Virtual Power Plants:

innovation in energy management systems
to utilize distributed energy resources
as a source of flexibility

2018.6.15

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Journey of DR & VPP introduction in Japan

2011  The great earthquake (Fukushima incident)
      ⇒ energy management became to be a big issue

2012  Electricity system reformation restarted

2014  National Energy Plan including DR enacted

2015  DR guideline established (baseline rule etc.)

2016  Capacity procurement per year started & DR participated
      VPP project started (Planned as a 5 year project)

2017  DR trading started  (in kWh trading and capacity procurement)
Energy management progress in Japan 2011

① Peak Demand reduction by electricity users and Power companies (energy conservation, peak shift, utilization of distributed generators)

② Introduction of peak cut appliances increased (Battery and Energy management systems)

③ Smart community trial expanded (Yokohama, Toyota, Keihanna, Kitakyushu・・・)

④ Study of DR resource installation on Japan’s electricity market started ⇒ Implementation started 2017
Implementation of DR resource; capacity procurement

2017 April started, year base contract by TSO among Generators & DR.

Category I : primary and secondary, 7% of area peak demand
Category I´: for emergency, about 1% of five areas

DR bid in Category I´
(Aggregators, Electric power companies, Customer directly)

<table>
<thead>
<tr>
<th>AREA</th>
<th>TOHOKU</th>
<th>TOKYO</th>
<th>CHUBU</th>
<th>KANSAI</th>
<th>KYUSHU</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>74</td>
<td>599</td>
<td>192</td>
<td>170</td>
<td>290</td>
<td>1,325</td>
</tr>
<tr>
<td>(DR)</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>72% of Total</td>
</tr>
</tbody>
</table>

Activated on 23～27 Jan. 2018 ⇒ Demand side contributed to system operation for the first time in Japan
Virtual Power Plant as advanced DR

METI challenged to next step; utilizing various DER by IoT technologies heat pump, batteries, demand response, EV, ENE-FARM,PV

Concept of VPP

Aggregators provide grid operators with energy services which Aggregators gathered

Electricity System

Wind farm
Hydropower
Nuclear Power
Thermal Power
VPP
Utility-scale solar PV
Micro CHP
Factories
Shops
EV and EVPS
Stationary battery system
Heat pump
What VPP can implement in energy market??

VPP project started to substitute generator’s flexibility utilizing distributed energy resources

Substitutional flexibility supplier

Harmonization with Renewables
Development of Energy Management Systems

Scales of Demand sides

- Large Commercial Buildings
  - BEMS/FEMS (~2010)
- Small Commercial Buildings
  - BEMS/FEMS (2012~)
- Condominiums
  - CEMS (2013~)
- Households
  - HEMS (2012~)
  - HEMS (2014~)
  - VPP (2016~)

Management Area

No connections with TSOs

Connections with TSOs
What is VPP’s significance??

VPP is a Symbol project integrating Japan’s excellent factor grown up after 2011 Earthquake

- Utilization of various DERs
- Facilitation of technologies
- Involvement of various players

[Factors among Japan’s VPP]

Resources (Enlarged from 2011)
Storages (Large & Small), EMS, EV, Heat Pumps • • • •

Technologies (Experience of Japan)
Platform building & operating
Innovation of DERs

Platform Players & Users
Energy companies, TSOs, Retailers, C&I users, Residential users • • •

ERAB (Energy Resource Aggregation Business) by METI is a Strategic path of collaboration of Japan’s DER factors
Major Aggregators in VPP Trial Projects

Aggregation Coordinators

Resource Aggregators
• **6 aggregators** joined VPP demonstration project in co-operation with **more than 30 resource aggregators**.
Solutions provided by VPP Servicer in Future (Business Model)

- Frequency Control (Flexibility & Reserve Market)
- Remain generation (Under FIT) or (Balancing Market)
- Energy Management
- CO2 Reduction
- Utilize Renewable Energy

VPP services

VPP incomes

Customer Service
Electricity Procurement
Avoid high imbalance penalty

Aggregate Demand Side Resources
Kansai VPP platform participating resources

Residential HEMS, EV, Battery, Co-generation system, etc

- VPP resources are operated through IoT, as per the monitoring and controlling systems

<table>
<thead>
<tr>
<th>House Hold</th>
<th>EMS</th>
<th>Air Conditioner</th>
<th>Boiler</th>
<th>EV·PHV</th>
<th>Secondary Battery</th>
<th>Generator</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HEMS</td>
<td>HEMS Air Conditioner</td>
<td>Household HP</td>
<td>PrivateCar</td>
<td>Small secondary Battery</td>
<td>Household Co-generative</td>
<td>Others</td>
</tr>
<tr>
<td>Enegate</td>
<td>Kansai Electric</td>
<td>Sumitomo Electric</td>
<td>Nihon Unisy</td>
<td>Enegate</td>
<td>NTT Smile Energy</td>
<td>Eliiy Power</td>
<td>Mitsubishi Corp</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry</th>
<th>BEMS</th>
<th>FEMS</th>
<th>Industrial air conditioner</th>
<th>Industrial HP</th>
<th>Company car</th>
<th>Large secondary battery</th>
<th>Co-generation</th>
<th>Generator</th>
<th>Pump</th>
<th>Freezer</th>
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</thead>
<tbody>
<tr>
<td>Sumitomo Electric</td>
<td>DAIHEN</td>
<td>Yokogawa Electric</td>
<td>Fukushima-Industries</td>
<td>Sumitomo Electric</td>
<td>Kansai Electric</td>
<td>Sumitomo Electric</td>
<td>Kansai Electric</td>
<td>Fuji Electric</td>
<td>Sumitomo Electric</td>
<td>Yokogawa Electric</td>
</tr>
</tbody>
</table>

Target resource

Total Resource 15MW
How to accelerate VPP Business Model

① Enlargement of VPP participants (Desirably GW level)

② Cost down of each energy resources (Battery, Appliances...) & IoT

③ Improvement of responding speed and certainty of VPP platform

④ Fair evaluation of VPP at flexibility & Reserve market
# VPP Challenges; Speeding up & Earning more income from reserve market

## Present plan by METI

<table>
<thead>
<tr>
<th>GF Primary</th>
<th>Secondary</th>
<th>Under 5 Min. Reserve</th>
<th>Under 15 Min. Reserve</th>
<th>Under 60 Min. Reserve</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
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</tr>
<tr>
<td>バッテリー</td>
<td>バッテリー</td>
<td>バッテリー</td>
<td>バッテリー</td>
<td>バッテリー</td>
</tr>
<tr>
<td>240秒以上</td>
<td>15分以上</td>
<td>7〜11時間以上</td>
<td>7〜11時間以上</td>
<td>3時間程度</td>
</tr>
</tbody>
</table>

### Present Position of VPP
- Potential of VPP resources (Battery, etc.)
- Capability of VPP system by speeding up
- Present Position of VPP