2011 Asia Pacific Clean Energy Summit & Expo

Geothermal Energy in Japan

1. Geothermal power generation

2. Geothermal heat pump systems

Thursday, Sept. 15, 2011; 10:30 a.m. – 12:00 noon

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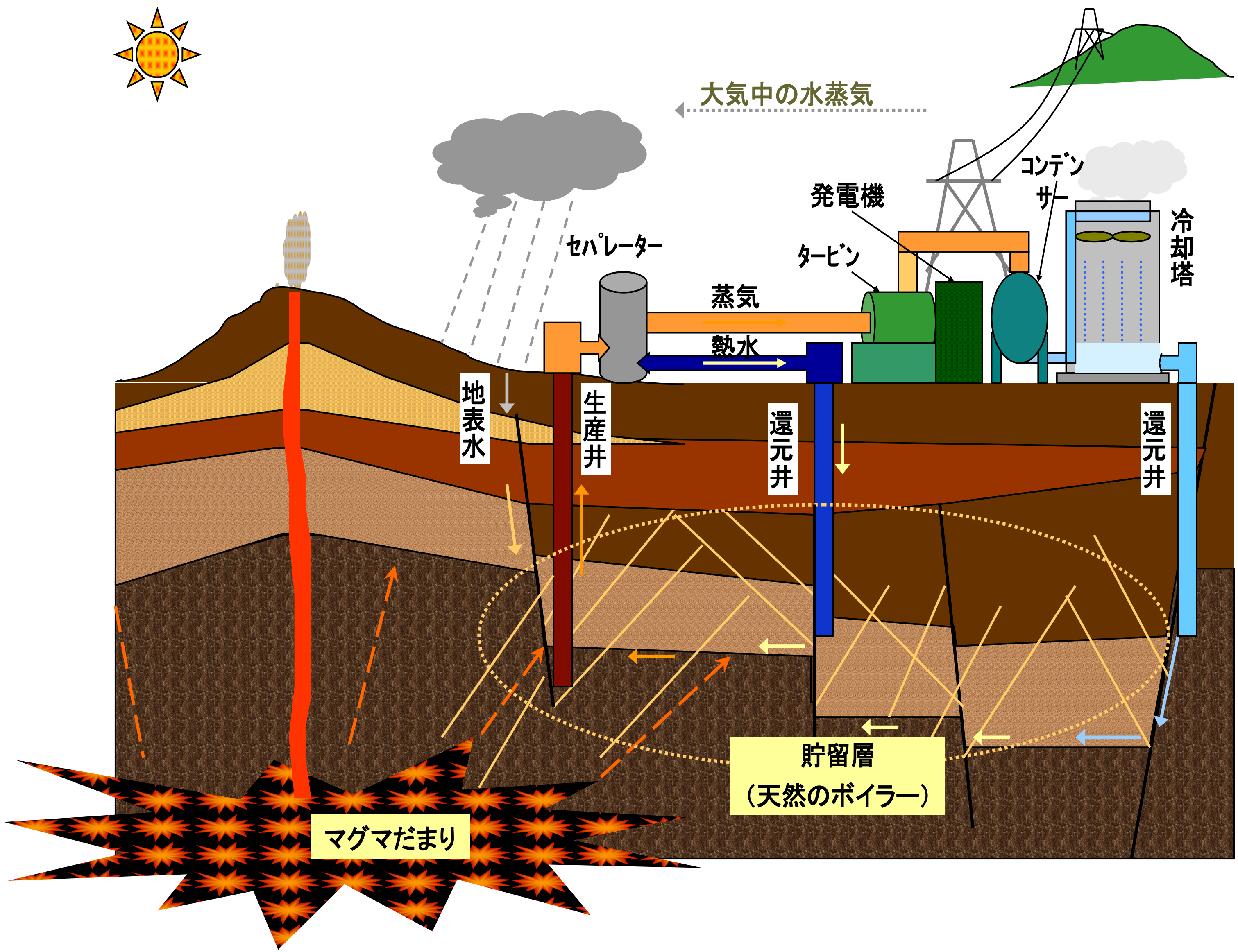
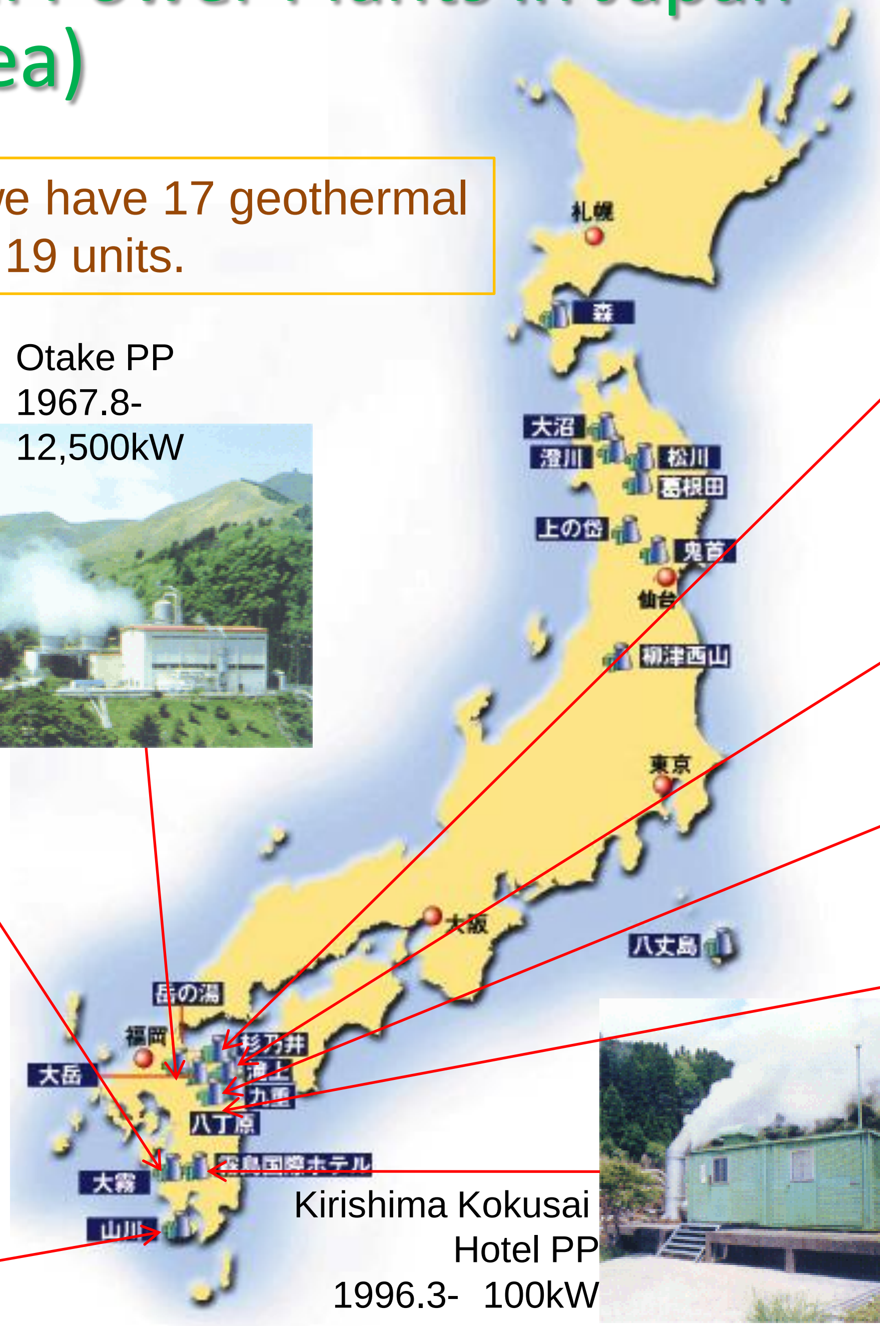
1. Geothermal power generation



