Distributed Energy Resources
and
Research Activities in CRIEPI related to DER Platform Requirement

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(ENIC)
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Stance of ENIC and presentation outline

The research fields of ENIC (Energy Innovation Center) of CRIEPI (Central Research Institute of Electric Power Industry) are demand side and distribution grid, which have been in great transformation with the massive integration of renewable energy, penetration of ICT (AI/IoT), and changes in customers. Our mission is to find solutions from the End Use of energy supply & demand chain.

Points:

1. Two categories of DERs depending on the relation with customers
2. EcoCute, an attractive device with high potential as DER
3. CRIEPI’s research activities related to analysis tools for DER Platform
Two categories of DERs depending on connected line voltage class and the relation with customers

<table>
<thead>
<tr>
<th>Line Voltage</th>
<th>PV</th>
<th>Battery</th>
<th>EV</th>
<th>EcoCute</th>
<th>Combined Heat and Power</th>
<th>WF</th>
<th>Bioamss, etc</th>
<th>Emergency Generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-200V 1φ</td>
<td>Roof top</td>
<td>ZEH, ZEB</td>
<td>V2H, V1G</td>
<td>V2G</td>
<td>Fuel Cell</td>
<td></td>
<td></td>
<td>Diesel</td>
</tr>
<tr>
<td></td>
<td>PV(&gt;10kW)</td>
<td>Battery for Emergency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200V 3φ</td>
<td>ZEB</td>
<td>Fast Charge</td>
<td></td>
<td></td>
<td>HP with Hot Water Tank</td>
<td></td>
<td></td>
<td>Diesel</td>
</tr>
<tr>
<td>6.6kV</td>
<td>Mega solar</td>
<td>ZEB</td>
<td>Fast Charge</td>
<td></td>
<td>Gas-Cogeneration</td>
<td>WF</td>
<td>Biomass</td>
<td>Diesel Gas-turbine</td>
</tr>
<tr>
<td>Over 20kV class</td>
<td>Mega solar</td>
<td>For Grid operation</td>
<td></td>
<td></td>
<td>For Grid operation</td>
<td>WF</td>
<td>Biomass</td>
<td></td>
</tr>
</tbody>
</table>

**Central Control**

**Autonomous Decentralization Control or Hybrid Control**
2. EcoCute is an attractive device with high potential as DER

1. Climate in Japan is very adequate for atmospheric heat source heat pump
2. Energy consumption for hot water supply is $\sim 30\%$ of residential sector in Japan
3. EcoCute is a high efficient (COP$\sim 4$) electric heat pump, water heating and supply system, equipped with a hot water reservoir tank and using low GWP refrigerant. More than 6 million units have already been installed.

Hot water is produced by day time PV, and can be used at night time.

http://www.hptcj.or.jp/individual/tabid/150/Default.aspx  Check 2019/9/4

https://www.corona.co.jp/eco/about/feature/  Check 2019/9/4
Heat pump can create electricity demand in daytime

— Simulation results of absorbing excess PV power using heat pump and battery —

(a) PV + Battery (2kWh)

(b) PV + Heat Pump

- Building a Win-Win Relationship between Various Players is essential

**Prosumer**
- Benefit Enhancement
- Technology for Coordination
- DER owned by Demand Side (Distributed Energy Resources)
- PV, PCS, EV, Battery, Cogeneration, Heat Pump
- Various Load including industrial use.
- All Consumer, Business Entity
- Cost Reduction

**Aggregator · VPP**
- Cost Reduction and Profit Improvement
- Ensuring Electricity Power Quality with Suppressing Cost
- Avoidance of Output Curtailment

**Power Grid Company**
- Power Transmission Department
- Power Distribution Department
- Retail Electricity Supplier
- Renewable Energy Power Producer

2019/10/10
Comprehensive simulation platform to evaluate cooperative operation techniques between supply side and demand side

**Program 1a,b,c**
- Demand Simulation Tool
- EV traffic simulator for creating demand profiles due to EV charge/discharge
- Solar irradiation forecast for the forecast of PV power output

**Program 2**
- Community Operation Planning Program

**Program 3**
- Supply-Demand Operation Simulator

**Program 4**
- Comprehensive Analysis Tool of Power Distribution System

**Program 5**
- Simulation of Community Operation
  - DR Request
  - Direct control
  - Change load profile
One Example of DER Simulation Study

Estimated demand creation potential in southern area of Japan with EV

• Wide spread of V2G charging points, especially at homes, and increasing the possibility of EV connection to the charging points can contribute to the demand creation potential by EVs
• Our estimation shows that the case of V2G_100% EV connection gives a maximum potential of 16160MWh/6hours.
Summary

1. It is important to consider two DER categories depending on the relationship with customers in order to design appropriate DER management.

2. EcoCute can be an attractive DER to absorb daytime surplus PV power by time shifting electricity demand, and by creating daytime electricity demand.

3. Building a win-win relationship between various players concerned with DERs is essential. Various analysis tools are inevitable for designing of such Platform for DERs. CRIEPI is working to develop each essential analysis tools.
Colleagues contributed to this presentation

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• Dr. Hiromu Kobayashi
• Dr. Hiroshi Asano
• Dr. Tomohiko Ikeya
• Mr. Eitaro Oomine
• Dr. Hiroyuki Hatta
• Ms. Madeleine Carlier

Thank you for your attention!