# Overview of Policies on Geothermal Development in Japan

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Hidenori Yonekura

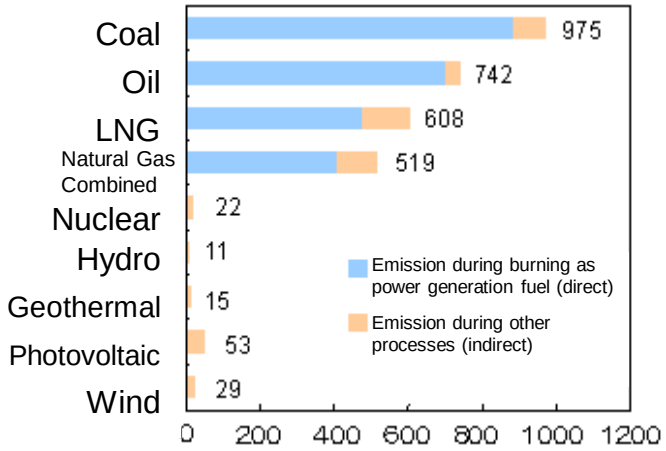
Agency for Natural Resources and Energy

Ministry of Economy, Trade and Industry of Japan

# 1. Advantages of geothermal power generation
（3 Merits）

a. Near-zero CO2 emission during power generation– helps prevent global warming
b. Outstanding capacity factor and output stability, compared with other renewable energies
c. Japan has the world's 3rd biggest potential for geothermal resources

CO2 emission per unit of power generation by power source




Lifecycle CO2 emission volume [g-CO2/kWh(at power transmission end)]

<Source>
Data regarding nuclear power are from "Evaluation of nuclear power generation technologies based on life cycle CO2 emissions (August 2001)" by the Central Research Institute of Electric Power Industry. Data regarding other power sources are from "Evaluation of power generation technologies based on life cycle CO2 emissions (March 2000)" by the Central Research Institute of Electric Power Industry

Capacity utilization ratio by power source (approx.)

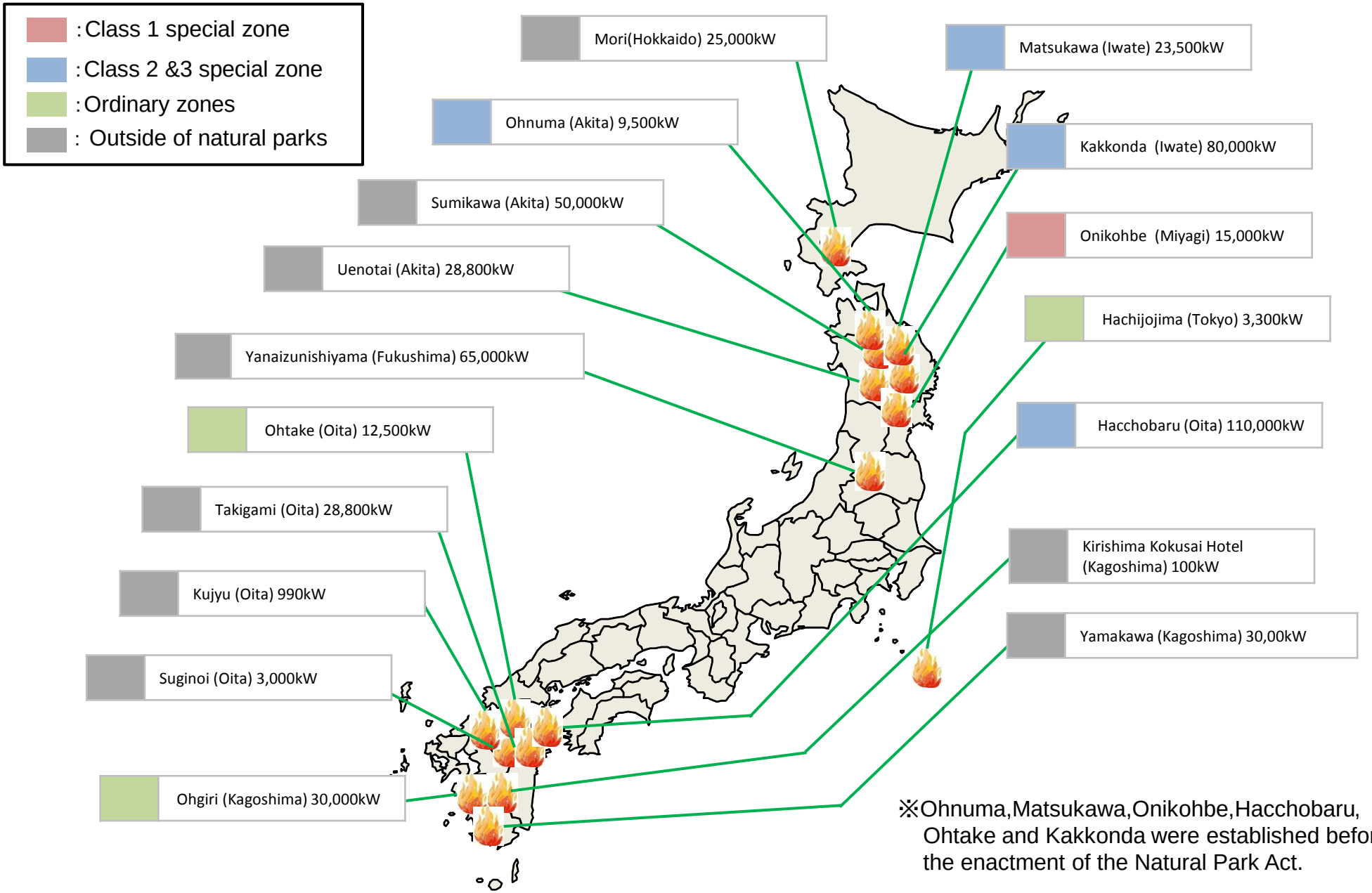
| | |
|---|---|
| Photovoltaic | 12% |
| Wind | 20% |
| Geothermal | 80% |

