Demonstration Result and Future Development of Kitakyushu Smart Community Creation Project

Kitakyushu Smart Community Council

June 20, 2014
Presented by:
Eiji Ohga, Fuji Electric Co., Ltd.
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III. Development of demonstration result

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Outline of Kitakyushu SC demonstration project
## Demonstration of smart community in Japan

### Categories for energy management demonstration in the community

<table>
<thead>
<tr>
<th>Control of a single sector (household) only</th>
<th>Integration and control of multiple sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Housing complex category</strong></td>
<td><strong>Wide-area metropolitan category</strong></td>
</tr>
<tr>
<td>Energy consumed at business buildings, universities, and 900 households is visualized and Subjects include business buildings, universities, and non-essential, non-urgent electricity is reduced. In addition, incentives such as eco-points if energy is saved are also given. (KEPCO, Mitsubishi Electric, Mitsubishi Heavy Industries, Ltd.)</td>
<td>Demonstration of mutual complementation of control by large storage batteries, CEMS and large-scale systems in three areas (business area, housing complex area, and individual house area) (Toshiba, TEPCO)</td>
</tr>
<tr>
<td>Highly dependent on the system</td>
<td></td>
</tr>
<tr>
<td><strong>Individual housing category</strong></td>
<td><strong>Regional major urban area category</strong></td>
</tr>
<tr>
<td>Implementing demand side management in 67 newly built houses. Gathering data on batteries and installation of optimum chargers are verified by demonstrating how to use the next-generation vehicles in everyday lives. (Toyota Motor Corporation, Chubu Electric Power Co., Inc.)</td>
<td>Demonstration is conducted in the special supply area for NIPPON STEEL &amp; SUMITOMO METAL CORPORATION. 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 Yawata Works as a backbone system, role sharing with the system is demonstrated. (FUJI ELECTRIC CO., LTD., NIPPON STEEL &amp; SUMITOMO METAL CORPORATION)</td>
</tr>
<tr>
<td>Less dependent on the system</td>
<td></td>
</tr>
</tbody>
</table>
Kitakyushu smart community creation project

Kitakyushu smart community creation project (next-generation energy and social system demonstration)

Promoted by Kitakyushu Smart Community Council (Kitakyushu City + 70 companies/organizations)
Management members: Kitakyushu city government (Social system), Fuji Electric (Energy), Nippon Steel & Sumitomo Metal Corporation (Energy), Japan IBM (Information infrastructure)

Community involvement type smart community

Community for master of energy

CO2 50% reduction

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

Building regional energy management system
- Regional brownout system
- Introduction of smart meters
- Eco-Point system for carbon offset

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

*BEMS: Building Energy Management System
*FEMS: Factory Energy Management System
Overall image of Kitakyushu smart community creation project
**Higashida area, Yahata-higashi ku, Kitakyushu**

**Yahata-higashida development area (about 120 ha)**

---

### Information on demonstration in Higashida area

<table>
<thead>
<tr>
<th>Location</th>
<th>Higashida area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>About 120 ha</td>
</tr>
<tr>
<td>Households</td>
<td>225</td>
</tr>
<tr>
<td>Offices</td>
<td>50</td>
</tr>
</tbody>
</table>
Kitakyushu smart community creation project

Goal
CO₂ 50% reduction

- EMS
- Renewable energy
- Energy-saving system and equipment

SMART SPOT

1. Human Media Creation Center / Kyushu
2. Takamiya Corporation
3. NITTETSU ELEX CO., LTD.
4. Community Energy Storage System
5. Environment Museum
6. NIPPON STEEL & SUMIKIN ENGINEERING CO., LTD
7. Higashiga Ecological Club House
8. Higashiga Eco Club House
9. KITAKYUSHU MUSEUM OF NATURAL HISTORY & HUMAN HISTORY
10. FamilyMart Dou., Ltd.
11. ENEOS Smart Energy Station
12. HIGASHIDA CLINIC

This sign marks each Smart Spot and lists its key features.
General schedule for demonstration project

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2010</td>
<td>Explanation of outline of project to and consent from residents (230 households and 70 companies)</td>
</tr>
<tr>
<td>FY2011</td>
<td>Detailed deliberation of and consent on demand side management</td>
</tr>
<tr>
<td>FY2012</td>
<td>Start of project</td>
</tr>
<tr>
<td>FY2013</td>
<td>Now</td>
</tr>
<tr>
<td>FY2014</td>
<td>Now</td>
</tr>
</tbody>
</table>

- **CEMS**
  - Development & unit test
  - Installation
  - DSM adjustment & incorporating into system

- **Smart meters**
  - Development & unit test
  - Installation
  - DSM adjustment & incorporating into system

- **HEMS/BEMS & F-EMS**
  - Development & unit test
  - Installation (23 households, 9 companies)
  - DSM adjustment & incorporating into system

