DER Integration Demonstrations in Japan

IRED 2014
November 18, 2014

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Grid-Connection related Projects in NEDO (2000-2010)

- Voltage control technology for clustered PV systems
- Control of supply system with several new energy and dispersed generators
- Voltage control technologies for distribution system when many DGs are connected
- Development of supply system with different power quality
- Energy storage system for new energy
- Demonstration Project on Grid-interconnection of Clustered Photovoltaic Power Generation Systems (FY2002-2007)
- Wind Power Stabilization Technology Development Project (FY2003-2007)
- Demonstration Project of Regional Power Grids with Various New Energies (FY2003-2007)
- Verification of Grid Stabilization with Large Scale PV Power Generation Systems (FY2006-2010)
- Development of an Electric Energy Storage System for Grid-connection with New Energy Resources (FY2006-2010)
- Power Control Technology for wind farm
- Interconnection technology for large scale PV generation system
Domestic Smart Community projects (2010-2014)

With the participation of many residents, municipalities, and enterprises, large-scale demonstration projects are in operation in four regions. They each have different characteristics and will be conducted for 5 years starting in 2010.
The projects shown below are promoted by NEDO for achieve collaboration between counterpart countries starting from 2010.

- **Lyon (France)**: Zero energy building, EV car sharing and energy audit demonstration in re-developed city.
- **Manchester (UK)**: Wind power fluctuation is absorbed by water heater type heat pump.
- **New Mexico (USA)**: Micro grid demonstration in Loa Alamos and Albuquerque.
- **Malaga (Spain)**: EV charging infrastructure and driver navigation system.
- **Maui island (USA)**: Direct control against EV, for absorbing sudden rump of renewable source.
- **Indonesia**: Power quality management at industrial park.
Renewable Energy Integration (Large Scale Battery)

Wind Power System Stabilization (2003-2007)
Tomamae Redox flow 6MWh battery for 30 MW Wind farm

Output of Wind Power
Charging and discharging of batteries
Reformed output of wind power
Smoothing time constant $T = 10$ Minutes

Wakkanai Mega-Solar (2006-2010)
5MW Solar Power
1.5MW NAS battery

Flow at grid-connection point
Target flow at connecting point: 600kW
Start of battery operation

1MW Solar on 3-5 MW feeder.
1MW NAS Battery + 0.8MW Lead Acid Battery

Reduction of fluctuation
Scheduled transmission
Micro-grid operation on distribution feeder
Renewable Energy Integration (Distributed Storage)

Clustered PV in Ota-city (2002-2007)
- Voltage control by distributed battery (9kWh)

Domestic HEMS demonstration in Toyota city (2011-2014)
- Achieving high % self-consumption of PV generation using Battery (5kWh LiB), HP and EV (PHEV)

Maui Project (2011-)
- Rapid demand response controlling EV charging when sudden drop of Wind Power happens.

Manchester Project (2013-)
- Rapid demand response controlling HP to achieve balance on energy market.
Electric Vehicle

Domestic V2H projects in Japan (2011-2014)

- V2H in Toyota City
- V2H in Kita-Kyushu Using ECY
- V2B demonstration at Okazaki Factory of MMC

Lyon Project (2011 - )
EV Car sharing and charging management for maximum usage of renewable energy.

Maui Project (2011 - )
Rapid demand response controlling EV charging when sudden drop of Wind Power happens.

Malaga Project (2012 - )
Rapid charging system demonstration inner city area. ICT service demonstration for EV drivers.
The Major Results of Demand Response in Four Domestic Demonstration Projects

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of Participating Households by groups</th>
<th>Peak Shaving Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yokohama</td>
<td>Control: 400* CPP: 800*</td>
<td>✅15.2% in summer 2013</td>
</tr>
<tr>
<td>Toyota</td>
<td>Control: 80 CPP: 80</td>
<td>✅15% in winter 2012 ✅11% in summer 2013</td>
</tr>
<tr>
<td>Keihanna</td>
<td>Control: 300 CPP: 381</td>
<td>✅22.4% in summer 2012 ✅21.3% in winter 2012</td>
</tr>
<tr>
<td>Kitakyushu</td>
<td>Control: 68 CPP: 120</td>
<td>✅13.1% in summer 2012 ✅12.0% in winter 2012</td>
</tr>
</tbody>
</table>

Analyzed by Kyoto-University
The Major Results of Demand Response in New Mexico Projects

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Grouping</th>
<th>Selection Probability</th>
<th>DR Effect</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opt-in CPP</td>
<td>Low</td>
<td>High</td>
<td>360</td>
<td></td>
</tr>
<tr>
<td>Opt-out CPP</td>
<td>Middle</td>
<td>Middle</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Opt-out PTR</td>
<td>High</td>
<td>Low</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Control Group</td>
<td>--</td>
<td>--</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>--</td>
<td>--</td>
<td>900</td>
<td></td>
</tr>
</tbody>
</table>

**ITT (gross peak-cut effects):** the effects of those who are offered certain treatment (Opt-in CPP, Opt-out CPP, Opt-out PTR).

