Status and Perspectives of the Utilization of Marine Renewable Energy in Japan

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The Bill of the Basic Act on Global Warming Countermeasures
(Cabinet approved in Oct. 8, 2010)

Mid-term Goals:
- A reduction of 25% in greenhouse gas emissions below the 1990 level by 2020.
- Increasing the share of renewable energy to 10% of the total primary energy supply by 2020.

Promoting “Ocean Renewable Energy” use

Topics: Current status of R&D/Problems/
Perspectives of the practical use
Demand and Supply of Energy in Japan

1. Final Energy Consumption

(Source: Agency for Natural Resources and Energy “Comprehensive Energy Statistics”)
Demand and Supply of Energy in Japan

2. Energy sources and Self-sufficiency ratio

(Source: Agency for Natural Resources and Energy “Comprehensive Energy Statistics”)
1. Distribution of Ocean Wind

Average Speed (m/sec)

(Source: Japan Railway Construction, Transport and Technology Agency)
Potential of ORE in Japan

2. Distribution of Ocean Current

Kuroshio: 500GWh/year

(Source: Suzuki et. Al., 2008)
Potential of ORE in Japan

3. Electricity efficiency and Area required for Generating the total Electricity of Japan

<table>
<thead>
<tr>
<th>Type of Energy /Technology</th>
<th>Electricity (kWh/m²)</th>
<th>Area required (km²)</th>
<th>Percentage of EEZ ≤1000m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offshore wind</td>
<td>41</td>
<td>25,100</td>
<td>3.1</td>
</tr>
<tr>
<td>Wave</td>
<td>8.5</td>
<td>121,000</td>
<td>15.1</td>
</tr>
<tr>
<td>Ocean Current</td>
<td>51</td>
<td>20,200</td>
<td>2.5</td>
</tr>
<tr>
<td>Solar PV</td>
<td>140</td>
<td>7,360</td>
<td>0.9</td>
</tr>
</tbody>
</table>

- Total Electricity Demands in 2008: 1.03 TWh
- Area of EEZ shallower than 1,000m depth: 803,000 km²
## Potential of ORE in Japan

### 4. Economics of Power Generation from ORE

<table>
<thead>
<tr>
<th>Type of Energy /Technology</th>
<th>Facility Cost (¥/kW)</th>
<th>Capacity Factor (%)</th>
<th>Power Price (¥/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offshore wind</td>
<td>300,000</td>
<td>40</td>
<td>9~14</td>
</tr>
<tr>
<td>Wave</td>
<td>400,000</td>
<td>10~30</td>
<td>10~30</td>
</tr>
<tr>
<td>Ocean Current</td>
<td>400,000</td>
<td>40~70</td>
<td>7~14</td>
</tr>
<tr>
<td>Onshore wind</td>
<td>250,000</td>
<td>30</td>
<td>9~14</td>
</tr>
<tr>
<td>Solar PV</td>
<td>300,000</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Nuclear</td>
<td>700,000</td>
<td>80</td>
<td>6</td>
</tr>
</tbody>
</table>

(Source: Suzuki, 2009)
Current Status of R&D and Practical Use

1. Offshore Wind

- Most promising type of energy source

  *Electricity target: 11MW → 1GW by 2020*

- R&D: Floating wind turbine

  ← Larger depth of ocean around Japan

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Experiment with 1/10 scale Model of Spar-type offshore wind turbine by Kyoto Univ.
Current Status of R&D and Practical Use

2. Ocean Current and Tidal Stream

• Location: *Straits and Isolated Islands*
• Size of Facility: *Small ~ Medium (1 ~ 2 MW)*
• R&D: A proposal of experimental plant for *Miyake-jima*

3. Ocean Wave

• R&D: Various accumulation of studies on *Oscillating Water Column type*, but *Studies are behind in Moving body type (ex. Pelamis Wave Power Convertor, UK)*
1. Accumulation of Fine-scale Oceanographic Data
   • Oceanographic data at 1 km mesh scale is requested to determine the type and size of a power generator.

2. Cooperation with Fisheries and Other Industries
   • Developing win-win relationships with fisheries and other industries is essential for introducing power generation systems using ocean renewable energy.

3. Development of a System for Verification tests
   • Areas reserved for the verification of devices should be prepared by the government for promoting the R&D and practical use of ocean renewable energy.

4. Harmony with the Environment
   • Assessment and mitigation of physical effects of a facility on the ecosystem and organisms around it are essential for the sustainable use of ocean renewable energy.
Perspective: A Closed system of ORE

Power Generation for Fishing Industry

Power Plants (Conventional Type)
Power supply using existed power grid

surplus  shortage

Power Generation using Ocean Renewable Energy

Storage

Fishing Village
- Illumination
- Communication
- Water supply
- Food processing

Fishing Port
- Illumination
- Water supply
- Refrigerated Store
- Ice manufacture
- Power supply for in port vessels

Aquaculture Facilities
- Heating/Cooling
- Feeding
- Harvesting

A Local Production for Local Consumption System in Energy
An Example of Wind Power Generation for the Facilities of Fishing Port

Hasaki fishing port

- Nominal output: 1MW
- Total Electricity: 2,702MWh
- Capacity Factor: 30.8%
- Avg. Wind Speed: 6.45m/sec.

(track record in 2005)

Reductions of 47.7% in power consumption by the ice plant, and 1,080ton of CO2 emission.
Summary

• To reduce CO2 emission, we must promote the utilization of ocean renewable energy.

• Enough ocean renewable energy is distributed in Japanese EEZ, and profitable economically.

• Some progress has been made on offshore wind, but behind in other energy source.

• For the verification tests in commercial scale, the Government should provide the test field.

• As a practical approach, we propose a closed system of ocean energy power generation for the fishery in a coastal area or remote island.