Smart Community and Hawaii-Okinawa Clean Energy Cooperation

Tomoya Ichimura
New Energy and Industrial Technology Development Organization (NEDO), Japan
Contents

- What is a Smart Community
- Activities to Realize a Smart Community
- Clean Energy Cooperation between Hawaii and Okinawa
Necessity of a Smart Community

- Improve the quality of life both in Japan and around the world
- Establish a new social system to reduce CO₂ emissions, introduce large-scale use of renewable energy, and facilitate diverse power supplier services

Challenges

- Improve electric grid performance to accommodate the large-scale introduction of renewable energy
- Enhance communication between power suppliers
- Establish services to respond to various demand side needs

The key solution to the above challenges is smart grid technology. It can efficiently control the flow of energy and enable various new services by means of IT, including to power suppliers as well as demand side users.

- To use energy efficiently, it is important to establish a new smart community social system that facilitates the effective use of electricity and heat energy.
A Smart Community

- Aiming to achieve a more convenient, reliable and greener social system by means of IT through coordination and cooperation between power suppliers and demand side users.

Main Grid

- Mega Solar
- Wind Power
- Na·S Battery
- Biogas
- Cogeneration
- Solar Power
- Wasted Heat

Energy Management System

- Construct an energy system which is mutually beneficial for main grid operator and regional energy management provider.

Information Network

- Connect BEMS with regional EMS.

Regional Energy Management Provider

- Zero Emission Buildings

Smart House

- EVs and PHEVs
- Home Storage Battery

EVs and PHEVs

- New-generation Gas Station
- Utilize IT for peak cuts.

Home Storage Battery

- Smart Meter: Visualization of home energy use and demand control

Storage Battery

- Solar Power
- Wind Power

Network

- Construct charging stations for EVs.
## 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 and nuclear power. This roadmap illustrates a future social system we are aiming at, concentrating on regional EMS and lifestyle changes, under such an energy supply structure.

<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><strong>Relation between regional EMS and entire grid</strong></td>
<td><strong>Relation between regional EMS and entire grid</strong></td>
</tr>
<tr>
<td>■ Solar panel prices will decrease significantly due to large-scale introduction of panels to houses as well as commercial buildings.</td>
<td>■ Due to a decline in PV prices, more PV systems will be installed at houses.</td>
<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>
</tr>
<tr>
<td>■ Measures to maintain the quality of electricity during the large-scale introduction of PV will be carried out mainly for the grid side. Storage cells will be installed at substations.</td>
<td>■ Regional EMS, which contribute to effective use of RE generated at houses, will become more important.</td>
<td>■ EMS that can provide an optimized balance in terms of economy and security between regional EMS and grid will be established.</td>
</tr>
<tr>
<td>■ As regional EMS are further demonstrated, technology and know-how will be accumulated.</td>
<td>■ Regional EMS will be realized as storage cells become cheaper and are further disseminated.</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>
</tr>
<tr>
<td>■ The cost of storage cells will go down due to technology development and demonstration.</td>
<td>■ Distribution and transmission networks that enable two-way communication between demand side and grid side will be actively established.</td>
<td>■ Distribution and transmission networks that enable two-way communication between demand side and grid side will be actively established.</td>
</tr>
<tr>
<td><strong>Houses</strong></td>
<td><strong>Houses</strong></td>
<td><strong>Houses</strong></td>
</tr>
<tr>
<td>■ Remote reading using smart meters will start.</td>
<td>■ HEMS and regional EMS will be integrated. All power generated at houses will be used optimally.</td>
<td>■ A fully-automated HEMS will be realized.</td>
</tr>
<tr>
<td>■ HEMS will be disseminated. Some houses will install home servers. Demand response demonstration will start.</td>
<td>■ Various services using home servers will be disseminated.</td>
<td></td>
</tr>
<tr>
<td>■ Demonstration of EVs will start.</td>
<td>■ EVs will be used for power storage.</td>
<td></td>
</tr>
<tr>
<td><strong>Buildings</strong></td>
<td><strong>Buildings</strong></td>
<td><strong>Buildings</strong></td>
</tr>
<tr>
<td>■ ZEB introduction will start.</td>
<td>■ ZEB will be realized at new public buildings.</td>
<td>■ ZEB will lead to a greatly reduced level of emissions for all new buildings as a group.</td>
</tr>
</tbody>
</table>
Japan’s Next-generation Energy Society Goal for 2030