Geothermal Power Plants in Japan (Kyushu Area)

In whole Japan, we have 17 geothermal power plants with 19 units.



Ogiri PP
1996.3-
30,000kW

Otake PP
1967.8-
12,500kW

Yamagawa PP
1995.3-
30,000kW

Suginoi GPP
1981.3-
3,000kW

Takigami PP
1996.11-
25,000kW

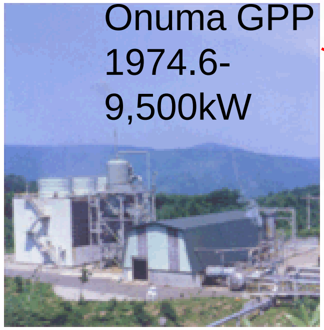
Kuju GPP
1998-
900kW

Hatchobaru PP
Ⅰ.1977.6-
55,000kW
Ⅱ.2000. 6-
55,000kW

Kirishima Kokusai
Hotel PP
1996.3- 100kW

Geothermal Power Plants in Japan (North-Eastern Area)

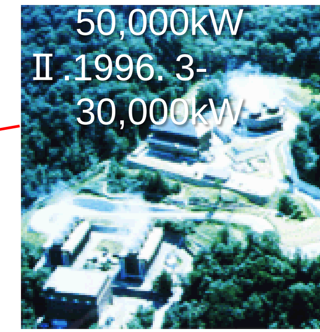

Mori GPP
1982.11-
50,000kW

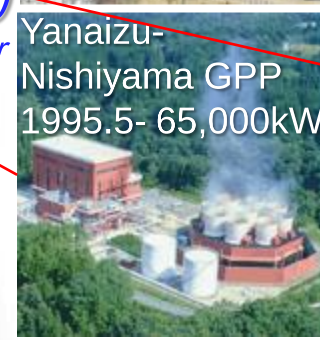

Onuma GPP
1974.6-
9,500kW

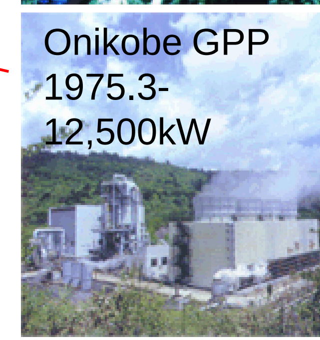
Sumikawa GPP
1995.3-
50,000kW

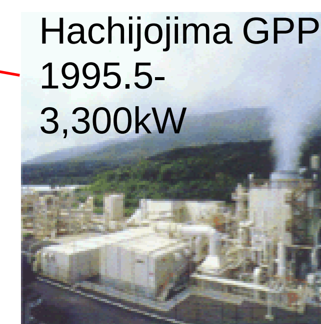

Uenotai GPP
1994.3-
28,800kW


Matsukawa GPP
1966.10-
23,500kW

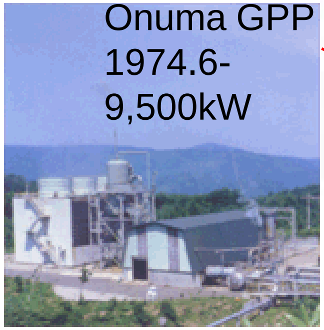

Kakkonda GPP
Ⅰ.1978.5-
50,000kW
Ⅱ.1996. 3-
30,000kW

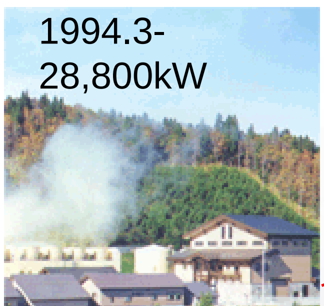

Yanaizu-Nishiyama GPP
1995.5- 65,000kW

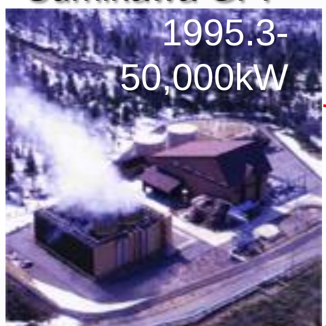

Onikobe GPP
1975.3-
12,500kW

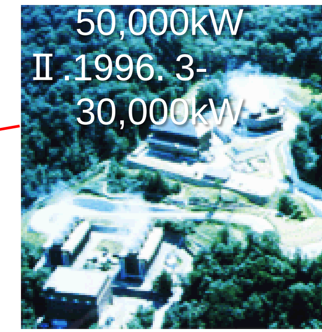

Hachijojima GPP
1995.5-
3,300kW

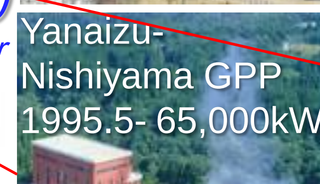
Geothermal Power Plants in Japan (North-Eastern Area)

