R&D for Innovative Technologies Applied to Geothermal Exploration and Exploitation

Supercritical/Greater utilization/Environment preservation

Summary・Outcomes

Three Projects	Targets
Development of supercritical geothermal resource technology	To assess the supercritical geothermal resource amount, 100 MW or more for each region (500 MW or more in total) shall be proposed and feasible regions for survey well drilling shall be selected.
Development of environment preservation technology	To support the revision of the environmental assessment guide, new methods for environmental assessment shall be developed. Furthermore, proposals shall be made to reduce the time and cost required for surveys and analyses.
Development of geothermal power generation greater utilization technology	Targets are as follows: increase production volume, reduce costs, improve usage rates, etc. (10–20% each).

Status and Background

Status of Japanese geothermal resources and power generation worldwide

- While Japan ranks third in the world in terms of geothermal resource quantity (following the US and Indonesia), it ranks tenth in terms of installed capacity.
  - Not fully utilizing abundant geothermal potential.
- The installed capacity of geothermal power worldwide is rapidly increasing, with an annual average growth rate of 270 MW.
  - Significantly increasing in the US, Indonesia, Turkey, and Kenya.
  - Stagnating in the Philippines, Mexico, Italy, and Japan.

Installed capacity and electricity output of geothermal power in Japan

- Although installed capacity has remained almost unchanged since the late 1990s, the electricity output has declined.
- Causes: Decreased pressure of reservoirs, decreased permeability of reservoirs, inflow of low-temperature fluid into reservoirs, and aging of wells (decrease in production capacity due to scale deposition).

Contact Information Renewable Heat and Geothermal Power Generation Unit, Renewable Energy Dept, NEDO
https://www.nedo.go.jp/english/activities/activities_ZZJP_100198.html

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Social issues

High development risks and costs

Geothermal power is a baseload power source capable of stable electricity generation regardless of natural conditions. However, its development has not progressed due to development risks and costs.

Issue 1
The uneven distribution of resources in mountainous areas and the associated regulations

Issue 2
High initial development risks and the associated costs

Issue 3
Long development lead time

Technical Challenges

As a key initiative of NEDO aimed at achieving kW/kWh increases, R&D projects are focusing on three topics: ① Expanding geothermal resource potential ② Reducing costs ③ Promoting regional coexistence and environmental conservation.

Expanding geothermal resource potential	①Development of supercritical geothermal resource technology
Reducing costs ・Increased production ・Cost reduction ・Improved utilization rate	②Development of geothermal power generation greater utilization technology
Promoting regional coexistence and environmental conservation	③Development of environment preservation technology