Homes

- Smart life with high QOL
  - PV
  - HEMS
  - Remote control of home electrical appliances
  - Security, fire prevention and fault detection systems
  - QOL enhancement services
  - Solar heat collector
  - Local area combined heat and power system
  - Utilization of waste heat from waste incineration plants

Offices

- Enjoy nature, even in the cities
  - Utilization of renewable energy
  - ZEB
  - HP water heaters
  - EV
  - Comfortable office space with natural light and controlled HVAC
  - Plant factory in a building
  - Waste utilization

Transportation

- Modal Shift
  - LRT
  - EV sharing
  - Rail cars with batteries
  - Electricity-assisted wheelchairs
  - Modal shift by EV, PHEV, FCV

Industry

- Industrial zones as power production areas
  - Large-scale PV on roofs of factories and tanks
  - Utilization of waste heat by HP technologies
  - Heat and power transmission to cities

Source: The 8th Conference on Next-generation Energy and Social System
Activities to Realize a Smart Community
Smart Community Related Experience

Technology development of renewable energies (PV, WT, etc.)

Grid-connected system development
Operation and grid-connection of high penetration RE or storage and EMS application technology to reduce fluctuation of renewable energy output

Development of individual technology for RE grid connection

- Demonstrative Project on Grid-interconnection of Clustered PV Power Generation Systems (FY2002-FY2007)
- Wind Power Stabilization Technology Development Project (FY2003-FY2007)
- Demonstrative Project of Regional Power Grids with Various New Energies (FY2003-FY2007)
- Verification of Grid Stabilization with Large-scale PV Power Generation Systems (FY2006-FY2010)


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

Ota City Demonstration Site

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
Future Plan for Smart Community Related Projects

**Countermeasures for PV penetration**
- Power system countermeasures for high penetration of distributed renewable energy
- Island power system demonstration
- Evaluation of renewable energy high penetration
- Load leveling equipment demonstration
- Optimal control for future grid demonstration

**EMS for electric and heat**
- Distributed energy resources optimization project
- Model project for natural gas application

**Energy conservation (HEMS-BEMS)**
- Next-generation high efficiency residential house project
- Demonstration of smart building
- Smart EV charger project

**Regional energy management**
- **Next-generation energy and social system demonstration**
- **Japan-New Mexico smart grid demonstration**

**FY2009 - FY2015 and After**

- **Collaboration among projects**
- **Technology development for a smart community**

**Technology Demonstration in a Real Environment**
Next-generation energy and social system demonstration
-Large-scale Smart Grid and Smart Community Pilot Projects in Japan-

Kyoto Keihanna District
(Kyoto Prefecture, Kansai Electric Power, Osaka Gas
KANSAI SCIENCE CITY, Kyoto University)
CO2 ▲20%: houses, ▲30%: transportation (from 2005)
• Install PV in 1,000 houses, EV car-sharing system
• Nano-grid management of PVs and FCs in houses
  and buildings (visualization of demand)
• Grant “Kyoto eco-points” to the usage of green-energy

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 (27,000 kW)
• Use of heat and unused energy
• 4,000 Smart houses, 2000 EVs

Kitakyushu City
(Kitakyushu City, Fuji Electric Systems, GE,
IBM, Nippon Steel)
CO2 ▲50% (from 2005)
• Real-time management at 70 companies and 200 houses
• Energy management by HEMS, BEMS
• Energy system which coordinates demand-side management with the overall power system