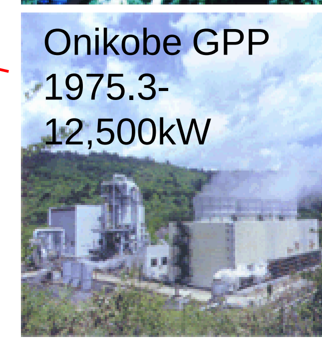












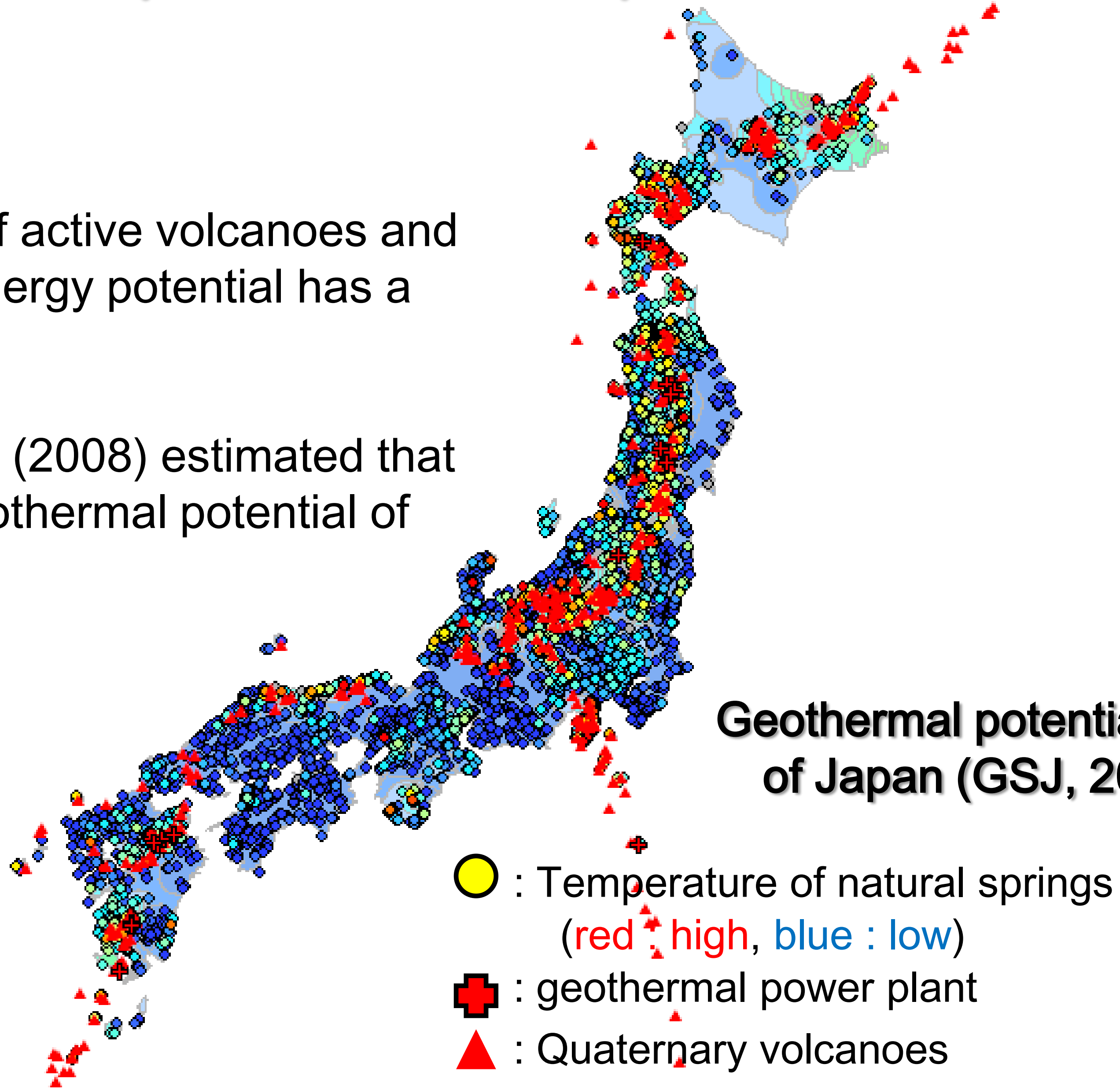
All GPPs affected by the earthquake on the 11th March 2011, recorded M9.0, are providing the same levels of power as before the event. Many of them automatically “tripped,” cut-off the power line to the grid, right after the event, but continued generation in the plants. The power line recovered in a few hours or in a few days.

Reliability of geothermal power plant is proved by this event.
Domestic power use in a geothermal power plant (and its surroundings if connected without national grid) is guaranteed.

Geothermal potential in Japan

The number of active volcanoes and geothermal energy potential has a linear relation.

Muraoka et al. (2008) estimated that Japan has geothermal potential of **23,470 MW_e.**



Geothermal potential map of Japan (GSJ, 2009)

Japan as a "big 3" of geothermal potential countries…

Number of active volcanoes & geothermal energy potential

(Muraoka et al., 2008)