- **Energy storage system**
  - Development & unit test
  - Installation
  - DSM adjustment & incorporating into system

- **PV, fuel cell, small wind power generation**
  - Development & unit test
  - Installation
  - DSM adjustment & incorporating into system

- **Transportation system**

- **Introduction & demonstration of equipment and system**
  - Additional 640 kW (PV500, FC105, wind power: 35)
  - Virtual introduction of mega solar and large-scale wind power

- **Demonstration**
  - Introduction of EVs and pHVs (300 units until 2014), charging system (50 units until 2014)

Note) DSM: Demand Side Management, DP: Dynamic Pricing, IP: Incentive Program
II
Result of Kitakyushu SC demonstration project
Summary of demonstration result
Future society Kitakyushu is aiming at

Environmental model city and environmental future city

Commitment from Kitakyushu to people, earth, and future generation
- Aiming at environmental capital of the world -
Grand design (basic principle)

Creating and handing down a city of “real wealth” to future generation

To live together and create together
Develop economy through environment

To enhance sustainability of cities

Kitakyushu smart community creation project

- Consumers such as residents and offices aim at transforming from energy consumers to prosumers by installing solar generation systems and trying to save energy and reduce consumption during peak hours.

- “Demand side self management” will be realized by citizens and businesses, who are prosumers, managing energy by themselves, thinking over and participating in the project, as well as by existing energy suppliers.

- Introduction of mechanism combining dynamic pricing and incentive program

Having implemented demonstration project

- Keywords are “versatility” and “enjoyment”.

- This demonstration could show the possibility of demand-side self management that consumers think over and participate in.

- The effect of reducing consumption during peak hours demonstrated in this project does not mean the result of actions by all participants.

- Supplying an energy management system (hardware and software) in which “various consumers” can “happily participate” is considered to establish both energy management and new business and be a means of realizing affluent lives.
Demonstration goal and achievements of entire project

Dynamic pricing

Dynamic pricing has been applied since the summer of 2012 and effect of reducing consumption by about 20% during peak hours has been confirmed.

Stanford University highly evaluated this result as precious data with an academically high accuracy.

CO2 reduction

CO2 emissions from households

CO2 emissions from offices

- 28% down
- 50% down
## Demonstration goal and achievements of entire project

<table>
<thead>
<tr>
<th></th>
<th>Consumer</th>
<th>EMS</th>
<th>Description</th>
<th>Scale</th>
<th>Peak consumption reduction effect (*1)</th>
<th>Energy-saving effect (*2)</th>
<th>CO2 reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Residents</td>
<td>Visualization</td>
<td>Acting by watching information on display device</td>
<td>C: 68 households  T: 120 households</td>
<td>Down about 20%</td>
<td>Energy-saving effect by dynamic pricing was not observed.</td>
<td>Down 28%</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>HEMS</td>
<td>HEMS controls batteries and some household appliances.</td>
<td>4 households</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Businesses</td>
<td>Visualization</td>
<td>Acting by watching information on display device</td>
<td>41 offices</td>
<td>0.2%</td>
<td>Comparison with 2011 2012: Down 4.32% 2013: Down 4.44% (total of 41 offices)</td>
<td>Down 50%</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>BEMS-A</td>
<td>BEMS using batteries and heat is demonstrated.</td>
<td>3 offices</td>
<td>Down 19.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>BEMS-B</td>
<td>BEMS that controls part of equipment is demonstrated.</td>
<td>6 offices</td>
<td>Down 2.6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C: Control group  T: Treatment group  Dynamic pricing implemented

Target value of consumption reduction during peak hours: Down 15%, Energy-saving effect: Down 20% from general town area in 2005, CO2 reduction effect: Down 50% from general town area in 2005

(*1) Effect of consumption reduction during peak hours
- Effect of the visualization group for residents was the result of comparison of five-stage electricity rate between the control group and treatment group in the summer and winter of 2012 and summer of 2013.
- Effect of HEMS is separately analyzed.
- Although price elasticity was observed during demonstration in the summer of 2012, its trend disappeared as the project continued.
- Effect of businesses is the result of comparison of rate of change from the immediately preceding period of time with rate of change on weekdays (winter of 2013).