International comparison of geothermal resource volume

| Country | Number of Active volcanos | Geothermal Resource volume (MWe) |
|---|---|---|
| USA | 160 | 30,000 |
| Indonesia | 146 | 27,790 |
| Japan | 119 | 23,470 |
| Philippines | 47 | 6,000 |
| Mexico | 39 | 6,000 |
| Iceland | 33 | 5,800 |
| New Zealand | 20 | 3,650 |
| Italy | 13 | 3,270 |

# 2.Current geothermal development in Japan

（17 plants, installed capacity of approx. 520 MW ）

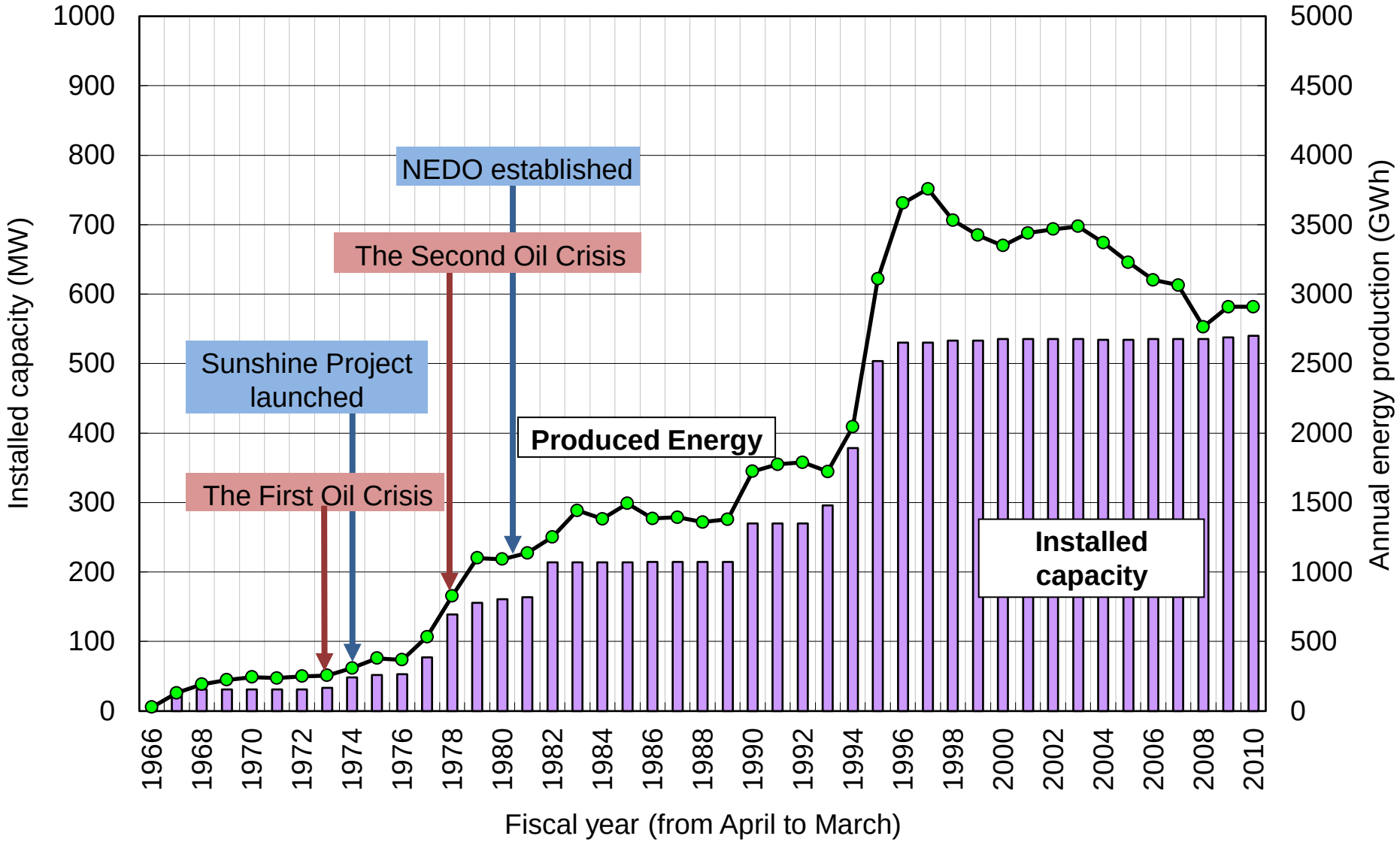



※Ohnuma,Matsukawa,Onikohbe,Hacchobaru, Ohtake and Kakkonda were established before the enactment of the Natural Park Act.

# 2.Current geothermal development in Japan

（Installed capacity and produced energy）

- No power plant has made since 1999. But the Tohoku earthquake and resulting nuclear accident have accelerated the growing interest in renewable energy including geothermal.

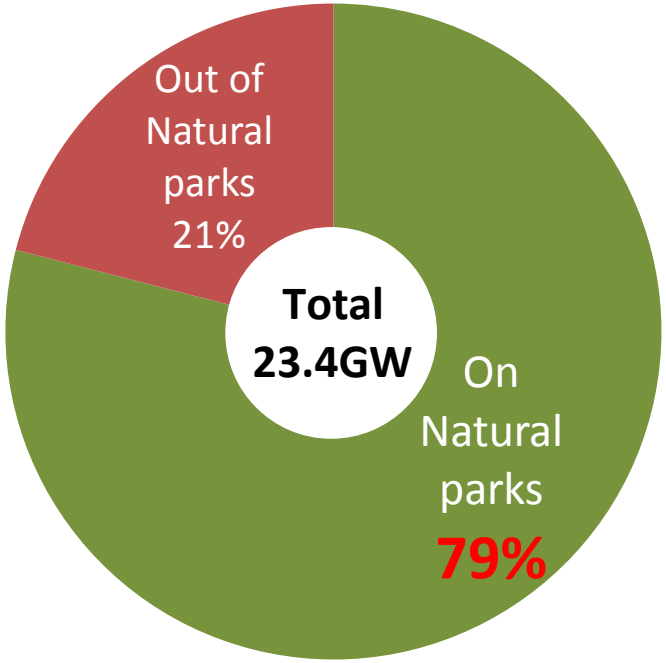


# 2.Current geothermal development in Japan

（Energy potential of geothermal in Japan）

- Approximately 80% of energy potential of geothermal is located on natural parks determined by Natural Parks Act in Japan.
- So far geothermal plants have mainly been developed on out of these natural parks.