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NEDO's Projects

Development of supercritical geothermal resource technology

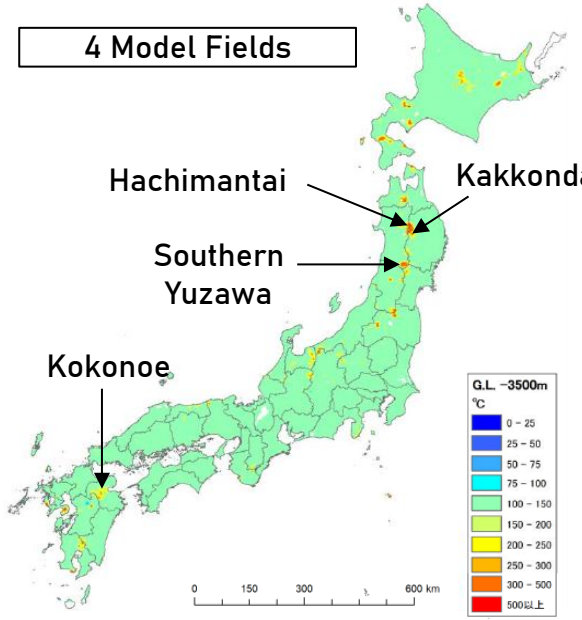
FY2021-2025

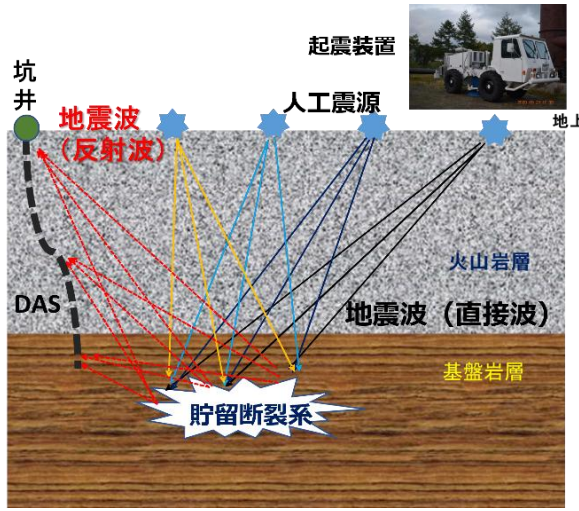
Resource amount assessment in the model fields

Four areas were selected where supercritical geothermal resources are expected to exist. In these model fields, resource amounts shall be assessed by the supplementary ground surface survey (e.g., microearthquake survey), physical property data collection, geological structure model/geothermal conceptual model building, production prediction simulation, etc.

Development of deep geothermal exploration methods

As an exploration method for supercritical geothermal reservoir imaging verification tests of elastic wave exploration, fiber-optic Distributed Acoustic Sensor (DAS) shall be conducted using conventional geothermal wells to develop highly precise fracture system exploration technology, even at greater depths than conventional wells.





Conceptual diagram Fiber-Optic DAS

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NEDO's Projects

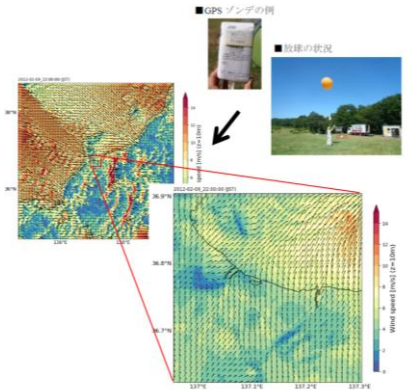
Development of environment preservation technology FY2021-2025

Development of a method to substitute meteorological survey and atmospheric dispersion prediction method

To reduce the time and cost for environmental assessment by 50% or more, a simulation method using a numerical weather model shall be developed. This method shall substitute conventional meteorological surveys and be applicable to mountainous areas, where most geothermal power plants are located.

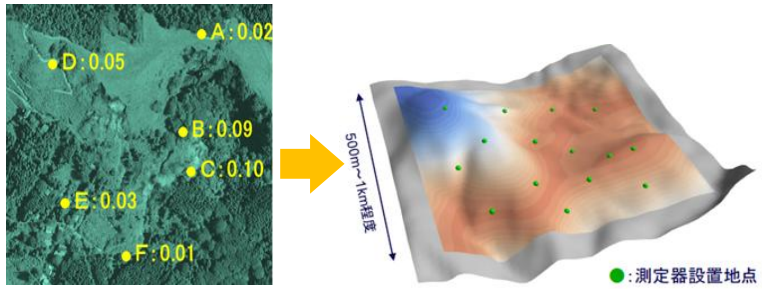
Development of IoT hydrogen sulfide monitoring system

Demonstration equipment using a constant potential electrolytic sensor shall be produced. After performance evaluation etc., a compact continuous measurement instrument with high time resolution and excellent portability was put to practical use. Measurement results from multiple stations shall be aggregated on the cloud using IoT so that real-time remote monitoring can be realized.