(*2) Energy-saving effect
- Energy-saving effect at households needs detailed analysis.
- Of 41 business offices, 11 (27%) have reduced power consumption since 2011
Demonstration goal and achievements of entire project

[Visualization group of residents]

[Impression of demonstration program of electricity rate fluctuation they participated]

<table>
<thead>
<tr>
<th></th>
<th>Summer 2012</th>
<th>Summer 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairly good</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>Pretty good</td>
<td>28</td>
<td>22</td>
</tr>
<tr>
<td>Neither</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td>Poor</td>
<td>11</td>
<td>28</td>
</tr>
<tr>
<td>Bad</td>
<td>0</td>
<td>28</td>
</tr>
</tbody>
</table>

[Reason for not being good]

<table>
<thead>
<tr>
<th></th>
<th>Summer 2012</th>
<th>Summer 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others</td>
<td>28</td>
<td>22</td>
</tr>
<tr>
<td>Indoor device was difficult to operate</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Mechanism of demand-response was difficult to understand</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>My house had not much room for saving power</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Effort to save power was hard</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Electricity charge did not fall as had been expected</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Electricity charge increased</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Major opinions

- Awareness of need of saving energy has been rising year after year. I renewed my determination to save electricity because my effort had clearly been reflected on electricity charge.
- I increasingly looking forward to the bill of electricity rate as my awareness of need of saving energy increased.
- I starting taking actions to save electricity as I could see the setting of electricity rate.
- I cannot take actions to save electricity because I have a small baby. Under the circumstances, it is stressful to see electricity rise.
- I will put a priority to comfort at the present difference in price. Saving electricity is difficult in summer when the children are at home on vacation.

[Visualization group of offices]

Major opinions

- We paid heed to saving electricity as we could see the amount of power we consumed. We made windows for lighting in our factory.
- We used to use three fluorescent lamps for lighting, but reduced the number to two and attached a reflector to save electricity.
- We stopped the heat storage air conditioner on holidays and succeeded in lowering annual electricity consumption more than 10%.
- We cannot make our customers uncomfortable.
- Saving energy more is difficult because we are already working in a hard environment.

Points of energy management differ as each consumer uses electricity different from others. It is necessary to supply various “products” of energy management, “realizing” that there are various consumers and responding them with “enjoyment”.

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Demand response
Concept of Demand Response in Kitakyushu

Demand-Side Management (Combination of the two approaches)

DP=Dynamic Pricing + IP=Incentive Programs

By controlling electricity price by season and time, change the behavior of consumers

By giving an incentive point when they act as "positive" for the community, change the behavior of consumers

Dynamic Pricing
(1) Basic Pricing (yearly TOU)
Notify cost-per-Notify Time-of-Use tariffs as the basis of the year from the past experience of actual electricity demand.

(2) Real Time Pricing
Notify the Real Time Price of next-day or today, based on the forecasting of the amount of renewable energy or demand Prediction

(3) Critical Peak Pricing
Notify the Critical Peak Pricing based on emergency status changes (Significant changes in the amount of renewable energy, significant fluctuations in electricity demand, such as equipment failure)

Pricing Operation

<table>
<thead>
<tr>
<th>Time</th>
<th>CEMS</th>
<th>BEMS, HEMS Smart Meter</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00</td>
<td>next-day tariff, weather forecast</td>
<td></td>
</tr>
<tr>
<td>14:00</td>
<td>Next-day Operation Plan</td>
<td></td>
</tr>
<tr>
<td>15:00</td>
<td>Supply plan</td>
<td>EMS equipped user</td>
</tr>
<tr>
<td></td>
<td>Threshold exceed</td>
<td>All user</td>
</tr>
<tr>
<td></td>
<td>Re-calc CPP price</td>
<td>Update CPP tariff</td>
</tr>
</tbody>
</table>
## Past approach and result (demand response)

<table>
<thead>
<tr>
<th>Goal</th>
<th>Approach</th>
<th>Result</th>
<th>Voice of customer</th>
</tr>
</thead>
</table>
| Dynamic pricing | ● Reducing consumption during peak hours (effect: 15%)  
● Shifting peak hours of consumption  
● Saving energy | ● 5-stage CPP for residents, etc.  
● Demonstration of demand control when electricity rate for business offices is increased two-fold or five-fold. | ● Effect of reducing consumption by residents during peak hours about 20% was confirmed.  
● Only notifying to visualization terminals for business offices does not motivate. Effect varies depending on whether functions of EMS such as batteries are available. | ● Household: I renewed my determination to save electricity because my effort had clearly been reflected on electricity charge.  
● Household: It's stressful to see electricity charge rise when my children or husband, who finished nighttime shift, is sleeping.  
● Office: We cannot make our customers uncomfortable  
● Office: We cannot save electricity more because we are already in a hard environment. |
| Incentive program | ● Creating voluntary business model in smart community | ● Verification of power-saving effect and economical effect of IP as DR service | ● Power-saving effect was proved.  
● It was confirmed that economic independence is difficult in present situation.  
● Improvement in value of service by effectively using power data was suggested. | ● User: Satisfaction is not high at present but I confirmed that IP was needed as a measure.  
● Electric company: Confirmed the need of IP toward liberalization. |
## Demonstration results (2012 to 2013)

