Environment & Environmental Technology

Geothermal Electricity

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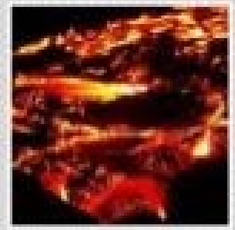
What is geothermal energy?

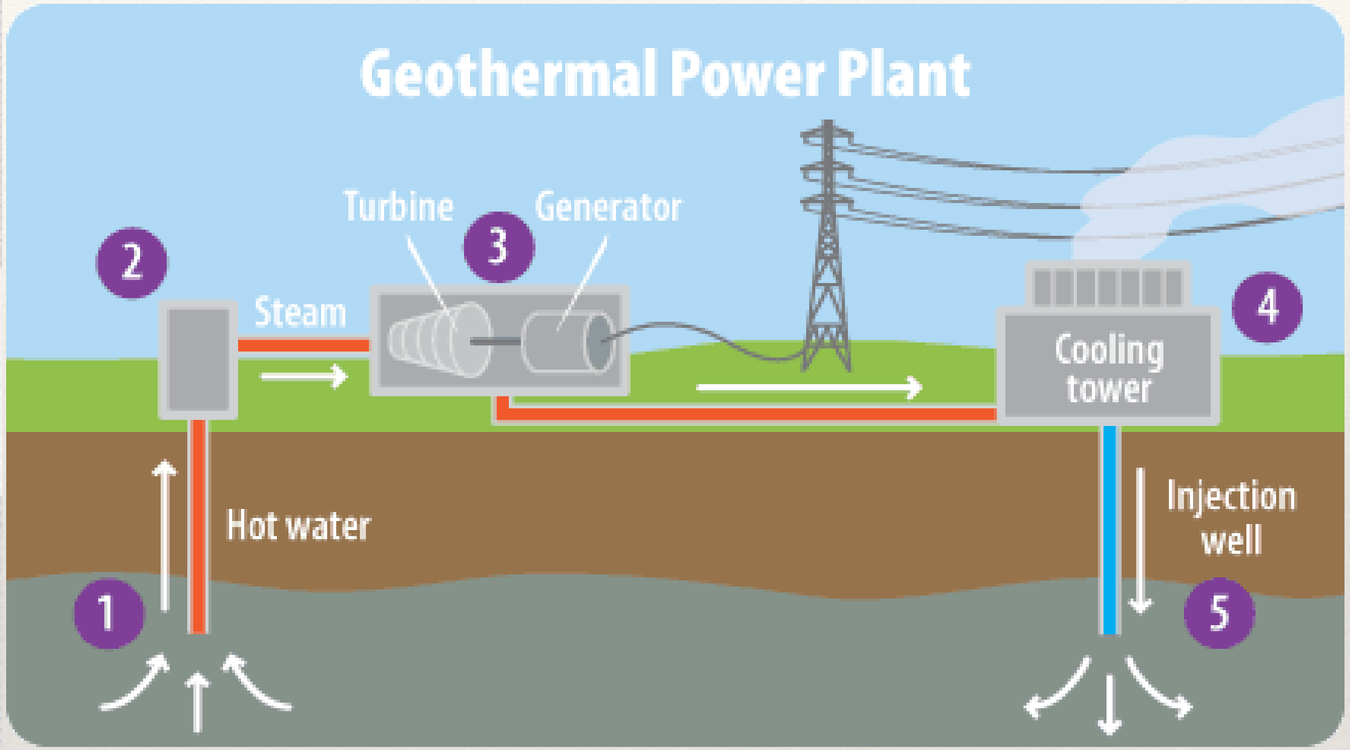


Geothermal energy is the thermal energy generated and stored in the Earth.

Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%)

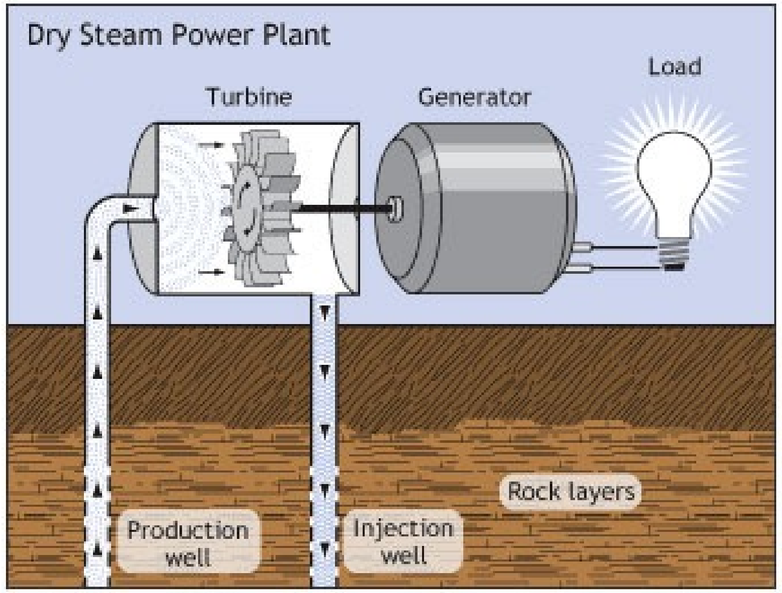
Geothermal power plants use the heat obtained from the earth's thermal energy

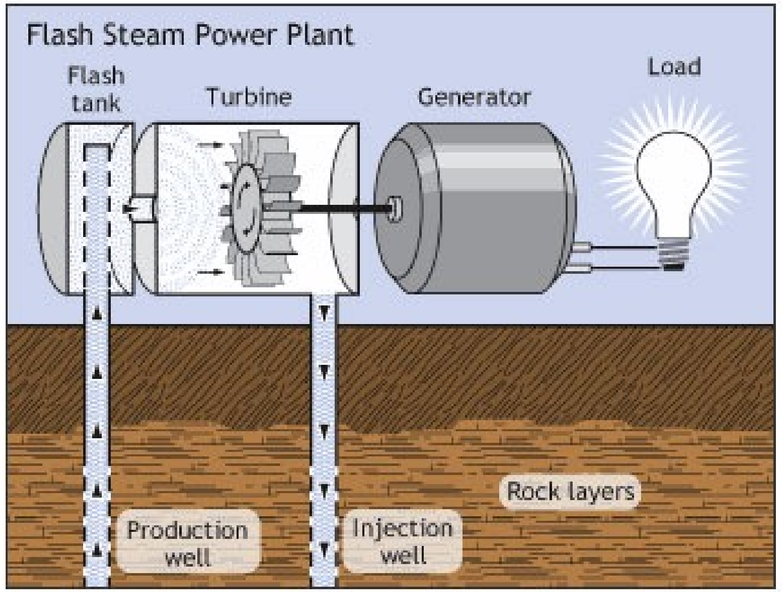
Inside a geothermal plant, the heat energy is used to heat water into water vapour and that rotates turbines, thus generating electricity

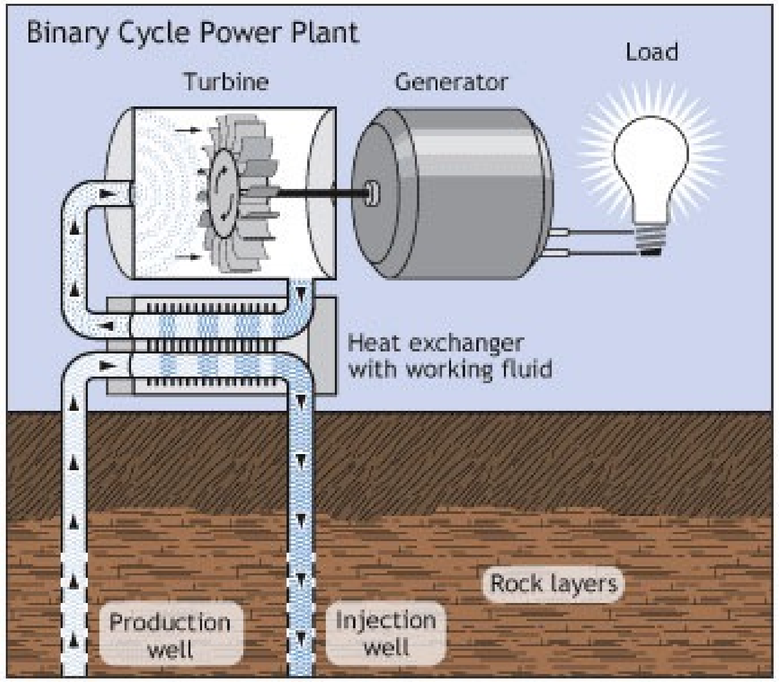


The Geysers Geothermal Complex, California, United States of America

Three types of power plants







<Dry Steam>

<Flash Steam>

<Binary Steam>

Pros VS Cons

Pros

- Almost entirely emission free
- Zero carbon
- The process can scrub out sulfur that might have otherwise been released
- No fuel required (no mining or transportation)
- Not subject to the same fluctuations as solar or wind
- Smallest land footprint of any major power source
- Virtually limitless supply
- Inherently simple and reliable
- Can provide base load or peak power
- Could be built underground