**Distribution of Geothermal Energy Potential in Japan**



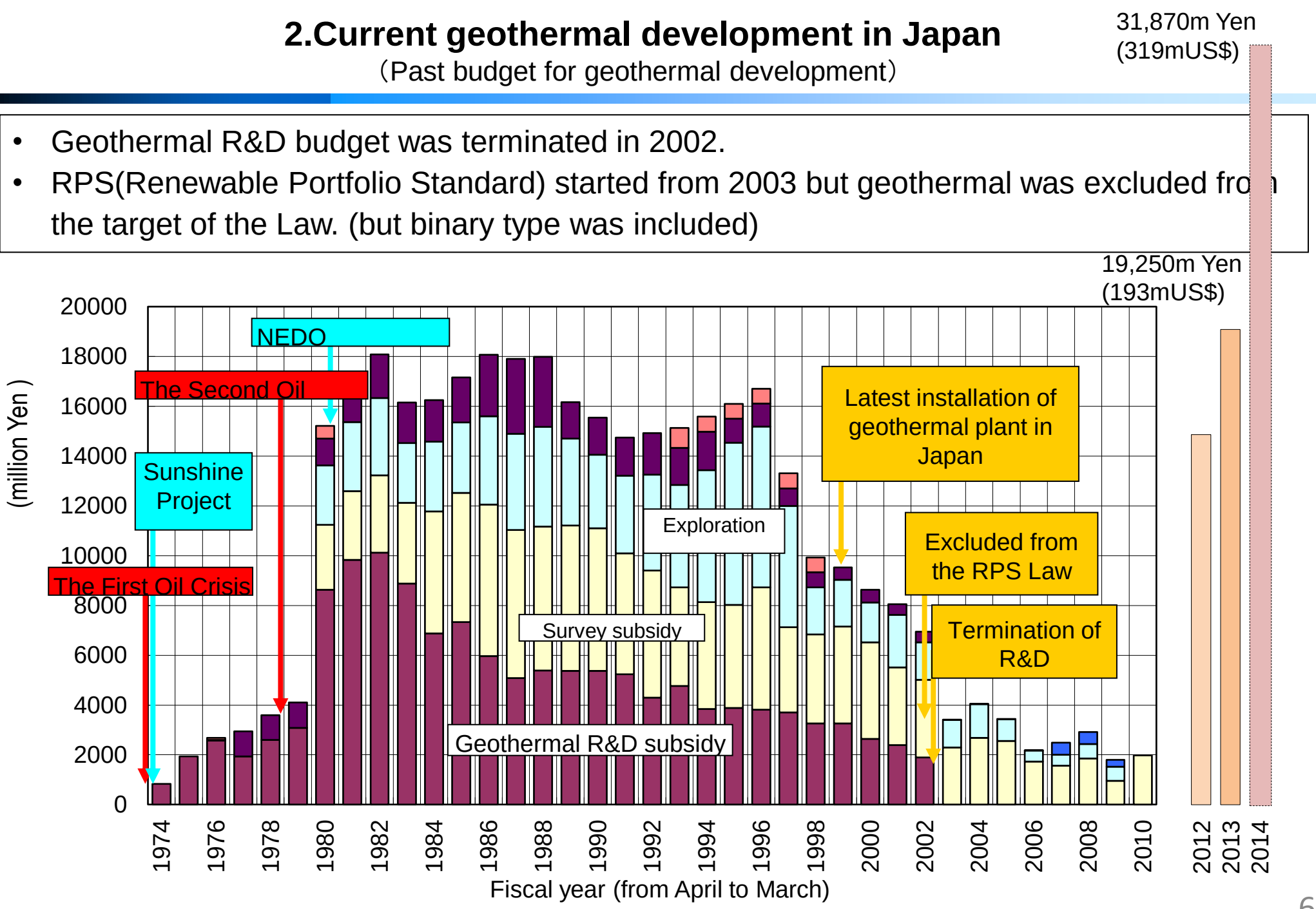

| Classification of Natural Parks | Energy Potential(MW) |
|---|---|
| Special Protection Zone | 7,000 |
| Special Zone (I ~ III) | 10,300 |
| Ordinary Zone | 1,100 |
| Other than Natural Parks | 5,000 |
| Total | 23,400 |

Source: AIST (2011)