### Effect of DP to reduce consumption during peak hours

<table>
<thead>
<tr>
<th>Function</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td>(1) Visualization (social demonstration)</td>
<td>-18.1% to -22.2%</td>
<td>-18.1% to -21.1%</td>
</tr>
<tr>
<td>(2) HEMS (communication robot including visualization)</td>
<td>About -25%</td>
<td>About -25%</td>
</tr>
<tr>
<td>(3) HEMS (battery)</td>
<td>-85%</td>
<td>-59%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) BEMS (storage battery)</td>
<td>-9.0%</td>
<td>-9.4%</td>
</tr>
<tr>
<td>(5) BEMS (control only)</td>
<td>-2.0%</td>
<td>-3.2%</td>
</tr>
<tr>
<td>(6) Visualization (social demonstration)</td>
<td>9.9%</td>
<td>4.7%</td>
</tr>
</tbody>
</table>
Demonstration of dynamic pricing for residents
Dynamic pricing demonstration in 2013 (for residents)

### Conditions of demonstration for residents (summer)

- **Period:** June 2013 through September 2013
- **Electricity rate was changed in the afternoon.**
- **Change in rate was notified in the evening of the day before.**
- **DR was started on weekdays when the highest temperature of the next day was forecasted to be 30°C or more.**
- **DR was effected on a total of 45 days.**

### Conditions of demonstration for residents (winter)

- **Period:** December 2013 through February 2014
- **Electricity rate was changed two times: in the morning and in the evening.**
- **Change in rate was notified in the evening of the day before.**
  - *CCP demonstration was conducted by notifying at noon of the very day in February 2014.*
- **DR was started on weekdays when the lowest temperature of the next day was forecasted to be -1°C to 9°C or less.**
- **DR was effected on a total of 38 days (with CPP effected six times).**
Results and problems of dynamic pricing for residents

Results of dynamic pricing

(1) Effect of reducing consumption by about 20% (with effect of TOU added) during peak hours has continued for several years.

(2) Once an action of saving energy has been started, it is kept even when the temperature falls (in summer) (made a habit).

<table>
<thead>
<tr>
<th>Price</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td>50 yen</td>
<td>-9.0%(-18.1%)</td>
<td>-10.2%(-19.3%)</td>
</tr>
<tr>
<td>75 yen</td>
<td>-9.6%(-18.7%)</td>
<td>-10.7%(-19.8%)</td>
</tr>
<tr>
<td>100 yen</td>
<td>-12.6%(-21.7%)</td>
<td>-9.0%(-18.1%)</td>
</tr>
<tr>
<td>150 yen</td>
<td>-13.1%(-22.2%)</td>
<td>-12.0%(-21.1%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effect of peak-hour consumption reduction</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Price elasticity</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Δ</td>
<td>?</td>
</tr>
</tbody>
</table>

Problems

(1) Subjects have increasingly tended to react to a price signal instead of a price level (attenuation of price elasticity).

(2) Data for analyzing quantitative correlation among temperature, price, and demand is insufficient.

(3) Interest in dynamic pricing is waning (attenuation of effect).
Demonstration of dynamic pricing for businesses
Demonstration of dynamic pricing in 2013

Conditions of demonstration for offices (summer)

- Period: July 2013 through September 2013
- Electricity rate was changed for 1 hour from 15:00 to 16:00.
- Change in rate was notified in the evening of the day before.
- DR was started on weekdays when the highest temperature of the next day was forecasted to be 30°C or more.

Conditions of demonstration for offices (winter)

- Period: December 2013 through February 2014
- Electricity rate was changed for 1 hour from 15:00 to 16:00.
- Change in rate was notified in the evening of the day before.
- DR was started on weekdays when the lowest temperature of the next day was forecasted to be -1°C to 9°C or less.
Effect of reducing consumption during peak hours (result of demonstration)

◆ Number of times

<table>
<thead>
<tr>
<th>Group</th>
<th>Summer in 2013</th>
<th>Winter 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMS-A</td>
<td>22 (0.5, 0.8, 2, or 5 times)</td>
<td>30 (2 or 5 times)</td>
</tr>
<tr>
<td>EMS-B</td>
<td>22 (0.5, 0.8, 2, or 5 times)</td>
<td>21 (2 or 5 times)</td>
</tr>
<tr>
<td>Visualization offices (with display device installed)</td>
<td>13 (2 or 5 times)</td>
<td>21 (2 or 5 times)</td>
</tr>
</tbody>
</table>

Multiplying factors of price are shown because price differs from one office to another. For example, where the normal price is 20 yen per kWh, the price will be 40 yen/kWh during hours of DP when the price is doubled.