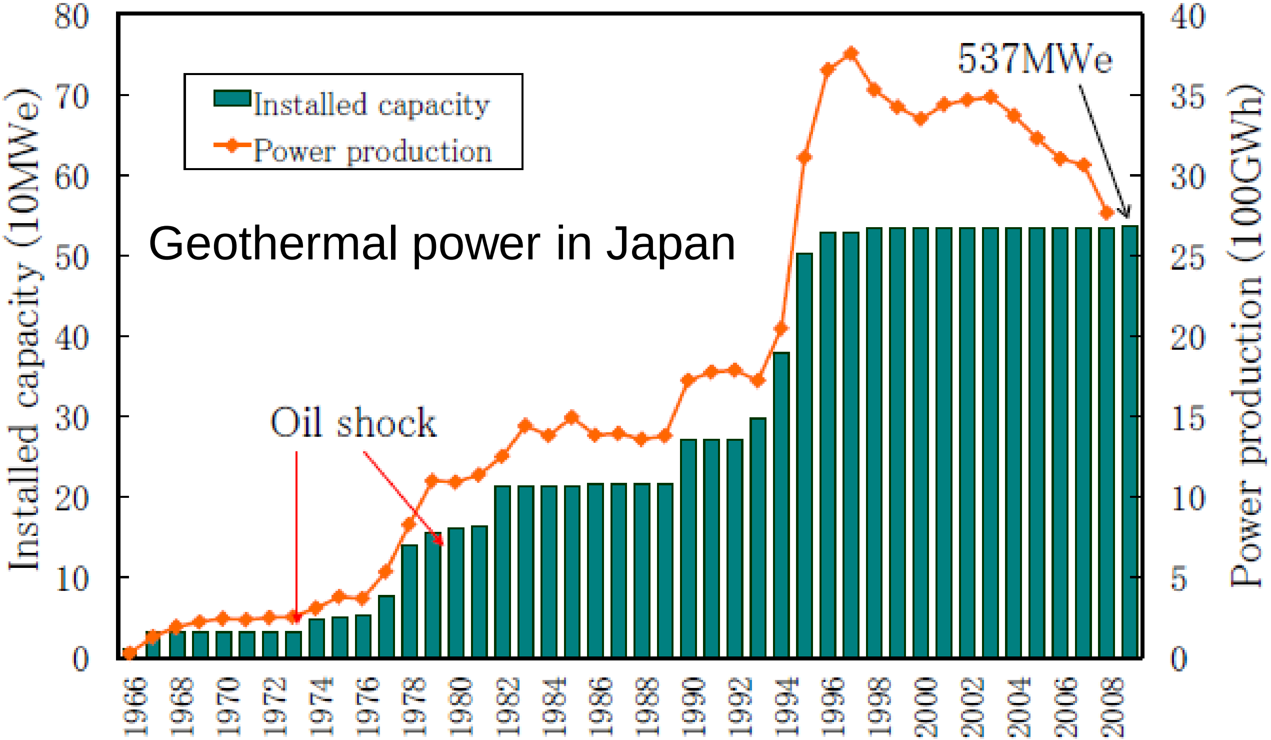
Country	No. of active volcanoes	Geothermal potential (MWe)	Geothermal Power generation on 2010 (GWeh)
USA	**160**	**30,000**	**16,603**
Indonesia	**146**	**27,790**	**9,600**
Japan	**119**	**23,470**	**3,064**
Philippines	47	6,000	10,311
Mexico	39	6,000	7,047
Iceland	33	5,800	4,597
New Zealand	20	3,650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

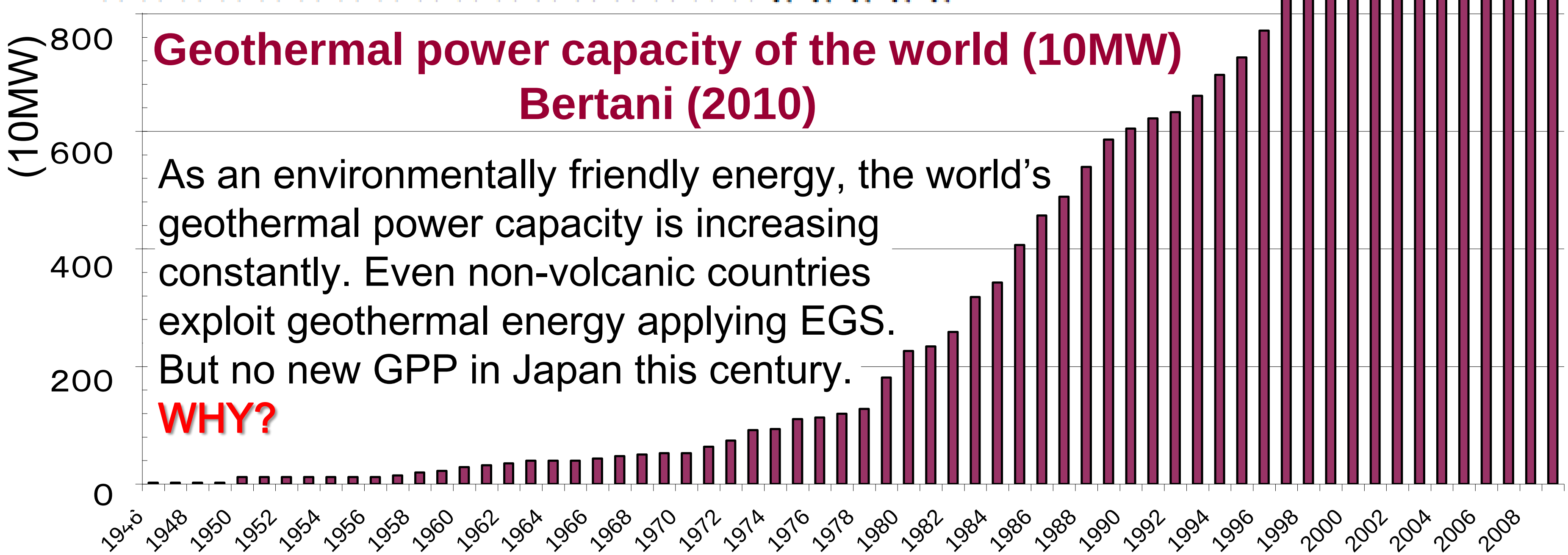
Geothermal potential in this table is an estimated value from heat energy stored at a depth of geological basement or shallower.