# 2.Current geothermal development in Japan

（Past budget for geothermal development）

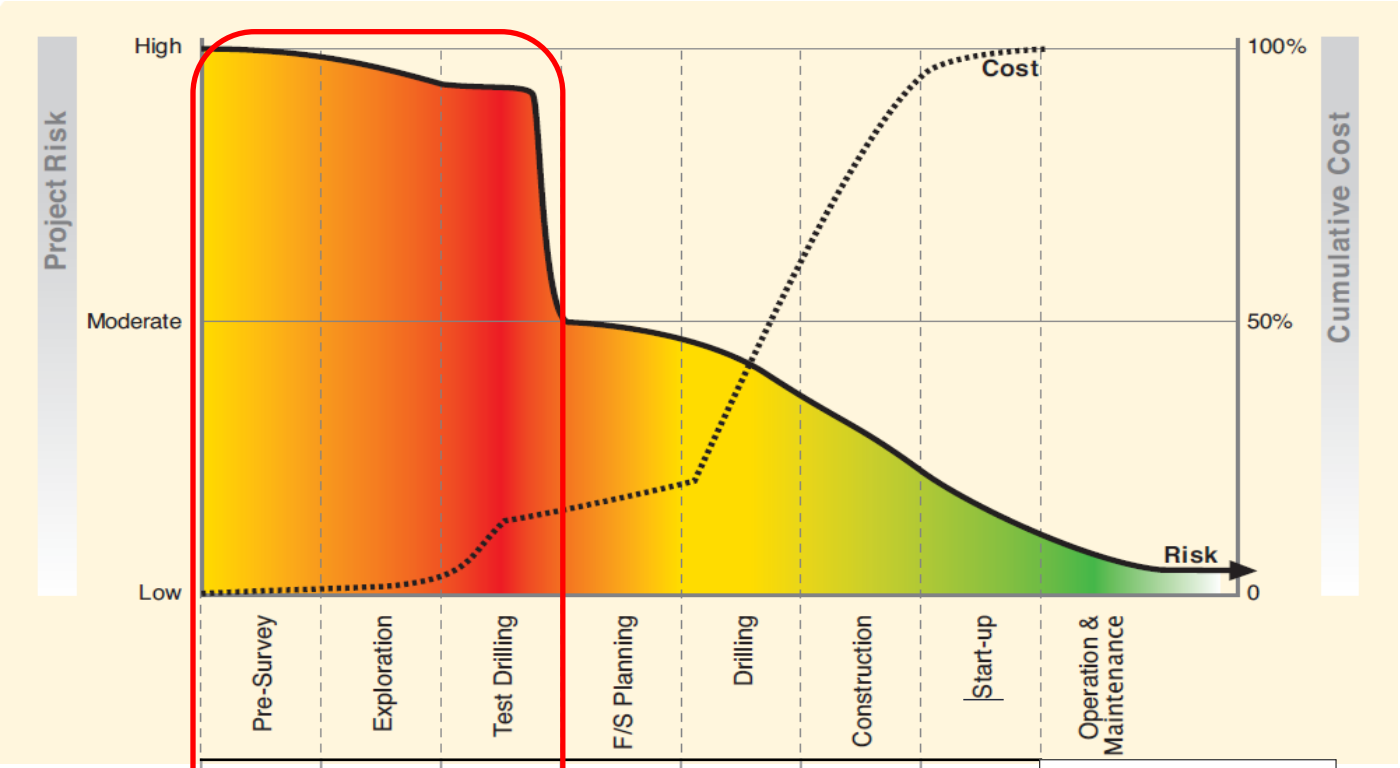
- Geothermal R&D budget was terminated in 2002.
- RPS(Renewable Portfolio Standard) started from 2003 but geothermal was excluded fro
  the target of the Law. (but binary type was included)



# 3.Current geothermal development in Japan

（Special risk on geothermal development）

- Geothermal development has specific risk such as drilling risk, opposition from region and steam reduction.
- Appropriate governmental support to reduce these specific risk is necessary for the dissemination of geothermal power plants.




| | Pre-Survey | Exploration | Test Drilling | F/S Planning | Drilling | Construction | Start-up | Operation & Maintenance |
|---|---|---|---|---|---|---|---|---|
| Cost by stage | 2 | 3 | 18 | 7 | 70 | 91 | 5 | **196 Million US$** |
| Percentage | 1% | 1% | 9% | 4% | 36% | 46% | 3% | **Capital Cost Total** |

(Medium Estimate of 50MW plant)

Source:Geothermal Handbook (The world bank)

# 3.Current geothermal development in Japan

The Government will promote geothermal development.

**Japan Revitalization Strategy -JAPAN is BACK-**

**(Cabinet decision on June 14, 2013)**

2. Strategic Market Creation Plan

Theme 2: Realizing clean and economical energy demand and supply

(2) Individual envisioned societies and efforts toward realization

*[1] A society where clean and economical energy is supplied*

II) Direction toward solution, strategic areas (markets and industries) and immediate key policy actions

○Regulatory and institutional reform, etc. to introduce renewable energy

・The government will increase investment to geothermal generation. The government will promote regulatory and institutional reform including streamlining the procedure of environmental impact assessments (usually procedures take three to four years hence, reduce the period by half) and streamlining safety regulations to promote small geothermal generation using existing hot spring wells, and promote understanding of local people.

http://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/en_saikou_jpn_hon.pdf

# 4. Challenges for further geothermal development

## 1.Risk Reduction

Geothermal development needs significant. Also it takes more than 10 years before starting plant operation.

- -Minimization of the risk by drilling
- -Drilling cost reduction
- -Shortening lead time

## 2.Public Acceptance

- -Japan has a cultural heritage of hot springs. Hot spring enterprises tend to be against geothermal development, concerned about effects to their hot spring resources.
- -Geothermal resources often exist in national parks. Environment-friendliness and harmonization with local scenery development is important.

## 3.Research and Development

- -Techniques for searching for fractures
- -Reservoir management technologies
- -Environment-friendly and high performance power generating systems

# 4. Governmental support （FY 2013 budget）

| Public Acceptance | Geological survey | Exploration (drilling of exploration wells, etc.) | Construction stage | Operation of power generation facilities |
|---|---|---|---|---|

EIA

| Subsidy | Subsidy | Investment | Loan guarantee | Feed-in tariff scheme |
|---|---|---|---|---|
| [Targets] Cost of projects to get public acceptance.<br><br>Budget:<br>\2.8 billion<br>Subsidy ratio:<br>100% | [Targets] Cost of test drilling, etc. including geological surveys.<br><br>Budget: \7.5 billion<br>Subsidy ratio:<br>50% to 100% | [Targets] Cost of drilling exploration wells to check whether a sufficient volume of steam can be stably extracted from heat sources.<br><br>Budget : \6 billion<br>Investment ratio: ~50% | [Targets] Cost of drilling wells necessary for power generation and construction of power generation facilities<br><br>Budget: \2 billion<br>Loan guarantee ratio: ~80% | Electric utilities purchase electricity generated from renewable sources including geothermal at the procurement price and for the procurement period. |

