Status of Renewable Energy in Japan

4th, February, 2014
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(Tokyo, Japan)
Introduction of Institute for Sustainable Energy Policies

An independent nonprofit policy think-tank (Environmental NGO) aiming at the realization of sustainable energy policy mainly engaged in the rationalization of natural energy, energy saving, and energy market.

- Green electricity, Green thermal Certificate system
- Community Fund (such as Ohisama Fund)
- Regional energy office
- Demand-pull strategy (such as FIT)
- Community Power Initiative

- Autonomy’s policy advisory
- Autonomy’s climate change policy research
- “Sustainable Zone” study group
- Regional economy effect study

Realization of sustainable energy policies

Adequacy of energy market

Renewable energy

- Renewable energy and building-up of social agreement
- Sustainable energy finance
- Japan Renewable Energy Policy Platform (JREPP)

Director: Tetsunari Iida
Chapter 1 Outline of renewable energy in Japan and abroad
- Renewable energy of the world
- Renewable energy of Japan
- Long-term Scenarios of Renewable energy
- Renewable Energy in Community

Chapter 2 Trend on renewable energy policies in Japan
- Trend on national policy
- Policy of Feed-in Tariffs
- Community Power
- Addressing toward project
- Industry and employment
- Renewable energy and financing
- Addressing toward dissemination
- Building-up of social acceptance

Chapter 3 Trend to the present and status quo
Field of electricity
- Photovoltaic power generation
- Wind power generation
- Small hydro power generation
- Geothermal power generation
- Biomass power generation
- Power generation by marine energy
- Solar power generation
Field of thermal power
- Solar heat
- Direct use of geothermal heat and earth thermal
- Use of biomass heat

Chapter 4 Long term scenario
- Renewables Global Futures Report
- Intermediate and long term scenario in Japan

Chapter 5 Situation of region-wise introduction and potential
- Situation of region-wise introduction
- Potential of introduction

Chapter 6 Proposition and summary

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Situation of energy in Japan

Energy supply structure in Japan

Source: [Energy Japan Status Report 2013] issued by the Agency for Natural Resources and Energy

[No. 211-3.1] Transition of energy supply in Japan

- Stagnancy of renewable energy
- Large scale introduction of nuclear power generation since 1980s
- Introduction of natural gas since 1980s
- Expanded use of coal since 2000s
- Petroleum-dependent structure since 1970s

(Note) In the [Comprehensive energy statistics] calculation method for the numeric has been changed since after FY1990.

(Source) Prepared on the basis of [Comprehensive energy statistics] issued by the Agency for Natural Resources and Energy

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Self-sufficiency rate of energy in Japan

[No. 211-4.1] Transition in domestic supply configuration and self-sufficiency rate of energy in Japan

<table>
<thead>
<tr>
<th>Year (Y)</th>
<th>Petroleum</th>
<th>Coal</th>
<th>Natural gas</th>
<th>Nuclear power</th>
<th>Hydro power</th>
<th>New energy, geothermal, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>58.1%</td>
<td>14.9%</td>
<td>6.3%</td>
<td>5.1%</td>
<td>4.2%</td>
<td>4.4%</td>
</tr>
<tr>
<td>70</td>
<td>58.1%</td>
<td>15.3%</td>
<td>12.6%</td>
<td>17.1%</td>
<td>20.4%</td>
<td>19.5%</td>
</tr>
<tr>
<td>80</td>
<td>58.1%</td>
<td>15.3%</td>
<td>12.6%</td>
<td>17.1%</td>
<td>20.4%</td>
<td>19.5%</td>
</tr>
<tr>
<td>90</td>
<td>58.1%</td>
<td>15.3%</td>
<td>12.6%</td>
<td>17.1%</td>
<td>20.4%</td>
<td>19.5%</td>
</tr>
<tr>
<td>00</td>
<td>58.1%</td>
<td>15.3%</td>
<td>12.6%</td>
<td>17.1%</td>
<td>20.4%</td>
<td>19.5%</td>
</tr>
<tr>
<td>05</td>
<td>58.1%</td>
<td>15.3%</td>
<td>12.6%</td>
<td>17.1%</td>
<td>20.4%</td>
<td>19.5%</td>
</tr>
<tr>
<td>10</td>
<td>58.1%</td>
<td>15.3%</td>
<td>12.6%</td>
<td>17.1%</td>
<td>20.4%</td>
<td>19.5%</td>
</tr>
</tbody>
</table>

Energy self-sufficiency rate (%)

(Note 1) Rate that can be secured in own country among primary energies required for living and economic activities is called the energy self-sufficiency rate. Numeric in the parenthesis ( ) is the value including nuclear power. Since uranium which is fuel for nuclear power can be used for several years once it is imported, nuclear power is dealt with as quasi-domestic production energy.

