The renewal of conventional energy systems is important countermeasures against global warming effects and natural disaster, and a self-sustainable decentralized energy system is one of the promising solutions for future sustainable and resilient societies.

This project, which is supported by the Technology Development Projects for Prevention from Global Warming by the Ministry of Environment, Japan, for 3 years (2012-2014), attempts to construct a prototype of a self-sustainable decentralized energy system, based on DC power feeding and effective utilization of renewable energy, as a demonstration experiment in Nushima Island.

In the project, the following sub-topics are considered:
1) highly efficient DC micro-grid,
2) highly efficient stationary and mobile battery systems,
3) demand-side energy management by adopting dynamic pricing, and
4) optimization of the design and the utilization of the total system.

In this organized session, the state-of-the-art of the project is introduced.
State-of-the-Art:

1) Installation of DC micro-grids at three locations with highly efficient converters and batteries.
2) Quantitative analysis of the effects of the demand-side energy management.
3) Quantitative evaluation of the micro-grid system by using the MP model.
State-of-the-Art:

1) Installation of DC micro-grids at three locations, with highly efficient converters and batteries.

2) Quantitative analysis of the effects of the demand-side energy management.

3) Quantitative evaluation of the micro-grid system by using the MP model.
DC Micro-Grid System

- Photo-voltaic cells
- Wind turbine generator
- Battery
- Commercial power line
- DC 360V Bus Line
- DC/DC converter
- AC/DC converter
- DC 24/19V
- AC 100V

- DC household appliances
  - Cleaner & Electric fan
  - Microwave oven
  - Personal computers
  - Charger for mobile phones

- AC household appliances
  - Business use refrigerator
  - Emergency satellite phone
  - Emergency watch camera

- Mobile battery (Type A)
- Mobile battery (Type B)
- Plug-in hybrid boat

- DC 200V
- DC 250V
- DC 360V
- DC 24/19V
- DC 96V

- DC Micro-Grid System
- Demonstration Experiment
- Social Experiment
- Virtual Experiment (Simulation)
- 51 Households
- Visualization & Dynamic Pricing
Appearance of DC Micro-grid System

PV Array (Roof-top)

Nushima Elementary School

Wind Turbine

Control & Monitoring

Li-ion Battery Units and DC-DC Converter

Mobile Battery Charger

Step-down DC-DC Converter
Demonstration Experiment — Efficiency of Power Conversion (May 29)
Demonstration Experiment — Efficiency of Power Conversion (May 27)
Demonstration Experiment — Efficiency of Energy Utilization

0.849

0.840

efficiency

time [min]

5/27 - 5/29
5/20 - 5/22
Social Experiment — Visualization of Electricity Consumption

Electricity consumptions in your house

<table>
<thead>
<tr>
<th></th>
<th>Now (W/person)</th>
<th>Today (Wh/person)</th>
<th>Yesterday (Wh/person)</th>
<th>This month (Wh/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your house</td>
<td>150</td>
<td>1,000</td>
<td>2,500</td>
<td>9,000</td>
</tr>
<tr>
<td>Average of all houses</td>
<td>3,625</td>
<td></td>
<td>3,625</td>
<td>10,756</td>
</tr>
</tbody>
</table>

Per-capita electricity consumptions

<table>
<thead>
<tr>
<th></th>
<th>Now (W/person)</th>
<th>Today (Wh/person)</th>
<th>Yesterday (Wh/person)</th>
<th>This month (Wh/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your house</td>
<td>450</td>
<td>3,000</td>
<td>7,500</td>
<td>27,000</td>
</tr>
<tr>
<td>Average of all houses</td>
<td>1,000</td>
<td></td>
<td>7,500</td>
<td>27,000</td>
</tr>
</tbody>
</table>

Least Electricity consumption ranking

Your rank: 14th (yesterday)
Virtual Experiment — Electricity Consumption in Nushima (Data)
Virtual Experiment — Optimal Allocation of PV and Wind Turbine

Degree of Dependence on KEPCO = 0.30
Future Issues:

1) Performing full-scale experiments in the experimental fields.
2) Setting up social experiments of dynamic pricing and evaluating the effect on the reduction of electricity consumption.
3) Evaluating the whole DC micro-grid system through simulation experiments (w.r.t. the reduction of CO₂ emission, etc.).
Future Directions

Environmental Future Initiative:

1) From demonstration to establishment.
   Guarantee for safety & stability, Validation of economic efficiency, Design of a system,
   Contribution to regional vitalization, etc.

2) From Nushima to Awaji-Island, all over Japan, and the whole earth.
   So many islands in the world!!