R&D

## Subsidy for projects to promote public acceptance

Budget(FY2013): \2.8 billion, Subsidy ratio: 100%

Examples of projects

○Projects using geothermal energy

＜Hothouse cultivation by geothermal energy＞


＜Fish raising by geothermal energy＞

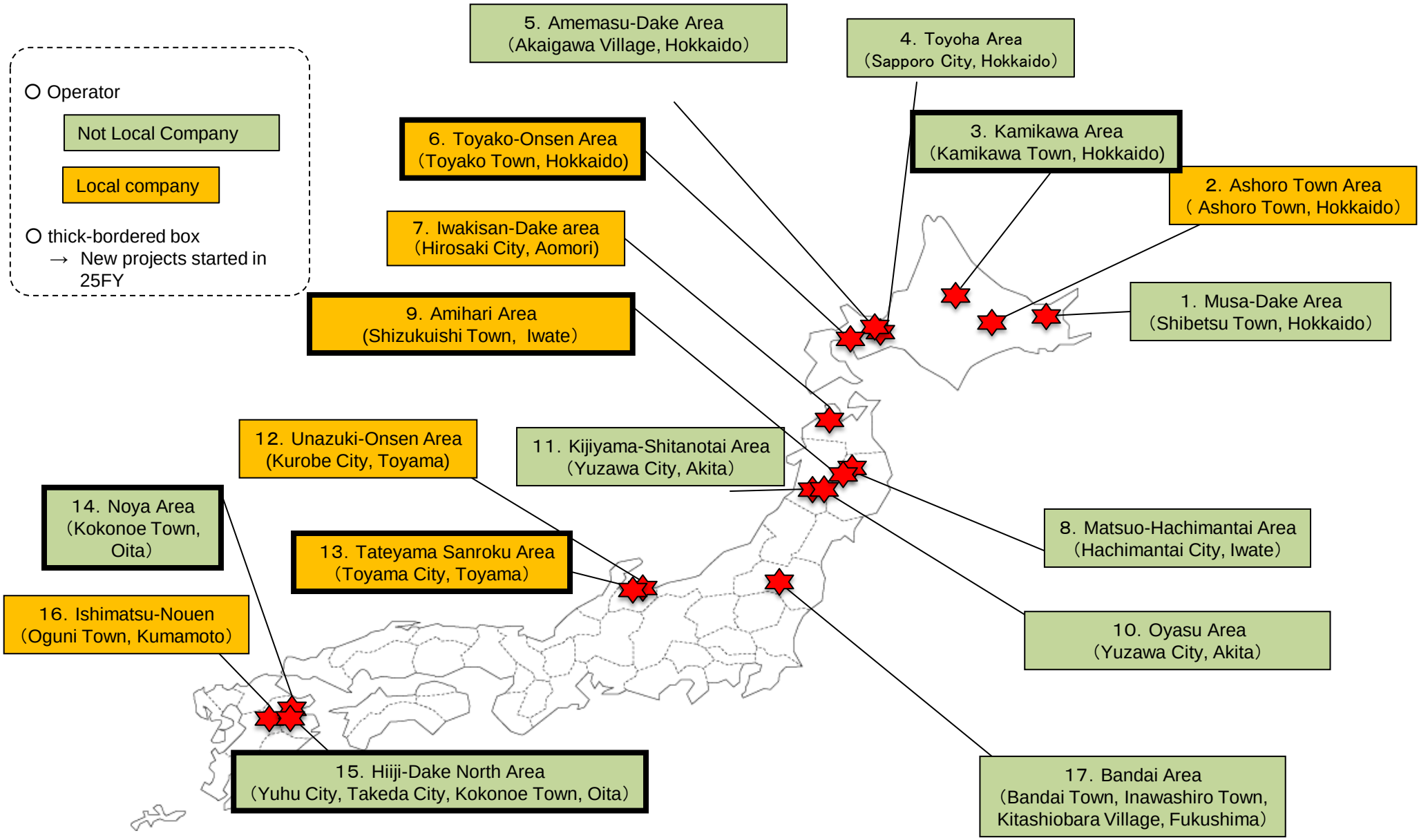
＜Snow melting by geothermal energy＞


○Lecture meetings for geothermal power

○Visit to geothermal power plants

→ 37 projects are subsidized.

# **Subsidy for** Geological survey
Budget(FY2013): \7.5 billion, Subsidy ratio: 50~100%

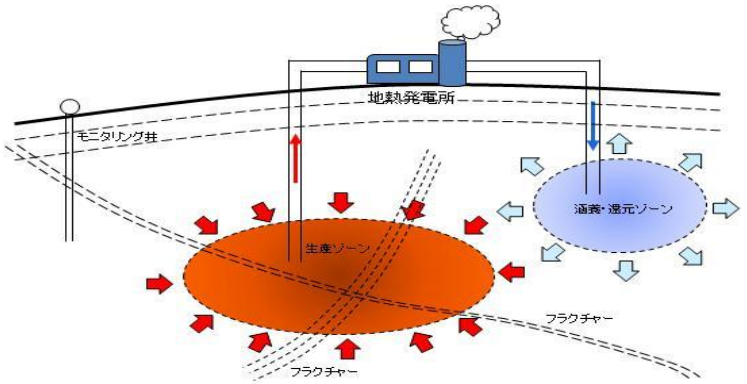


# 4. Governmental support （FY 2013 budget）

## ○Research and Development

Budget(FY2013): \0.95 billion, Subsidy ratio: 50~100%

-Techniques for searching for fractures
-Reservoir management technologies
-Environment-friendly and high performance power generating systems




## ○Shortening lead time

Budget(FY2014, now requesting): \3.37 billion, Subsidy ratio: 50%
-streamlining the procedure of environmental impact assessments (EIA)
(usually procedures take three to four years hence, reduce the period by half)

