
- Communication protocols
- Testing methods
### Focus Areas Identified by the Study Group

The Study Group, in view of the overall smart grid market, identified the following 26 focus areas and drew up a corresponding international standardization roadmap.

#### 26 Focus Areas Identified by the Study Group

| 1 Wide-area situational awareness (WASA) in transmission systems | 14 Fixed energy storage systems |
| 2 Optimized controls for system storage cells | 15 Storage cell modules |
| 3 Optimized controls for distribution storage cells | 16 Methods of assessing the salvage value of EV storage cells |
| 4 Optimized controls for building/community energy storage | 17 Quick EV charger-vehicle communications |
| 5 High-efficiency power conditioners for storage cells | 18 Quick EV charger connectors |
| 6 Distribution automation systems | 19 Quick EV charger unit design |
| 7 Power conditioners for distributed power supplies | 20 Safety testing of lithium-ion batteries for vehicles |
| 8 Power electronic devices for distribution | 21 Vehicle-to-regular EV charger infrastructure communications |
| 9 Demand response networks | 22 Infrastructure control of regular EV chargers |
| 10 HEMS | 23 Wide-area meter access communications |
| 11 BEMS | 24 Local meter access communications |
| 12 FEMS | 25 Gas metering for AMI systems |
| 13 CEMS | 26 Authentication method between meter communicators and higher-level systems |
26 Focus Areas

- **Top-tier control center**
- **Distribution transformer substation**
  - Sensor with built-in switch
- **Distribution lines**
- **Storage cells**
  - Power conditioner
- **Charging station**
- **Commercial solar power plant**
- **Buildings / Factories**
- **General customers**
  - High-efficiency water heater
  - PEV / PHEV
  - Controller
- **Power utility service provider, etc.**
- **Distribution automation system (DAS)**
- **AMI network (virtual network)**
- **DR network (virtual network)**
- **MDMS**
- **MDMS**
- **DR server**

Future Actions

1. Implementation of the international standardization roadmap
   • Set up an organization to assist the activities of related standardization bodies
   • Priority FY 2010 budget allotments for international standardization proposals

2. Collaborations with other countries
   • Extend cooperation to Asian nations using APEC 2010. Hold a workshop at ERIA in FY 2010
   • Standardization collaboration with NIST: Participate in PAPs based on the Japan-U.S. Cooperation on Clean Energy Technologies
   • Coordination with CENELEC: Joint workshop in November

3. Cohearent promotion of related policy studies and technical development with international standardization activities
   • Examine standardization for the smart grid and related fields
   • Link with R&D, pilot projects, and other measures
   • Examine authentication system measures

4. Pilot project with an implementation body
   • Set up a public-private consortium composed of many interested parties, along with effective government assistance policies for the consortium in April 2010.
Japan’s activity of international standardization on Smart Grid under JSCA

International Standardization Working Group

- Energy Storage Sub-Working Group
  - #2-5, #14-16
- Transmission & Distribution Sub-Working Group
  - #1, #6-8
- Energy Management System Sub-Working Group
  - #9-13, #23-26
- Next Generation Automobile Sub-Working Group
  - #19-21
- Communication Interface Sub-Working Group

Follow activity of 26 focus areas
Support for IEC, IEEE, SGIP/PAP etc.
Thank you very much.

nakanishi-hironori@meti.go.jp