Japan is the world's 3rd largest geothermal potential country,

but its power generation is merely No. 8 in the world…… Why?

Again, why?





As an environmentally friendly energy, the world's geothermal power capacity is increasing constantly. Even non-volcanic countries exploit geothermal energy applying EGS. But no new GPP in Japan this century. **WHY?**

The official reasons why there is no new GPP in Japan

Many geothermal colleagues say the problems are;

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

*Average geothermal cost /kWh in Japan is 20 yen (27 cent) while 5-15 cent in the world (IPCC, 2011)

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

--- but, are they the real reasons?

At least 1. and 3. can be changed by regulations…

Why these things haven't been improved?

The <u>real</u> reason why there is no new GPP in Japan

Strong points of geothermal power

Stable power & High operating rate

Not depending on weather

Low CO_2 emission

Hydro (11), **Geothermal (13), Nuclear (20),** Wind (24), PV (38), LNG (474, 599), Oil (738), Coal (943) g-CO_2/kWh (CRIEPI, 2010)

High energy return (generated power/used energy)

Hydro (50), **Geothermal（31）, Nuclear (24),** Oil(21) , Coal (17)

All these strong points are common virtues as nuclear power (although GPP is slightly better). Therefore, under the political “trust” in nuclear power, lows and regulations which are unfair for geothermal development have not been improved, which made geothermal cost higher or impossible to develop, while other nations give incentives to geothermal developments.

Recent movement especially after 3.11….

1. National Parks

For geothermal power as a low CO_2 emission energy source, the Ministry of Environment (MOE) decided to allow directional drilling toward national parks from outside site (June, 2010). In September 2011, MOE gave a drilling permission inside a national park for a scientific research by AIST.

3. Cost

The Energy Agency of METI, the cabinet office, etc., have began un-official investigation on which lows and regulations delay geothermal development and make generation cost higher and on what kind of incentives are needed. Private sectors (non geothermal companies) also seem to be interested in geothermal businesses, after 3.11.