→Development of measures for environmental research of EIA in advance

# 4. Governmental support
## Feed-in Tariff Scheme started on July 1st, 2012

Act on Purchase of Renewable Energy Sourced Electricity by Electric Utilities
(Feed-in Tariff Scheme for Renewable Energy)

- This Act obliges electric utilities to purchase electricity generated from renewable energy sources (Solar PV, wind power, hydraulic power, **geothermal** and biomass) at the procurement price and for the procurement period.
- Approved at the 177th session of the Diet 2011 and started on July 1st, 2012.

| Energy source | | Solar PV | | Wind power | | Geothermal power | | Small- and medium-scale hydraulic power | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Procurement category | | 10 kW or more | Less than 10 kW (purchase of excess electricity) | 20 kW or more | Less than 20 kW | 15,000 kW or more | Less than 15,000 kW | 1,000 kW or more but less than 30,000 kW | 200 kW or more but less than 1,000 kW | Less than 200 kW |
| Cost | Installation cost | 280,000 yen/kW | 427,000 yen/kW | 300,000 yen/kW | 1,250,000 yen/kW | 790,000 yen/kW | 1,230,000 yen/kW | 850,000 yen/kW | 800,000 yen/kW | 1,000,000 yen/kW |
| | Operating and maintenance costs (per year) | 9,000 yen/kW | 4,300 yen/kW | 6,000 yen/kW | – | 33,000 yen/kW | 48,000 yen/kW | 9,500 yen/kW | 69,000 yen/kW | 75,000 yen/kW |
| Pre-tax IRR | | 6% | 3.2%(*1) | 8% | 1.8% | 13%(*2) | | 7% | 7% | |
| Procurement price per kWh | Tax inclusive (*3) | **37.80 yen** | **38 yen(*1)** | **23.10 yen** | **57.75 yen** | **27.30 yen** | **42.00 yen** | **25.20 yen** | **30.45 yen** | **35.70 yen** |
| | Tax exclusive | 36 yen | 38 yen | 22 years | 55 yen | 26 yen | 40 yen | 24 yen | 29 yen | 34 yen |
| Procurement period | | 20 years | 10 years | 20 years | 20 years | 15 years | 15 years | 20 years | | |

For your reference

# Regulations on geothermal development

1. Natural Park Act

Geological surveys and drillings for geothermal energy in national parks are restricted according to the protection zones.

2. Hot Spring Act

Drilling in pursuit of hot springs (hot water, mineral water, steam and other gas from underground) requires a permission of the prefectural governor.

3. Forest Law

Cutting down protected forests for constructing a base for drilling or a power generation plant requires delisting from protected status. Delisting requires a proven necessity for the public interest.

4. Act on Special Measures concerning Reform of National Forest Business Management

Constructing a base for drilling or a power generation plant in a national forest requires loaning. A national forest can be used for public use or within 5ha in area, otherwise it cannot be used.

5. The Environmental Impact Assessment Law

Constructing a power generation plant with output of 10,000kW or over requires EIA.
When constructing a power generation plant with an output of 7,500kW−10,000kW, the necessity of EIA is judged by project.

6. Electric Utilities Industry Law

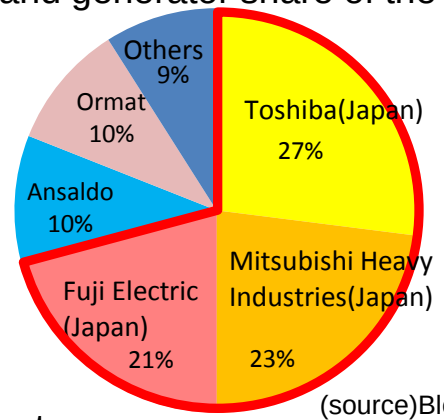
Power facilities requires placing chief engineers in charge of supervision of safety matters of construction work, maintenance and operation of the power facilities.

# Active participation in overseas projects

## ○Japan is the largest supplier of geothermal equipment

Toshiba Corporation, Mitsubishi Heavy Industries .,Ltd. and Fuji Electric Co.,Ltd. have supplied 70% of geothermal turbines and generators worldwide.

Turbine and generator share of the world




(source)Bloomberg

## ○Recent move toward plant construction and operation

Adding to turbines supply, Japan participates in the projects from the very initial stage.

| Area | Country | Japanese company | Schedule(planned) Operation starts | |
|---|---|---|---|---|
| Imperial Valley, California | USA | Fuji Electric Co.,Ltd. | in 2015 | IPP / 49MW |
| Sarulla, Sumatra | Indonesia | Kyushu Electric Power Co. ,Inc., Itochu Corporation | in 2013 | IPP / 330MW |
| Rantau Dedap, Sumatra | Indonesia | Marubeni Corporation | in 2016 | IPP / 220MW |
| Pathua, Java | Indonesia | Marubeni Corporation, Toshiba Corporation | in 2014 | EPC / 55MW |
| | | JFE Engineering Corporation | | Construction of steam supply facilities / 55MW |
| Muara Laboh, Sumatra | Indonesia | Sumitomo Corporation | in 2016 | IPP / 220MW |
| Rajavasa, Sumatra | Indonesia | Sumitomo Corporation | in 2016 | IPP / 220MW |
| Taupo | New Zealand | Sumitomo Corporation, Fuji Electric Co.,Ltd. | in 2010 | EPC / 140MW |

# Environmentally considered geothermal development（1）

Consideration for the view

## Examples of buildings

○Minimizing the impact to the view, by adopting comfortable and nature-matched colors to the buildings, along with planting trees in the area.