(Note 2) Configuration ratio may not sometimes become 100% in total because its fraction is rounded off.

Power Generation in Japan

- After Fukushima, power generation by nuclear was rapidly decreased.
Policy target of renewable energy

- EU directive causes NREAP for each country in EU
- Sufficiently-high policy target will be needed for Japan as soon as possible.

New Strategic electricity scenarios in Japan after Fukushima(3.11)

37% renewables in electricity by 2020, 100% renewable by 2050: New targets were proposed by ISEP (Japanese government target of renewable electricity is 20% by 2020s, prime minister Kan said the)

Renewables 10% → 30%(37%) → 100%

Scenario: Nuke ban by 2020 politically

In Japan, rapid Energy Shift must be initiated politically after Fukushima(3.11)

New legislation for FIT to promote all practical renewables such as PV, Wind, Geothermal, Small Hydro and Biomass

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
<th>2050</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>8.0%</td>
<td>13%</td>
<td>28%</td>
<td>33 GW</td>
</tr>
<tr>
<td>Wind</td>
<td>0.4%</td>
<td>8%</td>
<td>17%</td>
<td>50 GW</td>
</tr>
<tr>
<td>Solar</td>
<td>0.3%</td>
<td>10%</td>
<td>28%</td>
<td>143 GW</td>
</tr>
<tr>
<td>Geothermal</td>
<td>0.3%</td>
<td>3%</td>
<td>16%</td>
<td>12 GW</td>
</tr>
<tr>
<td>Biomass</td>
<td>1.1%</td>
<td>4%</td>
<td>11%</td>
<td>8 GW</td>
</tr>
</tbody>
</table>

Ref. ISEP “A report on Japan’s Energy Shift since March 11th”

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Renewable Energy Strategy Plan for Rebirth of Tohoku area

Proposal by ISEP

- How this regional strategy ties into the 2020 goal of 100% renewables in the Tohoku, proposed by ISEP in 2011

Demand(2010) and Potential

- special FIT scheme for Tohoku area
- Support system for Renewable Business in the area
- Unbundling of power supply system in East Japan Area

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Renewable Energy Trend in Japan

Trends of Renewables electricity in Japan (excluding large hydro): 17GW (FY2012)

Ref: Renewables Japan Status Report 2014 (Executive Summary)
Renewable Energy Trend in Japan

Right now, Renewable Energy makes a small contribution to the power generation in Japan, except large hydro power (over 10MW).

Power Generation in Japan (FY2012)

Trends of Renewables electricity in Japan (excluding large hydro)
4.1% renewables in FY2012

Ref: Renewables Japan Status Report 2014 (Executive Summary)

*FY2012: 10.1% Renewables in power generation in Japan (including large hydro)
Large Potential of Renewable Energy in Japan
Estimated by MoE, Japan

Small Hydro

Onshore Wind

Offshore Wind

Potential: 14GW

Tohoku and Hokkaido area

Hokkaido area

Potential: 273GW

Potential: 141GW

Ref: “Study of Potential for the Introduction of Renewable Energy (FY 2010)” MoE, Japan

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Energy Sustainable Zone (SZ) is an indicator to identify areas where local production of renewable energy exceeds local consumption of energy by residential and service sector.
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Energy Sustainable Zone (SZ) is an indicator to identify areas where local production of renewable energy exceeds local consumption of energy by residential and service sector.