A weather model will substitute an on-site meteorological survey

地点	ppm
A	0.02
B	0.09
C	0.10
D	0.05
E	0.03
F	0.01



Remote real-time measurement

Plotting on topographic maps

Visualization of concentration distribution

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NEDO's Projects

Development of geothermal power generation greater utilization technology

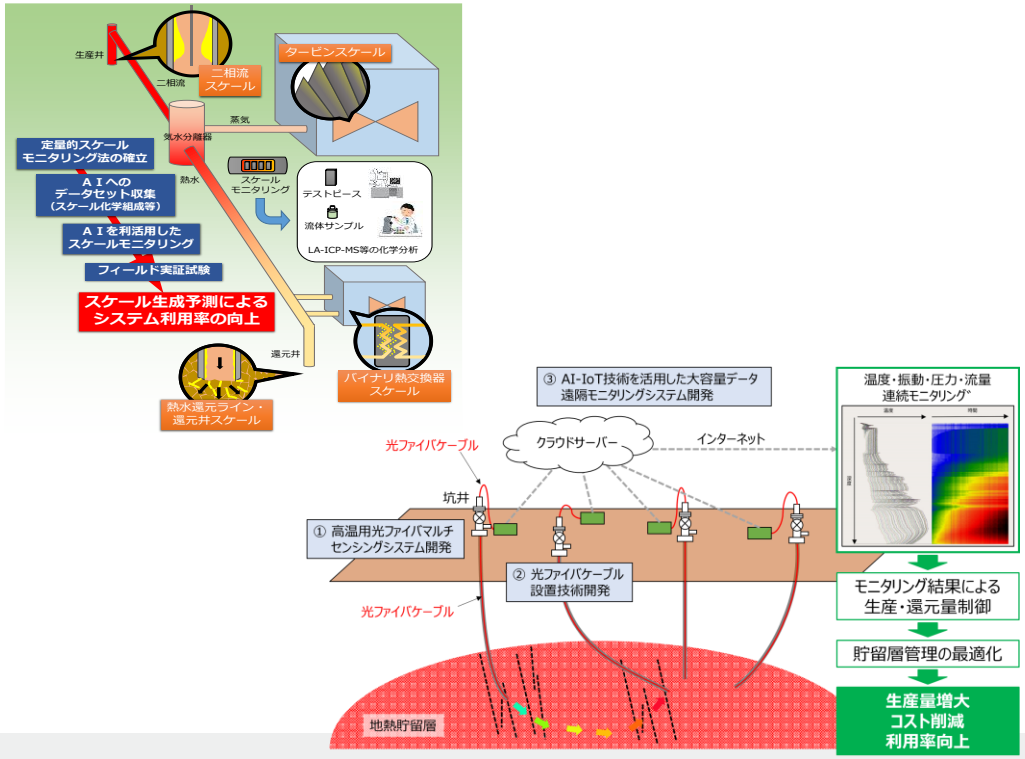
FY2021-2025

Development of a management method for power generation facilities

By aggregating data concerning facilities that are related to power generation, wells, and steam and managing the data on the cloud, effective and optimal operation and maintenance will be realized and the usage rate will be improved. Technology to predict scale formation with AI shall be established to take timely and adequate measures against problems caused by scale.

Development of a reservoir management method

Information on steam production fluctuations included in steam production data and undetectable by visual inspection shall be extracted using AI and statistical and mathematical techniques to presume the causes of production fluctuations.



NEDO Project R&D for Innovative Technologies Applied to Geothermal Exploration and Exploitation

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Prospects

In addition to " Conventional Geothermal" pursued through NEDO projects, also "Next-Generation Geothermal*" will be promoted to boost geothermal power generation. *Utilizing high-temperature/pressure fluids found at depths of 2 km or more below the surface.

Target Development Areas	Vision for 2040 and Beyond
<Conventional Geothermal> ➢ Areas currently under investigation and development ➢ Undeveloped areas within natural parks (special zones) and other locations with promising geothermal potential ➢ Potential areas where private companies face challenges entering due to factors (e.g., information access)	< Conventional Geothermal > ➢ Steady Expansion of power generation ➢ Further promotion of conventional geothermal development through nationwide deployment of development models in potential areas
< Next-Generation Geothermal> ➢ Development of wider range and greater depths ➢ Expansion into water and crack-free areas	< Next-Generation Geothermal> ➢ Increase in developable resource volume ➢ Early development and securing capacity

Source : Agency for Natural Resources and Energy https://www.meti.go.jp/shingikai/enecho/shigen_nenryo/pdf/043_03_00.pdf (Translated by NEDO)

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