Cons

- Prime sites are very location-specific
- Prime sites are often far from population centers
- Losses due to long distance transmission of electricity
- Water usage
- Sulfur dioxide and silica emissions
- High construction costs
- Drilling into heated rock is very difficult
- Minimum temperature of 350F+ generally required
- Care must be taken to manage heat and not overuse it

Barriers:

- High initial capital costs and resource development risk.
- Low awareness and limited information about geothermal energy
- A shortage of trained geothermal scientists and engineers
- Perceived environmental issues (induced seismicity, subsidence, etc.).

Case study: Japan

Reasons:

1. Japan has high potential and technology for this;
2. Japan has the primary energy self-sufficiency ratio: 6.0% (2013) including nuclear;
3. Due to the nuclear accident, Japan got whose serious injuries.

A plant of “Kyushu Electric Power” at Indonesia

Potential: electricity supply

Recoverable reserves = 23 million kW ... (1),
= 23 million kW × 24h/d ×365d
≃ 201.480 billion kWh ... (2),

[Note]
1. Japanese FY2014
2. Significant figure: 3digits

Total supply: 893.61 billion kWh ...(3),
Total consumption: 823.0 billion kWh ... (4),
∴ Loss energy = (893.61 - 823.0) ÷ 893.61 [billion kWh]
= 7.907% ... (5) ‖
The past most peak demand of a day: 183 million kWh ... (6),
∴ Total ratio: (201.48 - 201.48 × 0.07907) ÷ 823.0 [billion kWh]
= 22.545% ... (7),
The most peak ratio: (23 – 23 × 0.07907) ÷ 183 [million kW]
= 11.575 ...(8) ‖

Environmental impact: CO_2 reduction effect

In addition to formulas (4) and (7),

CO_2 emissions from electricity: 45.7 million t-CO2/FY ... (9)

Japan could mine all of geothermal resources, and electrify it at Japan.

The CO_2 reduction effect: 45.7× 0.22545

= 1,303.65 [million t-CO_2 /FY] ... (10) ||

Investment analysis 1/3

An example: “KYUSHU ELECTRIC POWER CO. INC.”

Reasons:

1. The company began a business to mine geothermal resources from 2013, and sale the electricity from 2016 at Indonesia;
2. Japan has few cases of geothermal business internally on account of the legal prohibitions.
3. The company would succeed in a business at Indonesia, which will be an example for Japan.

Investment analysis 2/3

Date:

1. Initial investment cost: ￥100 billion
2. Investment ratio: 25%
3. Scale: 320.8MW and 30 years
4. Return ratio: 40%
5. Indonesian electric charge: 773 rupiah/kWh = ￥6.8/kWh
6. Interest rate: 1.10%/FY (“MIZUHO Bank”)
7. Government subsidy: Deducting from objects of taxation:
    (1) Investment: 30%
    (2) Total sales: 10%
    (3) Profit move tax rates:10%

Investment analysis 3/3

Calculations:

1. Return = (320,800kWh × ¥6.8/kWh × 0.4× 30years × 1.1
   + Investment: ¥100 billion × 0.1)
   = ¥99,931,260 ... (11).
2. PV = ¥ - 47,727,273 < 0 ... (12),
3. IRR 13% > Interest rate: 1.1% ... (13)

∴ The company is worth conducting this business.

Conclusions

1. Geothermal Electricity has high potential for electricity supply, and zero emissions.
2. A business of developing geothermal resources have a profitable condition which is enough to invest.
3. As soon as possible, Japan and the other volcanic zone countries should develop the geothermal resources to achieve 3E+S:

    Energy secure +

    Environment +

    Economic growth +

    Safety

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THANK YOU FOR YOUR ATTENTION.