50 towns and villages over 100% Sustainable Zone (100% renewables)

Ratio of Renewable Energy =

Renewable Energy Supply

Energy Demand

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World’s investment on renewable energy (nation-wise)

- Invested amount in Japanese market ranks 4th, occupying approx. 7% share (2012)
- Investment in Japanese market was mostly on solar light for houses. (2012)

**Figure 14: New Investment in Renewable Energy by Country and Asset Class, 2012, and Growth on 2011, $BN**

<table>
<thead>
<tr>
<th>Country</th>
<th>Investment (Billions USD)</th>
<th>Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>64.7</td>
<td>22%</td>
</tr>
<tr>
<td>United States</td>
<td>34.2</td>
<td>-36%</td>
</tr>
<tr>
<td>Germany</td>
<td>19.8</td>
<td>-35%</td>
</tr>
<tr>
<td>Japan</td>
<td>16.0</td>
<td>73%</td>
</tr>
<tr>
<td>Italy</td>
<td>14.1</td>
<td>-53%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>8.8</td>
<td>-12%</td>
</tr>
<tr>
<td>India</td>
<td>6.4</td>
<td>-50%</td>
</tr>
<tr>
<td>South Africa</td>
<td>5.7</td>
<td>17598%</td>
</tr>
<tr>
<td>Brazil</td>
<td>5.3</td>
<td>-38%</td>
</tr>
<tr>
<td>France</td>
<td>4.6</td>
<td>-31%</td>
</tr>
</tbody>
</table>

Top 10 countries. *Asset finance volume adjusts for re-invested equity. Excludes corporate and government R&D*

Source: UNEP, Bloomberg New Energy Finance

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Japan gave away its world’s top ranking to Germany in 2004 as single fiscal year and in 2005 as cumulative capacity. Its gap further expanded in subsequent years and Japan stays world’s 4th ranking in cumulative capacity at the end of 2012.

Source: IEA PVPS, EurObservER, etc.
Transition in introduction of solar power generation for each field in single year
In FY2012, PV for business and industrial market rapidly increasing by new FIT scheme.

Source: Japan Photovoltaic Energy Association (JPEA)
Wind power trends in Japan

- After FY2011, annual installed capacity keeps very low level because of several regulation.
- New wind farm were planned to begin operation after new FIT starts, however…
Data taken from [Renewables Japan Status Report 2013]

Introduction potential of wind power generation

- Introduction potential is big in Hokkaido, Tohoku and Kyushu. Especially offshore wind power
Restrictive factors in natural energy market in Japan (Example of wind power generation)

Wind power generation market in Japan has unavoidably stayed stagnant due to [triple restrictions] arising out of institutional, techno-electrical and social themes.

⇒ It is necessary to change governmental and autonomous energy policy and institution.

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Power generation cost in nuclear power generation goes up higher than cost for bearing accident risk.

Cost for power generation by renewable energy can possibly become cheaper in future.

(Fig. 37) Power generation cost of major power sources (2030 model plant)
Consideration on power generation cost

Cost incurred by power generation

*1 Power generation cost in narrow sense resulting in profit/loss for electric companies (This has no direct connection with electricity charges.)
*2 Electricity cost which consumers pay under the name of electricity charges and taxes
*3 Cost which does not need to be considered

**External cost *3**
- Global environment (Air pollution, destruction of nature, etc)
- Accident risk
- Compensation for damage
- Employment

**Regional economy**
- Dole-out budget
  - Official fund (Land location subsidy, research & development, etc)
- Cost for safety measures (Measures against tsunami & earthquake)
- Cost for system (power transmission & distribution)

**Cost which consumers pay for electricity**
- (Cost in interface with users *2)
- Hidden cost
  - Cost for safety measures (Measures against tsunami & earthquake)
  - Contribution of electric companies to autonomy
  - Cost of advertisement & sale business

**Cost for electric companies *1**
- Conventional [Power generation cost]
  - Cost for fuel
  - Construction cost, etc.
  - Cost for operation maintenance
  - Cost for abandoning nuclear plant

**Hidden cost**
- Cost for safety measures (Measures against tsunami & earthquake)
- Contribution of electric companies to autonomy
- Cost of advertisement & sale business

**Safety**
- Nuclear non-proliferation

**International peace**
- Sustainability

**Absolute principle**

Source: Energy Scenario Civil Evaluation Panel (2011)
http://www.facebook.com/enepane

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The challenges involved in introducing locally owned renewable energy in Japan (Before new FIT)

(1) Community Wind Power since 2001 in East area of Japan
(2) Community Solar Photovoltaics (PV) since 2005 in Iida city, Nagano Pref.
(3) Community Small Hydro Power since 2010 in Toyama Pref.

