Japan - Renewed Opportunities

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3. Summary
1. **Before the nuclear accident in 2011**
   - Why there was no geothermal development?
17 geothermal power plants with 19 units (2000-2012)

- **Uenotai**
  - 1994 - 28.8MW

- **Sumikawa**
  - 1995 - 50MW

- **Onuma GPP**
  - 1974 - 9.5MW

- **Suginoi**
  - 1981 - 3MW

- **Otake**
  - 1967 - 12.5MW

- **Kuju**
  - 1998 - 0.9MW

- **Yamagawa**
  - 1995.3 - 30MW

- **Takigami**
  - 1996 - 25MW

- **Suginoi**
  - 1996 - 25MW

- **Kakkonda GPP**
  - I. 1978 - 50MW
  - II. 1996 - 30MW

- **Onikobe GPP**
  - 1975.3 - 12.5MW

- **Hachijojima GPP**
  - 1999 - 3.3MW

- **Hatchobaru**
  - I. 1977 - 55MW
  - II. 2000 - 55MW
  - Binary 2MW

- **Matsukawa GPP**
  - 1966 - 23.5MW

Before the nuclear accident in 2011
Geothermal potential in Japan

<table>
<thead>
<tr>
<th>Country</th>
<th>No. of active volcanoes</th>
<th>Geothermal potential (MWₑ)</th>
<th>Geothermal Power generation on 2010 (GWₑh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>160</td>
<td>30,000</td>
<td>16,603</td>
</tr>
<tr>
<td>Indonesia</td>
<td>146</td>
<td>27,790</td>
<td>9,600</td>
</tr>
<tr>
<td>Japan</td>
<td>119</td>
<td>23,470</td>
<td>3,064</td>
</tr>
<tr>
<td>Philippines</td>
<td>47</td>
<td>6,000</td>
<td>10,311</td>
</tr>
<tr>
<td>Mexico</td>
<td>39</td>
<td>6,000</td>
<td>7,047</td>
</tr>
<tr>
<td>Iceland</td>
<td>33</td>
<td>5,800</td>
<td>4,597</td>
</tr>
<tr>
<td>New Zealand</td>
<td>20</td>
<td>3,650</td>
<td>4,055</td>
</tr>
<tr>
<td>Italy</td>
<td>13</td>
<td>3,270</td>
<td>5,520</td>
</tr>
</tbody>
</table>

Geothermal potential in this table is an estimated value from heat energy stored at a depth of geological basement or shallower.

Japan is the world’s 3rd largest geothermal potential country, but its power generation is merely No. 8 in the world......

Why?
Before the nuclear accident in 2011

Geothermal power in Japan

The world’s geothermal power capacity is increasing constantly.

But no new GPP in Japan this century.

WHY?
All these strong points are common with nuclear power. Therefore, under the federal policy pushing nuclear power, lows and regulations which limits geothermal development had not been improved.
The reasons why there was no new GPP in Japan

1. **National Parks** (no drillings, no researches)
80% of the geothermal energy in Japan exist inside national parks where no exploitation has been allowed. Even scientific survey has been limited.

2. **Hot springs**
Some hot spring owners make strong campaign against geothermal development in afraid of degradation of the springs (amount, quality).

3. **Cost**
Thermal and nuclear power have been considered more cost effective so that GPP has not been attractive for electric power suppliers.

➢ How these things have been improved after the nuclear accident in 2011?
2. Renewed Opportunities

- Recent movement after 3.11, 2011
1. National Parks
The cabinet decided to mitigate restrictions on geothermal development in national parks, as a low CO₂ emission energy source (June, 2010). Ministry of Environment (MOE) changed ordinance on national park in 2012.

Ordinance of the Ministry of the Environment

1) Special Protection zone and Class 1 Special zone (SP and S1)
The development is not admitted but the gravity or MT survey will be admitted, which covers wide area. A deviated well drilling is not admitted.

2) Class 2 and 3 Special zones (S2 and S3)
The development is basically not admitted. Only deviated well drilling from outside will be admitted if there is no effect on the surface. (November 2011)
The development is basically not admitted but it may be allowed if environmental consideration is well treated. (March 2012)
1. National Parks

It has been…

Never enter! (Even survey is prohibited)

Special Protection zones
Class 1 Special zones
Class 2 Special zones
Class 3 Special zones
Ordinary Zones
Outside parks

- SP:
- Higher protection
- >20 Yen/kWh
- 15 - 20 Yen/kWh
- 10 - 15 Yen/kWh
- < 10 Yen/kWh

Surface survey and small scale development may be allowed

Renewed Opportunities
Renewed Opportunities

1. National Parks Since March 2012

- Special Protection zones
- Class 1 Special zones
- Class 2 Special zones
- Class 3 Special zones
- Ordinary Zones
- Outside parks

Surface survey may be allowed

Small scale development may be allowed

Higher protection

Development allowed

if enough environmental consideration is made,
2. Hot springs
The only social problem that cannot be solved by laws and regulation. But...

The Ministry of Environment (MoE) made a new guideline on permission of geothermal drilling in March 2012, to be referred by local (prefecture) government, in order to avoid delay in giving permission.

May geothermal development affect on shallow hot spring aquifer?