“Harmonious utilization with hot spring resources” project

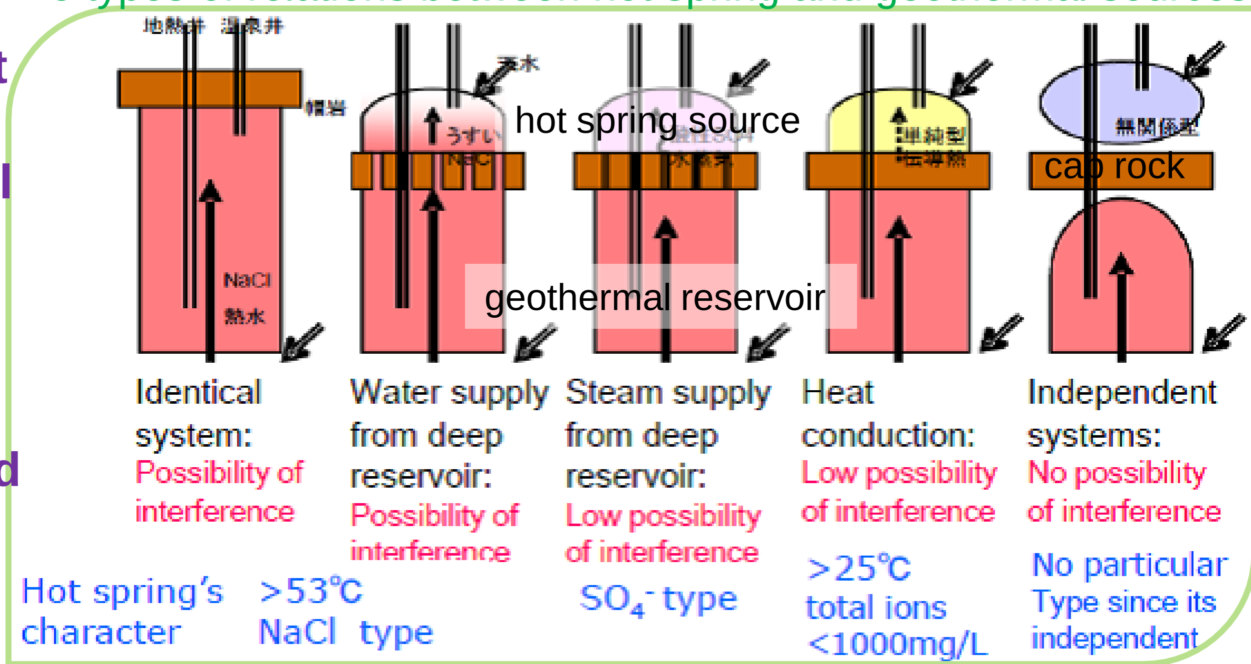
2. Hot springs

The only social problem that cannot be solved by laws and regulation:

Logically there should not be an interference if ;

- **the amounts of natural heat & fluid recharges and utilization are well balanced, or**
- **there exist a caprock between hot spring and geothermal reservoirs.**

5 types of relations between hot spring and geothermal sources



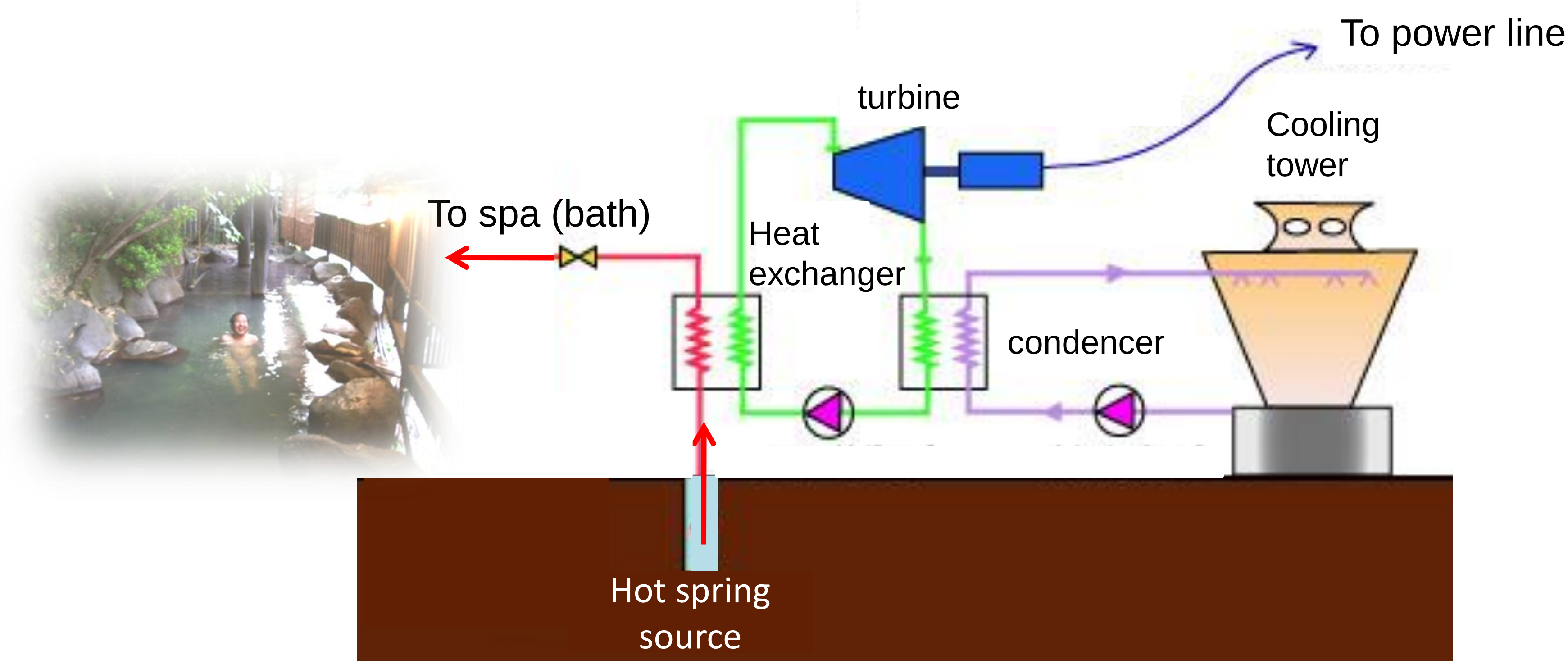
In order to prove this for model fields, AIST began a 3-year research project in 2010, consists of the whole system modeling, monitoring, and judgment of interference.