**TOT (net peak-cut effects):** the effects of those who actually accepted the treatment, thus excluding customers who were offered the treatment but did not accepted it.

### 2013 Summer

<table>
<thead>
<tr>
<th>Group</th>
<th>Intent-to-treat (ITT)</th>
<th>Treatment-on-treated (TOT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opt-in CPP</td>
<td>-6.90%*** (0.016)</td>
<td>-10.49%*** (0.025)</td>
</tr>
<tr>
<td>Opt-out CPP</td>
<td>-4.59%** (0.020)</td>
<td>-4.71%** (0.021)</td>
</tr>
<tr>
<td>Opt-out PTR</td>
<td>-4.06%** (0.019)</td>
<td>-4.17%** (0.019)</td>
</tr>
</tbody>
</table>

### 2013 Winter

<table>
<thead>
<tr>
<th>Group</th>
<th>Intent-to-treat (ITT)</th>
<th>Treatment-on-treated (TOT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opt-in CPP</td>
<td>-4.78%*** (0.013)</td>
<td>-7.12%*** (0.022)</td>
</tr>
<tr>
<td>Opt-out CPP</td>
<td>-4.27%*** (0.016)</td>
<td>-4.41%*** (0.016)</td>
</tr>
<tr>
<td>Opt-out PTR</td>
<td>-3.26%** (0.015)</td>
<td>-3.37%** (0.016)</td>
</tr>
</tbody>
</table>

Analyzed by Kyoto-University
HEMS (Home Energy Management System)

Clustered PV in Ota-city (2002-2007)

One Server controlled 550 battery beside of houses through optical communication.

Domestic HEMS demonstrations (2011-2014)

Mainly visualization of energy usage plus storage management.

Self-consumption HEMS in domestic demonstrations (2011-2014)

HEMS controlling battery, heat pump and V2H for increasing self consumption.

HEMS demonstration in Lyon (2011-)

- Energy audit system for developed area
- HEMS for residence area in Positive Energy Building

Full automatic HEMS in Los Alamos (2009-)

- Independent energy supply by battery
- Auto demand response communicating with utility EMS
HEMS: Self consumption of generated energy

Contribution Ratio of Solar Generated Power for Captive Consumption Rate (PHV)

Average of 10 households with daytime charging (8:00 to 17:00) more than 10 times throughout the year.

- Contribution ratio of PHV was a maximum in May (4.6%), a minimum in January (2.1%), and an average of 3.4%.
Communication between CEMS and HEMS

If price of electricity becomes expensive, HEMS reduces demand of home appliances and increases discharge from battery storage.

Source: KYOCERA

Demand Response

1. DR Mode
2. Reduction
3. PV Generation
4. Battery Charge/Discharge, SoC
5. Power Consumption
6. Energy Flow (Buying or Selling)

Time of Day

Source: KYOCERA

Nov. 29, 2013
BEMS (Building Energy Management System)

Commercial BEMS or FEMS

Domestic BEMS demonstrations (2011-2014)
- Demand Response by BEMS
- Battery SCADA system

BEMS demonstration for ZEB (2011-)
- Positive Energy Building achieved by BEMS control

Resiliency BEMS demonstration in ABQ (2009-2014)
- Positive Energy Building achieved by BEMS control
Resiliency BEMS: Independent Operation

Stand-alone operation (without interruption) at a commercial building with a micro-grid controlled by BEMS.

Source: Extracted from a report form Shimizu Corporation
CEMS (Community Energy Management System)

- **Distribution system data management system**
  - NEDO Hawaii Project introduced pole transformer level management system.

- **Demand response management**
  - METI domestic smart community introduced Demand Response Management System
  - NEDO New Mexico micro-EMS has function of create DR (& ADR) signal and measurement of effect.

- **Micro Grid EMS**
  - NEDO New Mexico micro-EMS can manage micro grid operation on a feeder

- **KPI measurement system**
  - NEDO Lyon project will create CEMS for evaluate KPI for local government

...
Micro Grid Demonstration

All inverter based micro grid.

Hachinohe Micro Grid (2003-2007)
Micro grid with 5km private distribution line. One week independent operation was achieved.

Virtual micro grid similar to virtual power plant..

Micro Grid with independent operation capability when outage happens on utility grid.

MW solar
Micro-EMS
MW Battery

Albuquerque Micro grid Building (2009-2014)
Resiliency BEMS
Distributed generators and storages
**Conclusion**

- Smart Grid or community means allocation of intelligences along the supplier and customer.
- Japanese Smart related demonstrations focus on allocation of EMS along the public service system.
Thank you for your attention

IRED2014 Nov.17-20 in Kyoto, Japan

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