Toyota City
(Toyota City, Toyota Motor, Chubu Electric Power,
Toho Gas, Toshiba, Mitsubishi Heavy Industries,
Denso, Sharp, Fujitsu, Dream Incubator, etc.)
CO2 ▲20%: houses, ▲40%: transportation
• Use of heat and unused energy as well as electricity
• Demand response at more than 70 homes
  3100 EV, V to H, to G
Japan-New Mexico smart grid demonstration

- Research will be carried out at five sites in the State of New Mexico, US. NEDO will participate in research in Los Alamos and Albuquerque as well as collective research on the overall project.
- Real scale demonstration, including demand response, will be conducted.
The “Japan Smart Community Alliance,” a public-private organization, consists of a broad range of Japanese organizations, companies, etc. It held its inaugural meeting on April 6, 2010.

JSCA carries out various work for development of roadmaps or dissemination of information to achieve international standardization, strengthening collaboration between wide range of people or organizations concerned.

Members: 416 (As of August 25, 2010)

Establishment: April 2010

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.
Clean Energy Cooperation between Hawaii and Okinawa
Okinawa relies on fossil fuels for 100% of its electricity production. The electricity supply to the outer islands is from small diesel generators, and the surrounding nearby islands receive power via underwater cables.

(Source: Federation of Electric Power Companies (FEPCO) web site, Nippon Keidanren web site)
Okinawa is making an effort to promote the widespread use of renewable energy, and various projects are being carried out.

- **Okinawa main island**
  - **Bioethanol production plant** (Use of sugar cane gases)
  - **9 MW solar power plant** (NHK broadcast station)
  - **180 kW wind power plant** (NHK broadcast station)

- **Miyakojima**
  - **4 MW solar power plant and microgrid testing**

- **Hateruma**
  - **245 kW retractable wind power generator**

(Source: FEPCO web site, NHK web site, Okinawa Power Co. web site)
Hawaii currently relies heavily on fossil fuels for electricity and the fees for electricity are high. The Hawaii Clean Energy Initiative is working on a variety of measures, including introduction of large-scale renewable energy facilities and a Smart Grid.

### Hawaii’s electricity situation

- **266 M kWh**
  - Fossil fuel: 83%

- **8,293 M kWh**
  - Fossil fuel: 96%

### Hawaii Clean Energy Initiative measures

- **1,385 M kWh**
  - Fossil fuel: 82%

- **1,259 M kWh**
  - Fossil fuel: 83%

- **680 kW solar power facility**

- **30 MW wind power facility**

- **400 MW wind power facility**

- **30 MW geothermal power facility**

- **Maui SmartGrid Project**

- **Ocean temperature differential power conversion project**

#### Key points:
- **Large dependence on fossil fuels (69%)**
- **Electricity rates are high (2x to 3x US average)**
- **Introduce Renewable energy**
- **Improve power efficiency by introducing Smart Grid technology**

(Source: Hawaii Clean Energy Initiative web site, US Energy Information Administration, State of Hawaii web site)
Hawaii-Okinawa Clean Energy Cooperation

The Signing Ceremony of the Memorandum of Cooperation on the Okinawa–Hawaii Clean Energy Cooperation took place on Thursday, June 17th at Ministry of Economy, Trade and Industry.

Signatories included Economy, Trade and Industry Minister Naoshima, U.S. Ambassador to Japan John V. Roos (on behalf of the U.S. Department of Energy), Governor of Okinawa Nakaima and Governor of Hawaii Lingle.
# Study Tour (Okinawa part)(1/2)