- No information on their relation
  - Judgment by basic geo-scientific info.
- Model exists on their relation
  - Judgment based on the Model
- Monitoring data on their relation
  - Judgment based on Monitoring data

Procedure for permission shown in the guideline
3. Cost
The Energy Agency of METI supports domestic geothermal businesses by:

- Financial support
  1. Drilling
     • Government’s support for geothermal drilling was to be abolished in FY2011. But after the big earthquake, government increased the budget from ~USD 15 to 90 million in FY2012. It covers up to 50% of exploration well drilling costs.
  2. Public Acceptance
     • New budget for PA covers 100% of PA activities by private sectors.
  3. RD&D (EGS, etc.)

- Feed in Tariff (FIT)
  FIT law for geothermal power was enacted and price is fixed in 2012.
  1. 15 MW or bigger: 27.3 yen/kWh for 15 years
  2. Smaller than 15 MW: 42 yen/kWh for 15 years.

Geothermal projects get double financial incentives from the government (drilling support and FIT).
Private sectors (Industries)

- Japan Geothermal Association (JGA) was established in Dec. 2012. It consists of 49 companies and 3 organizations (dated May 2013), including metal developers, oil and gas developers, power supplier, trading companies, construction companies, turbine makers, plant makers, geothermal consultants, drillings companies, and banks.

- Kawasaki Heavy Industry, KOBELCO, IHI, etc., began production of 50-100 kW generator for small binary plants. Many local groups (municipal or hotel owners) show interests in such small GPP.

- Currently 44 or more exploration and/or development projects are run by geothermal developers and local groups (see next page).
4. New developments

Current projects
(Explorations, evaluations and installations)

- 19 prospects over 10MW
- 7 prospects 1MW-10MW
- 18 prospects less than 1MW
(as of July 2014)

Preceding projects
(began before 2011)

- TOHGEC group began exploration drilling in 2013 in Hachimantai, aiming at 10 MW GPP.
- Yuzawa-Chinetsu Co. Ltd. (J-Power, MMC and Mitsubishi Gas) began environmental assessment in Wasabizawa geothermal field, aiming at 42 MW GPP in 2020.

Activity Index

Higher number indicates higher subsurface temperature (expected).

Map made by JGA
4. New developments

Present geothermal power stations

- 12 areas, 14 units 10MW or bigger
- 3 + 1 units 1MW-10MW
- 9 units less than 1MW
  (6 are installed in 2014 and Abo Tunnel was in 2013)
  as of July 2014

Ongoing projects
- Some of these small plants have plans to enlarge capacity.
- Abo Tunnel will have additional 2MW in 2015.
- Goto-en will have additional 0.05MW by 2015.
3. Summary

• Renewable preference after the nuclear power plant accident in March 2011 pushed Japanese government to support geothermal development.

• Financial incentives for geothermal developments, drilling support and FIT system are given by METI.

• New RD&D has begun supported mainly by METI (also by MOE and Reconstruction Agency).

• MOE released constrains for national parks. MOE made a new guideline on giving geothermal drilling permission to speed-up the process.

• Industries have moved forward to accelerate domestic geothermal developments. Currently 44 or more exploration and/or development projects are running.
Geothermal study by AIST

- Geothermal studies by AIST, which used to be done by geo-scientific units, would be mainly conducted in FREA.

Fukushima Renewable Energy Institute AIST (FREA)

Renewable Energy Research Center (RERC)  Administration offices

- Energy Integration Team
- Hydrogen Energy Carrier Team
- Wind Power Team
- Solar Cell Technology Team
- Geothermal Energy Team (GET)
- Shallow Geothermal and Hydrogeology Team (SGHT)

Collaboration

Other organizations

Universities
Institutes
Industries
Overseas
5. Geothermal study by AIST

Major projects by Geothermal Energy Team in FREA

BUDGET for FY2014 (April 2014- March 2015)

* JOGMEC Project (Sponsored by METI)
  ➢ AE monitoring in Yanaizu-Nishiyama (AE Mapping, Risk evaluation), ~USD 100,000
* Japan-US collaboration project (Sponsored by METI)
  ➢ Development of decision tree for hydro-fracturing process, ~USD 720,000
* ERIA project (Sponsored by METI)
  ➢ Sustainability Assessment of Utilizing Conventional and New-Type Geothermal Resources in East Asia, USD 65,000

* Local FS (Sponsored by Reconstruction Agency)
  ➢ 1-year projects to support FS by local firms in area struck (Fukushima, Miyagi and Iwate prefectures), Max ~USD 300,000.
  ➢ 4 projects are currently conducted by Geothermal Energy Team.

FY2014 Budget for geothermal researches in FREA (total: ~USD 1,443,000)
**Reference**

- **What is Activity Index?**

**Activity Index by Hayashi (1982)**

- Higher number indicates higher subsurface temperature (expected).

**Updated by Muraoka et al. (2008)**

**Map by JGA**
2. Hot springs

“Harmonious utilization of geothermal energy with hot spring resources”
- to avoid conflicts between hot spring owners and geothermal developers -

AIST had conducted a 3-year research project from FY2010 sponsored by MoE, consists of modeling, monitoring, and data integration for a whole subsurface system including hot spring aquifer.
A Kalina cycle enables power generation by ~85 C water. GERD and AIST have been conducting a demonstration project in Niigata sponsored by MoE. Many hot spring owners have interest in such small plants for their own use.

**2. Hot springs**

For utilizing local energy and *reducing “geothermal allergy” of hot spring owners*,

**“Hot spring power plant” project**

Low temperature binary system

A Kalina cycle enables power generation by ~85 C water. GERD and AIST have been conducting a demonstration project in Niigata sponsored by MoE. Many hot spring owners have interest in such small plants for their own use.