◆ Effect of reducing consumption during peak hours (simplified analysis)

<table>
<thead>
<tr>
<th></th>
<th>Summer 2013</th>
<th>[Preliminary value] Winter 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMS-A</td>
<td>-15.0%</td>
<td>-19.9%</td>
</tr>
<tr>
<td>EMS-B</td>
<td>-3.6%</td>
<td>-2.6%</td>
</tr>
<tr>
<td>Visualization offices (with display device installed)</td>
<td>-0.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Overall</td>
<td>-2.1%</td>
<td>-1.8%</td>
</tr>
</tbody>
</table>

<Method of simplified analysis>
Difference between estimated reduction of consumption during hours of implementing DP and estimated reduction on weekdays
*Estimated reduction = Power consumed during hours in question – Power consumed hours before those when DP is implemented
Effect of reducing consumption during peak hours by group and level

- EMS-A and EMS-B offices reacted to a difference in multiplying factor of price.
- All visualization offices did not show reaction to a difference in price multiplying factor.
Day of thoroughly reducing consumption during peak hours
Outline of day of thoroughly reducing consumption during peak hours

Outline

- Date of implementation: July 17 (Wed), 2013
- Electricity rate was changed for 1 hour from 15:00 to 16:00.
- Change in rate was notified in the evening of the day before, in the morning of the day, and 10 minutes before.
- Participant offices: 27 offices in visualization group

Methods of implementation and evaluation

- “Survey Guidance” and “Action Record List” were handed out and the participants were requested to save power and record their actions when dynamic pricing was executed. The record was later collected.
- The rate of reduction was the difference between average value of power consumed in the week of the challenge day and the week earlier, and power consumed during hours of dynamic pricing.

“Survey Guidance”

“Action (7) Record List”
Results of day of thoroughly reducing consumption during peak hours

Graph of results (all participant offices)

List of power-saving actions on day of thoroughly reducing power consumption during peak hours

<table>
<thead>
<tr>
<th>Action</th>
<th>Reduction rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>[Action record lists will be put in order and distributed for reference on demonstration activities in the future.]</em></td>
<td></td>
</tr>
</tbody>
</table>

Results

(1) Offices that scored highest reduction rate:
   - First place: 50.98%
   - Second place: 36.76%
   - Third place: 28.66%

(2) Office that reduced consumption most:
   - First place: 41.2kWh

<table>
<thead>
<tr>
<th>Reduction rate</th>
<th>Number of offices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10%</td>
<td>10</td>
</tr>
<tr>
<td>10% or more to less than 20%</td>
<td>4</td>
</tr>
<tr>
<td>20% or more to less than 30%</td>
<td>4</td>
</tr>
<tr>
<td>30% or more to less than 40%</td>
<td>1</td>
</tr>
<tr>
<td>40% or more to less than 50%</td>
<td>—</td>
</tr>
<tr>
<td>50% or more</td>
<td>2</td>
</tr>
<tr>
<td>No effect or increase</td>
<td>6</td>
</tr>
</tbody>
</table>
Demand response implementation plan for 2014
## Demand response in 2014

### 1. Demonstration of dynamic pricing
- Evaluation of continuity of effect of reducing consumption during peak hours (third year)
- Re-evaluation of price elasticity (applying pricing that can be evaluated)
- Quantification of changes in demand (expected value) due to changes in temperature and price → To be incorporated into CEMS
- Evaluation of arousing demand by super low-price CBP
- Evaluation of acceptability as social system (by questionnaire)

### 2. Demonstration of incentive program
- Introduction of mechanism consumers can actively participate in (interaction with indoor display device)
- Granting monetary incentive (PTR: Peak-Time Rebate)
- Timely feedback to consumers (visualization of contribution)
- Quantification of changes in demand (expected value) → Consideration of future incorporation into CEMS

### 3. Demonstration of regional energy management
*Certainty and economical value of demand response will be evaluated by performing demonstration aiming at practical use of regional energy management (integrated control).*
- Incorporation of demand forecast (automated) of dynamic pricing into CEMS
- Demand response will be appropriately mixed with households, offices, and batteries to lower demand by the entire community for energy during specific hours so as to confirm that demand and supply can be adjusted.
System overview of Kitakyushu Smart Community

**Generation/Battery**
- Higashida Co-generation
  - 33000 kW

**Community Energy Management System (CEMS)**
- Fuji Electric

**Service Provider**
- iPhone mobile
- Asset Management
- Portal service
- Point system etc.

**Information Networks**
- Self-supporting power grid

**BEMS for Building**
- NITTETSU ELEX
- Human Media Creation Center
- YASKAWA INFORMATION SYSTEMS
- Fuji Electrics
- Johnson Controls

**Smart Meter/Weather Sensors**
- Fuji Electric

**FEMS for Factory**
- Toyota Motor
- YASKAWA Electric

**HEMS for Residential**
- SEKISUI CHEMICAL
- DAIWA HOUSE INDUSTRY
- SHARP

**EV charging**
- JX Nippon Oil & Energy
- NITTETSU ELEX

**50 Buildings, Factory**
- 250 Residential
- Transportation
Controlling building supporting dynamic pricing
(Office building of Nippon Steel & Sumitomo Texeng)