Uenotai Geothermal Plant
（Akita Prefecture）

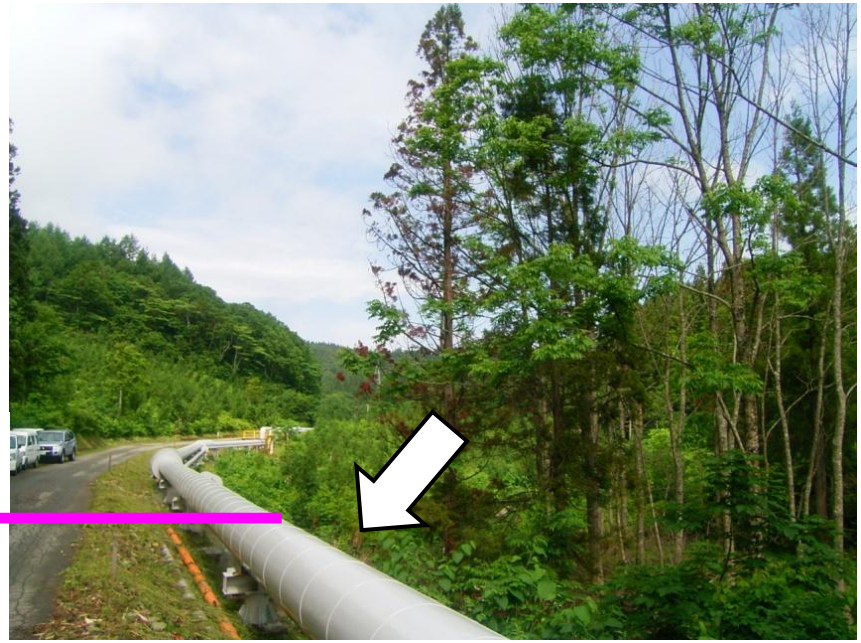
Kakkonda Geothermal Plant
（Iwate Prefecture）

Sumikawa Geothermal Plant
（Akita Prefecture）

# Environmentally considered geothermal development（2）

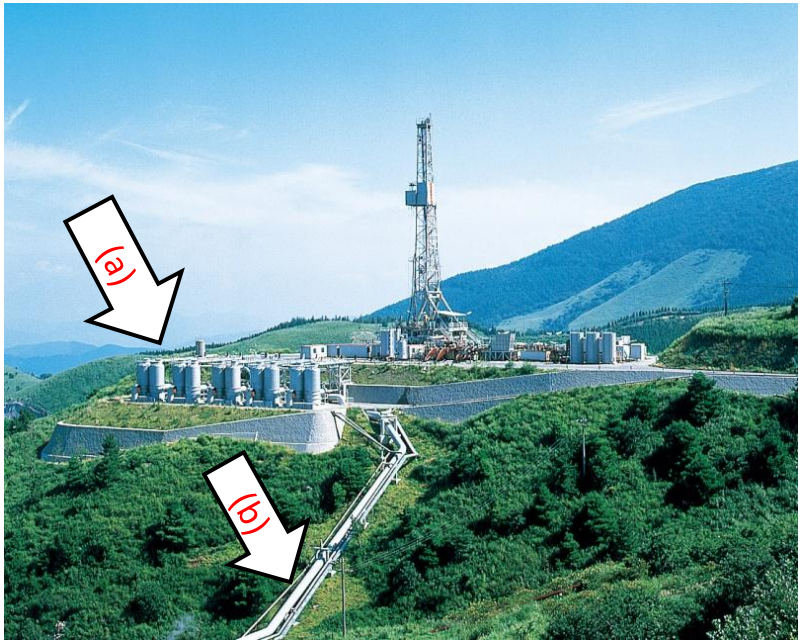
Consideration for the view

## Examples of buildings




○Uenotai Geothermal Plant

Adjusting pipes to the height of the road, not to ruin the scene.




○Hacchobaru Geothermal Plant (Oita Prefecture)

(a) Constructing silencers in a position lower than a base, not to ruin the scene.
(b) Adjusting pipes along the valley, hiding them with trees around.

# Environmentally considered geothermal development（3）

Consideration for the view

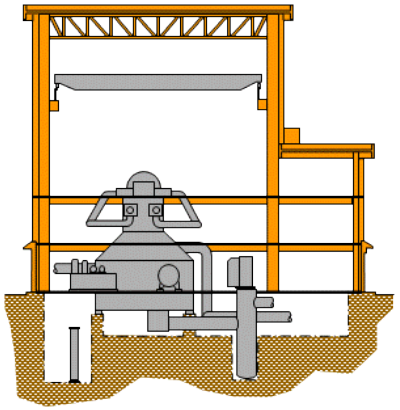
## Minimizing the height of buildings

- ○6 Geothermal plants were established before 1980 in Matsukawa, Kakkonda, Onikohbe, Ohdake, Hacchobaru and Ohnuma. These plants excluding Ohnuma installed turbines with downward exhausts.
- ○Later, turbines with upward exhausts were installed to make the overall height of the buildings lower.
- ○Recently, axial-flow turbine technology is being developed.

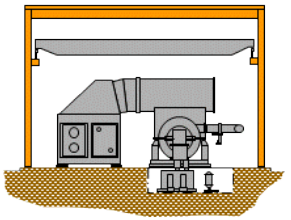
### Comparison of height by turbine types

| Type of turbine exhaust | Downward | Upward | Axial-flow |
|---|---|---|---|
| Height of turbine | High | Low | Low |
| Height of building (comparison in floor space index ) | High (100%) | Low (50%) | Low (35%) |
| An example of plants | Hacchobaru | Ohgiri | not yet |