Community business of Renewable Energy using Community Fund Scheme in Japan

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Development, operations and financing models for community power, joint research funded by JST


- **Operation and Financing**: Project Financing by leading banks (Capacity Investment), Regional Finance (Participation of Regional Financial Institution, Joint Financing, et al), Community Fund, Financing Scheme on Feed-in Tariffs, guaranty of liabilities.

- **Supply and Demand**: Green PPS, electricity deregulation, unbundling, et al.
What is the fixed price buying system of renewable energy?

Japan’s fixed price buying system (adopted in national diet on Aug. 26, 2011 → Started as from July 2012)

- [Special measures law relating to procurement of renewable energy electricity by electric business enterprisers]

Natural energy (Solar power, wind, geothermal, small hydro, biomass, etc.)

- Electric generation enterprisers
- Investment
- Return
- Financial institutions, industries, citizens, etc.

Electricity charges (Long term fixed price)
- Priority access
- Priority power feed
- Electricity (Total capacity)

Electricity charges (Added charges)
- Operating company of power transmission line (Electric power companies)
- Electricity

Houses

Industries, etc.
Feed-in Tariffs starts in Japan

- “Partial” FIT for Solar only started in 2009
- “Full” FIT starts in July 2012

Conditions for FY2012 (Tariff of Solar PV is 36 JPY/kWh for FY2013)

<table>
<thead>
<tr>
<th>Capacity [kW]</th>
<th>Solar PV</th>
<th>Wind</th>
<th>Geothermal</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;20</td>
<td>&lt;15000</td>
</tr>
<tr>
<td>&gt;=10</td>
<td>&gt;=10</td>
<td>&gt;=20</td>
<td>&gt;=15000</td>
</tr>
<tr>
<td>PIRR(with Tax)</td>
<td>3.2%</td>
<td>1.8%</td>
<td>13%</td>
</tr>
<tr>
<td>Tariffs [JPY]</td>
<td>42</td>
<td>55</td>
<td>40</td>
</tr>
<tr>
<td>Length [Years]</td>
<td>10</td>
<td>20</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacity [kW]</th>
<th>Hydro</th>
<th>Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;200</td>
<td></td>
<td>1 – 8%</td>
</tr>
<tr>
<td>&gt;=200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;=1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;=1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;=1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;=30000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No limit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PIRR(with Tax)</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>Tariffs [JPY]</td>
<td>34</td>
<td>24</td>
</tr>
<tr>
<td>Length [Years]</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

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“Full” FIT starts from July, 2012 in Japan

Renewables (PV, Wind, Geo, Hydro, Biomass)

Tariffs for electricity

Ave.: 15 JPY/kWh

Electric Price (Surcharge)

0.3 JPY/kWh

Priority Access

Total: 380B JPY

Utilities

Investment: 1000B JPY

Power Facility

Electricity

26 TWh

Company

Electric Consumer

Investment, Loan

Financial Institution

Employment: 100,000

Home

Total: 380B JPY

200B JPY

Data: Estimation by ISEP

Total capacity of certified facilities is 26GW until October, 2013 since July 2012.
PV capacity is 94%(25GW) of certified facilities. And certified large PV over 1MW is 14GW(54%)
Operating facilities are only 17%(6GW) of certified facilities.
Renewable energy
Revenue and expenditure of power generation enterprise

- Business plan in which long term power generation business can be set up

![Image of cash flow for 20 years (business period)]

Project IRR (Internal interest rate): 6 ~ 13%

- Development of business
- Procurement of fund
- Continuation of business (securing maintenance expenditure)
- Repayment of loan, Corporate enterprise tax
- Dividend to investors
- Mitigation of business risk (business evaluation, insurance, etc)

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Initial investment of renewable energy business in Japan is estimated from case study of community based project.

The chart shows the initial investment in JPY/kW for different energy sources in Japan:
- PV (150kW)
- PV (1MW)
- Wind (2MW)
- Hydro (200kW)
- Biomass (5MW)
- GeoThermal (70kW)

The breakdown of initial investments includes:
- Others
- Electro Installation
- Construction
- Site preparation
- Planning
- Direct (Hardware)

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Annual cost of renewable energy business in Japan is estimated from case study of community based project.