Past approach and result (1)-1

Outline of facility of office building of Nippon Steel & Sumitomo Texeng

Office building
- Structure: Reinforced concrete
- Building area: 1,536.10 m²
- Total area: 7,189.73 m²
- Number of floors: 5F above ground
- Completed: May 2011

Systems to be controlled in office building
- Lighting
- Multi-function air conditioners in building
- Ventilation facilities
- Public announcement equipment

- Reception of high voltage (6.6 kV)
  Contract power: 682 kW
- Reception of solar-generated power
  10 kW
- Factory buildings (3 buildings)
  (Power monitoring only)

Kitsuyuhi Project Center (KJC) energy demand-supply condition
- Contract power: 682 kW
- Power currently received
  Total demand
  Common

Development building
Production building
FA building

KJC main building
5F: 42 kW
4F: 32 kW
3F: 35 kW
2F: 32 kW
1F: 39 kW

Storage battery
100 kW (50 kWh)
Medium-speed charger
15 kW
Rapid charger
50 kW x 3 plugs + virtual EV x 2 units
Storage battery for virtual EV
19 kWh + 19 kWh

SOC: 4 kWh
MLX: 39 kW
SOC: 37 kWh

Medium-speed charger (15 kW)
Rapid charger
Storage battery
Elevator

Monitoring only
System to be controlled...
Past approach and result (1)-2

Controlling building supporting dynamic pricing
(Office building of Nippon Steel & Sumitomo Texeng)

Attention please.
Power CPP has just started.
Lighting and air conditioning will be suppressed in 2 hours.
Your cooperation is requested.

The following efficacy of BEMS was demonstrated:
● Up to 25% of reduction of power consumption by DP during peak hours
● About 2% of shifting peak hours by electricity storage system
● Saving energy about 10%

During hours when electricity charge rises, facilities and equipment are automatically controlled to reduce the power consumed, and the employees are requested by the public announcement system to cooperate.

Kitakyushu Project Center (KJC) energy demand-supply condition

Contract power: 682 kW

Power currently received: 374 kW
Total demand: 489 kW

Lighting: Extinguished
Air Conditioning: Shut down
Virtual EV: Discharged
Storage battery: Discharged

EV charging: Prohibited
Rapid charger

KJC main building

Reduction of power consumption by up to 25% by DP during peak hours
Past approach and result (2)-1

Hospital (Higashida Clinic)

Outline of facilities of clinic

- **Solar power generation**
  - 6 kW

- **Reception of high voltage (6.6 kV)**
  - Contract power: 152 kW

- **Solar heat collector**
  - Dual vacuum glass tube
  - 3 m²/unit x 14 units

- **Reception of high voltage**

- **Hospital main building**
  - Structure: Reinforced concrete
  - Number of floors: 3F above ground
  - Completed: March 2012

- **Lighting equipment**
  - Multi-function air conditioners in building
  - Radiation air conditioning system

- **Heat source flow**
  - **Hot water storage tanks**
    - 6M³, 3m³, 1.25m³
  - **Ecological hot water suppliers (heat pumps)**
    - 80kW, 30kW × 2

- **Medical equipment**
  - Number of beds: 74
Dynamic pricing at clinic

Past approach and result (2)-2

Hospital (Higashida Clinic)

Electricity rate (dynamic pricing)

Operation plan

Power CPP has just started. Lighting and air conditioning will be suppressed in 2 hours. Your cooperation is requested.

Power-saving schedule for today (August 21, Wed)

Power to be saved: 10.3 kWh

Efficacy of BEMS related to reduction of power consumption by up to 8% by DP during peak hours was demonstrated.

During hours when electricity rate rises, lighting and air conditioning in areas that have nothing to do with medical treatment (such as shared areas including corridors and waiting room, and staff area) and the heat source facility is also stopped. Employees are notified by mail.
III
Development of demonstration
Developing demonstration into business

- **Development of demand response service into business**
  - Expertise in demand response demonstration conducted in Kitakyushu is planned to be developed into business.

- **Introduction of independent electric power system**
  - Creation of a town of coexistence with independent systems that serve as bases of large-scale factories

- **Keywords are “versatility” and “enjoyment”**.
  - Proposing and introducing various “services (prices and others)” and “products (EMS and ICT)” that meet the interest of each consumer in how to use electricity, energy saving, and reduction of power consumption during peak hours is necessary.
  - Equipment for only demand response would not sell (not enjoyable or pay off investment). Various EMS products attractive to consumers are necessary as bases. Demand response should be a standard function of such products.
  - Attractive peripheral services should be “application” functions that consumers can freely add and delete.
  - For further development, “communication/data aggregate services” for data from sensors for metering should be made open and EMS terminals should be standardized.
Expanding Kitakyushu model to other regions

- **Smart community in Japan (example: Hibikinada area in Kitakyushu)**
  (Point)
  Making industrial and operational consumers prosumers
  (Suggestion)
  System to effectively use local resources (reuse FIT) and national aid policy
  Assistance in development of technologies related to collection and use of waste heat
  Assistance in development of technologies for using industrial resources such as hydrogen