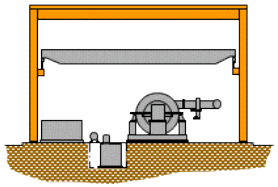
downward



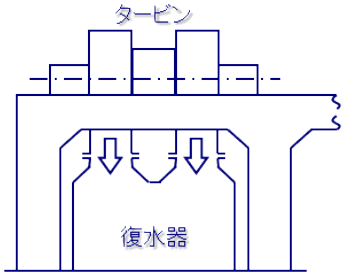
upward

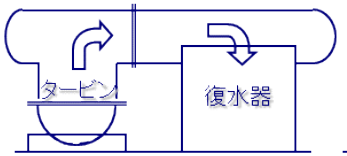


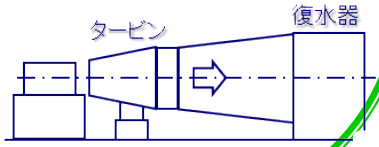
axial-flow



downward　upward　axial-flow



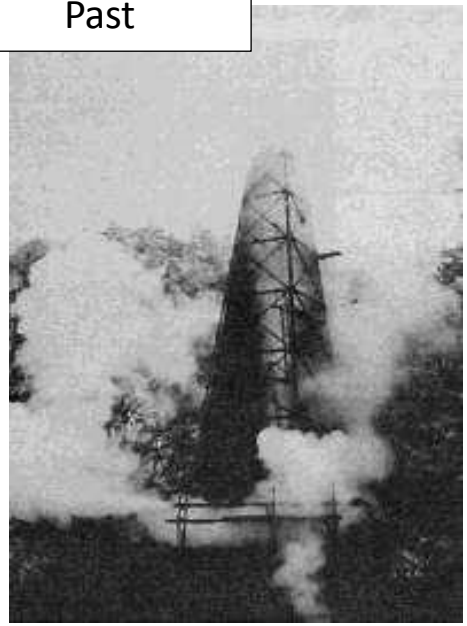

source：Fuji Eectric co., Ltd.

# Environmentally considered geothermal development（4）

Technology development

## Development in steam emission tests

Past



Picture: from materials of "Committee of Technology Developments considering the Environment" by Mr. Nakata of Geothermal Energy Research & Development Co. Ltd.

Afforesting after cutting down the affected trees (Ohnuma plant)
picture : from The Nature Conservation Society of Japan

○Steam with hot water caused noise, hot water scattering or icing damage etc.

Now

○Nowadays, dried steam comes out through separator, reducing noise, hot water scattering or icing damage.

# ⑤環境アセスメント調査早期実施実証事業

平成26年度概算要求額 33．7億円

【うち優先課題推進枠 33．7億円】

資源エネルギー庁 新エネルギー対策課
03-3501-4031
資源エネルギー庁 資源・燃料部政策課
03-3501-2773

## 事業の内容

### 事業の概要・目的

○風力・地熱発電の導入を加速化するため、3～4年程度を要する環境アセスメントの手続期間を半減することを目指すこととしています。

○その実現のためには、国や自治体の審査期間を短縮するだけでなく、環境アセスメントの手続における環境影響調査を前倒し、他の手続と同時並行で進めること（前倒環境調査）が必要です。

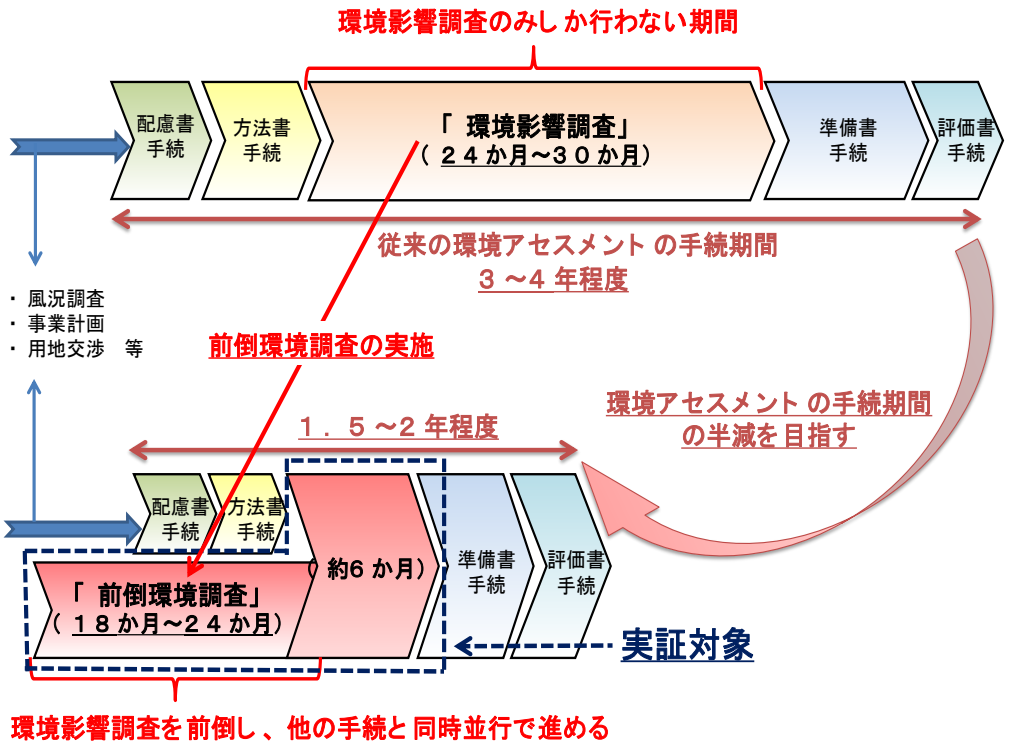
○そこで、本事業において、前倒環境調査を実施する上での課題等の特定・解決を図るための実証事業を集中的に実施します。

○これにより、前倒環境調査の方法論（調査項目の選定、地域との調整、調査手法の高度化等）の確立を目指します。

### 条件（対象者、対象行為、補助率等）


## 事業イメージ

＜前倒環境調査のイメージ＞




＜事業内容＞

①風力・地熱発電所の設置にかかる前倒環境調査の実証

②実証によって得られた環境調査結果のデータベース化

# Thank you for your attention!

Hidenori YONEKURA

International Affairs Office
Energy Conservation and Renewable Energy Dept
Agency for Natural Resources and Energy
Ministry of Economy, Trade and Industry(METI) of Japan

Email: yonekura-hidenori@meti.go.jp