<table>
<thead>
<tr>
<th>Sites</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okinawa Prefecture</td>
<td>Okinawa Energy Vision</td>
</tr>
<tr>
<td>AEC Corporation</td>
<td>EV project</td>
</tr>
<tr>
<td>Okinawa Electric Power Company</td>
<td>Electric power system in Okinawa</td>
</tr>
<tr>
<td>University of Ryukyus</td>
<td>OTEC, Smart-grid, PV, WT and Biomass</td>
</tr>
<tr>
<td>Itoman City</td>
<td>Energy efficiency building</td>
</tr>
<tr>
<td></td>
<td>PV system</td>
</tr>
<tr>
<td></td>
<td>Itoman wind farm</td>
</tr>
<tr>
<td>Miyakojima City</td>
<td>Miyakojima activities</td>
</tr>
<tr>
<td>Okinawa Electric Power Company, Fukuzato area</td>
<td>Microgrid project in Miyakojima</td>
</tr>
<tr>
<td>Resource center of an underground dam, Fukuzato area</td>
<td>Underground dam</td>
</tr>
<tr>
<td>Sites</td>
<td>Contents</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>• Okinawa Electric Power Company, Suzaki Uruma</td>
<td>• Flywheel facility</td>
</tr>
<tr>
<td>• Biomass recycling center in Uruma City</td>
<td>• Woody biomass pellet recycling plant</td>
</tr>
<tr>
<td>• Haebaru Clean Center</td>
<td>• Waste power generation facility</td>
</tr>
<tr>
<td>• Naha Sewage Disposal Center, Naha</td>
<td>• Digestive gas power generation facility</td>
</tr>
</tbody>
</table>

Wrap-up meeting

Exchange of opinions on the ZEB

Flywheel

Woody biomass pellet recycling plant
## Study Tour (Hawaii part)

<table>
<thead>
<tr>
<th>Sites</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hawaii Natural Energy Institute</td>
<td>• Smart grid, RE, and OTEC</td>
</tr>
<tr>
<td>• Halsey Community Center</td>
<td>• Low energy housing</td>
</tr>
<tr>
<td>• The State of Hawaii</td>
<td>• Hawaii Clean Energy Initiative</td>
</tr>
<tr>
<td>• Lockheed Martin</td>
<td>• OTEC</td>
</tr>
<tr>
<td>• NELHA</td>
<td>• Seawater-cooled building, CSP, PV</td>
</tr>
<tr>
<td>• Cellana</td>
<td>• Biomass</td>
</tr>
<tr>
<td>• Hawaii Electric Company</td>
<td>• Electric Power System in Hawaii</td>
</tr>
<tr>
<td>• Maui Electric Company</td>
<td>• Fuel cell test facility</td>
</tr>
<tr>
<td>• Xtreme Power</td>
<td>• Kaheawa Wind Farm 30 MW with energy storage system</td>
</tr>
<tr>
<td>• First Wind</td>
<td></td>
</tr>
</tbody>
</table>

### Meeting with the state of Hawaii and Lockheed Martin

- Halsey Community Center (Forest City)
- Gateway Center (NELHA)
- Kaheawa Wind Farm
Cooperation between Hawaii and Okinawa

<table>
<thead>
<tr>
<th>Area</th>
<th>Geographical Conditions</th>
<th>Social Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okinawa</td>
<td>• Located midway between the USA and Asia</td>
<td>• Highly-dependent on fossil fuels for power</td>
</tr>
<tr>
<td></td>
<td>• Remote islands with tropical climates</td>
<td>- Hawaii: ~91%</td>
</tr>
<tr>
<td></td>
<td>• Abundant natural energy resources</td>
<td>- Okinawa: ~99%</td>
</tr>
<tr>
<td>Hawaii</td>
<td></td>
<td>• Tourism industry is very important</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 22% of total industry in Hawaii</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 11% of GDP in Okinawa</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sister-city relationship with each other</td>
</tr>
</tbody>
</table>

Hawaii and Okinawa have a lot in common.

Hawaii and Okinawa cooperation on energy has various possibilities:
- establishment of a **smart community**,
- introduction of **next generation vehicles** (e.g. EV),
- promotion of **energy efficiency** (e.g. ZEB for subtropics),
- development of **REs** (e.g. OTEC and other island-wise techs).
Thank you!

http://www.nedo.go.jp/
ichimuratmy@nedo.go.jp