- **Overseas smart community (example: Suryacipta City of Industry, Surabaya, Indonesia)**
  (Point)
  Development of private-private project from national aid program
  (Suggestion)
  Establishment of business environment for expansion of private-private business
  Assistance in establishing international standards and trading

- **Reconstruction following earthquake (example: Kamaishi City, Iwate prefecture)**
  (Point)
  Spreading smart systems based on consensus of local residents
  (Suggestion)
  Guidance and assistance in timely construction of smart infrastructure in accordance with scenario of reconstruction
Outline of project for promoting creation of regional energy bases in Kitakyushu City

Background and objective of project

• Kitakyushu City has been addressing energy conservation and creation of new energy from the viewpoint of preventing global warming. In the wake of the Great East Japan Earthquake, the city decided to take certain responsibility for supplying stable and inexpensive energy from the viewpoint of supporting the local activities such as the citizens’ life and industrial activities.

• The city is now proceeding with a “project for promoting creation of regional energy bases in Kitakyushu City” mainly in its Hibikinada area as the city’s new major growth strategy project, in light of the results of survey and study that have been conducted since the year before last.

• This project is aimed at supplying low-carbon, stable, inexpensive energy. Formation of the regional energy bases is extremely important for supporting the growth of the city. The city also aims to make contribution to the entire Kyushu, making the best use of its potential.

Potential of Kitakyushu City

● Potential for generating renewable energy and constructing high-efficiency thermal power stations
  • Good wind conditions
  • Presence of large-scale coal and LNG import
  • Vast land

● Expertise in energy management through smart community demonstration

Kitakyushu is one of the areas in Japan ideal for solving energy problems.
Study system of this year toward realization of project

- "Kitakyushu City Community Energy Promotion Council" comprising city, prefectural, and state officials, members of local industries, and people with relevant knowledge and experience was set up.
- Under control of this promotion council, working groups “Thermal Power Station Construction Study Group” and “Offshore Wind Power Station Construction Study Group” were set up.
- The city's scheme for realizing the project based on the study by and advices from the promotion council and groups is summarized below.

<table>
<thead>
<tr>
<th>Kitakyushu City Community Energy Promotion Council</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[Members]</strong></td>
</tr>
<tr>
<td>City, prefecture, national government, local industries, people with relevant knowledge and expertise</td>
</tr>
<tr>
<td><strong>[Activities]</strong></td>
</tr>
<tr>
<td>Organizing problems to be solved to promote the project</td>
</tr>
<tr>
<td>Study of overall project scheme</td>
</tr>
<tr>
<td>Study of mechanism of community energy management, etc.</td>
</tr>
</tbody>
</table>

<<Working groups>>

<table>
<thead>
<tr>
<th>Thermal Power Station Construction Study Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[Members]</strong></td>
</tr>
<tr>
<td>Internal bureaus of city hall, energy-related businesses, etc.</td>
</tr>
<tr>
<td><strong>[Activities]</strong></td>
</tr>
<tr>
<td>Feasibility study of location</td>
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<td>Business feasibility investigation</td>
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<td>Study of legal and regulatory problems, etc.</td>
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<table>
<thead>
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<th>Offshore Wind Power Station Construction Study Group</th>
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</tbody>
</table>
Community energy plan in Hibikinada Area, Kitakyushu City

**General electric utilities**
- Solar power generation (200,000 kW)
- Wind power generation (300,000 kW)
- Biomass power generation (100,000 kW)
- Thermal power generation (2 million kW)

**To supply electricity not only to city but also to entire Kyushu**

**Regional power-saving generation**
- (300,000 kW)
- (200,000 kW)
- (100,000 kW)
- (2 million kW)

**Higashida CEMS function**
- STEP 1 Visualization of metering system for consumers
- STEP 2 Coordination with BEMS and HEMS
- STEP 3 Operation for electricity business in specific scale
- Operation for heat supply business

**Kitakyushu City**
- Private facilities
- City-owned facilities
- Other facilities
- City facilities at 331 places in all
Smart community in Kamaishi City

Smart community master plan

Kitakyushu City
CEMS

Resistive to disasters
Gentle to environment
Protector of citizens’ life

Major business
- CEMS and BEMS (public facilities, schools, reconstructed houses, ion)
- Supplying energy to reconstructed houses, solar power generation on tent roof
- Mega solar power generation business
- Plant factory project
- Ecological fishery and fishery product processing business
Expanding business chances of electric utilities by using shared cogeneration system for industrial complexes

(Recovery of loss by using factory private power generation system of opportunities to supply electric power. Steam as a new source of income)

**Conventional system**
- Power companies supplied electricity to consumers.
- Steam consumers supply steam from a boiler they own.

**Shared cogeneration system for industrial complex**
- **SPC** supplies electric power and steam.
- SPC stably supplies power as it is in the premises of the industrial complex.
- SPC can avoid loss in transmitting and distributing power because it is located close to consumers.

As compared with the ongoing business that supplies only electric power, power companies can expect a potential of an about 50% increase in income.
Industrial complex in Surabaya, Indonesia

- “Infrastructure and System Export Promotion Survey Project” of the Japanese Ministry of Economy, Trade and Industry was implemented (March 2012 through February 2013).
- Result of the demonstration experiment of smart community in Kitakyushu City was exported to overseas industrial complexes as infrastructure.
- Use of technologies and expertise of Yahata Higashida Smart Community Project
- Energy-related services were provided to businesses whose employees moved into the industrial complex.
  - Heat (steam) sales
  - Electric power sales
  - Energy-saving service
- Sales of excess power to local power company (PLN)

![Diagram of Energy (electric power & steam) supply and saving project](source)

Local operating company (SPC)
- Design and construction of cogeneration plant
- Operation, maintenance, and management of cogeneration plant, etc.
- Procurement of raw materials for operation, maintenance, and management, and supply heat & electric power service
- Energy-saving service, etc.
Suryacipta City of Industry in Indonesia

NEDO demonstration project (October 2012 through March 2016)
- Power distribution automating system
- High-quality power supply system
- Energy demand-supply management system
Prachin Buri industrial complex in Thailand

1. Outsourcing business
   (1) Energy supply
      • Optimum supply of electric power and heat through on-site power generation
      • Air conditioning service (regional, individual, on-site)
      • Power supply stabilization service for factories
   (2) Introduction of high-efficiency equipment and energy conservation
      • Leasing high-efficiency equipment and operation service
      • Total energy diagnosis by cloud FEMS
   (3) Operation and maintenance service
      • Management, operation, and maintenance of factory equipment and facilities
   (4) Environment monitoring
      • Atmosphere, factory waste water
   (5) Transporting employees
   (6) Human resource development
      • Employees and managers
   (7) Regional contribution

1. Outsourcing
   2. Japanese car manufacturers (affiliates, electric machine manufacturers, etc.)
   3. Factory for rent

ECO (power saving and energy saving) utilities

♦ Ecology industry town
   • Energy efficiency improvement
   • Energy conservation
   • Business continuity

♦ Local resident service
   • Education, transportation, medical treatment
   • Electric power, water supply, sewerage
IV
Public relation and information dissemination
(1) Only winner of “ISGAN AWARD” in Japan

(2) Tochiku Senior High School Super Science High School (SSH)

(3) Visitors from overseas
(1) Only winner of “ISGAN AWARD” in Asia

ISGAN

- International SmartGrid Action Network
- **Officially established as an execution organization of IEA to work on joint programs of smart grids** in April 2011, sponsored by IEA that is engaged in activities for international joint development of energy technologies
- At present, 25 countries are participating.
- Participants: Australia, Austria, Belgium, Canada, China, EU, Finland, France, Germany, India, Ireland, Italy, Japan, South Korea, Mexico, Norway, the Netherlands, Russia, Singapore, Spain, South Africa, Sweden, Switzerland, England, U.S.A
(1) Only winner of “ISGAN AWARD” in Asia
[Outline of ISGAN Award]

Sponsor: ISGAN (International Smart Grid Action Network)
Outline: Awarding excellent smart grid projects in the world
Applicants: More than 40 projects from 15 countries
Finalists (winners): 10 projects
Official announcement: Officially announced at the Fifth Clean Energy Minister Conference (CEM5) to be held on May 12 in Seoul, South Korea
Evaluation points of Kitakyushu: Involvement of citizen, consumers, in smart grid
2013
- Visit to local power-saving station: December 17
- Discussion with Director Matsuoka (freshmen): February 24
- Presentation in U.S.A.: March 13

To learn “logical communication” with Kitakyushu smart community creation project as theme

Theme: “Can citizen participate in energy management?”
(2) Tochiku Senior High School Super Science High School (SSH)
• The Netherlands
  – January 24, 2014 (Friday)
  – Mr. Roderik Wols, Consul-General of the Netherlands
    • 11 companies, universities, administrative bodies including Amsterdam City, Phillips, and University of Amsterdam
  – Morning: Information exchanging meeting
  – Afternoon: Visit
(3) Visit from overseas – the Netherlands
(3) Visit from overseas – Malaysia

• Malaysia
  – April 5, 2014 (Saturday)
  – Malaysian Industry-Government Group for High Technology “MiGHT”
    • Director and co-chairman: Mr. Zakri Abdul Hamid
    • President: Mr. Mohd Yusoff Sulaiman
  – Afternoon: Courtesy call on mayor, visit, exchange of opinions
(3) Visit from overseas – Malaysia
Thank you for your attention.