For sustainable use of the both hot springs and geothermal reservoirs, scientific investigation of the whole system is essential.

Another way for “Harmonious utilization with hot springs”;

“Hot spring power plant” project

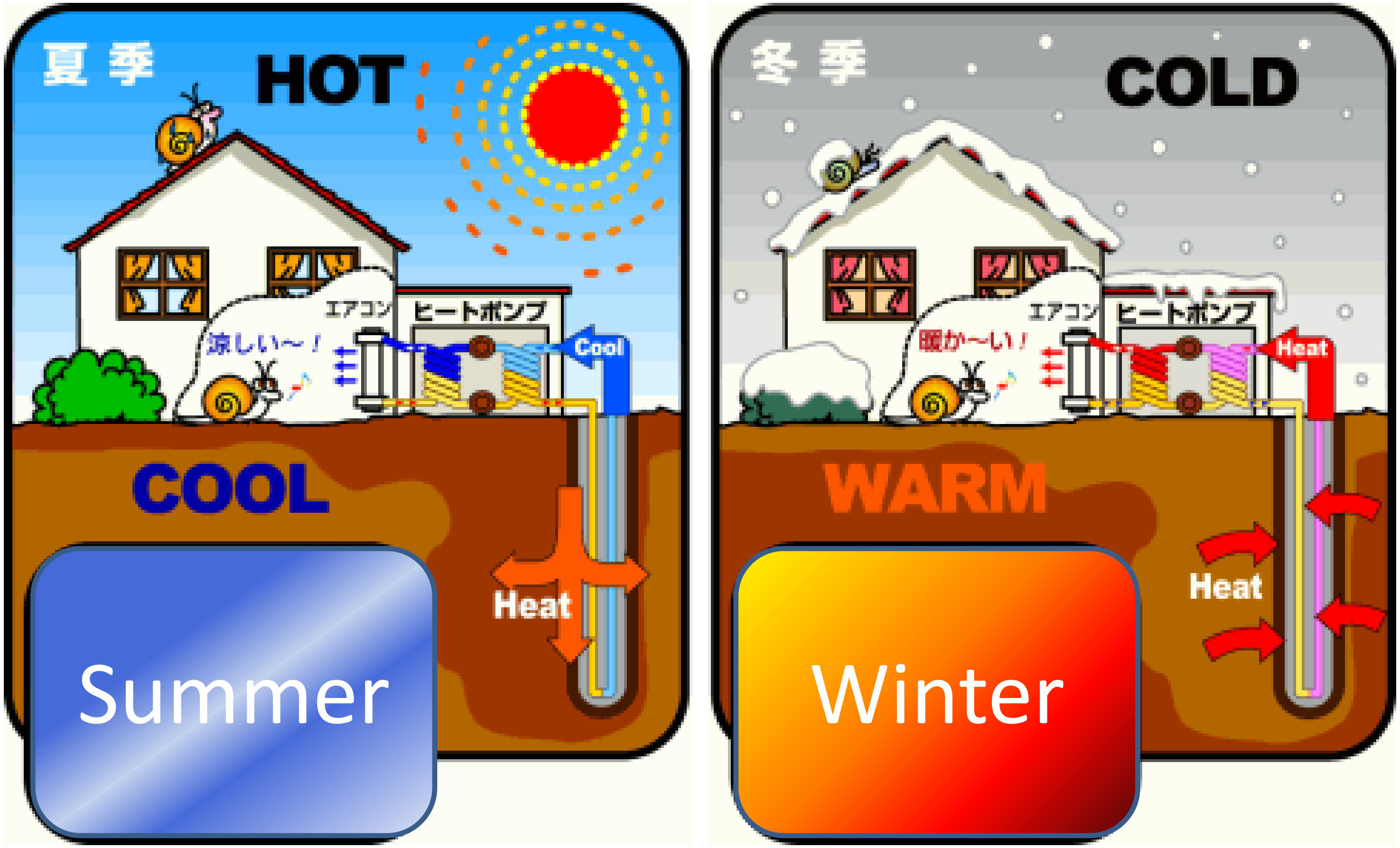
Low temperature binary system



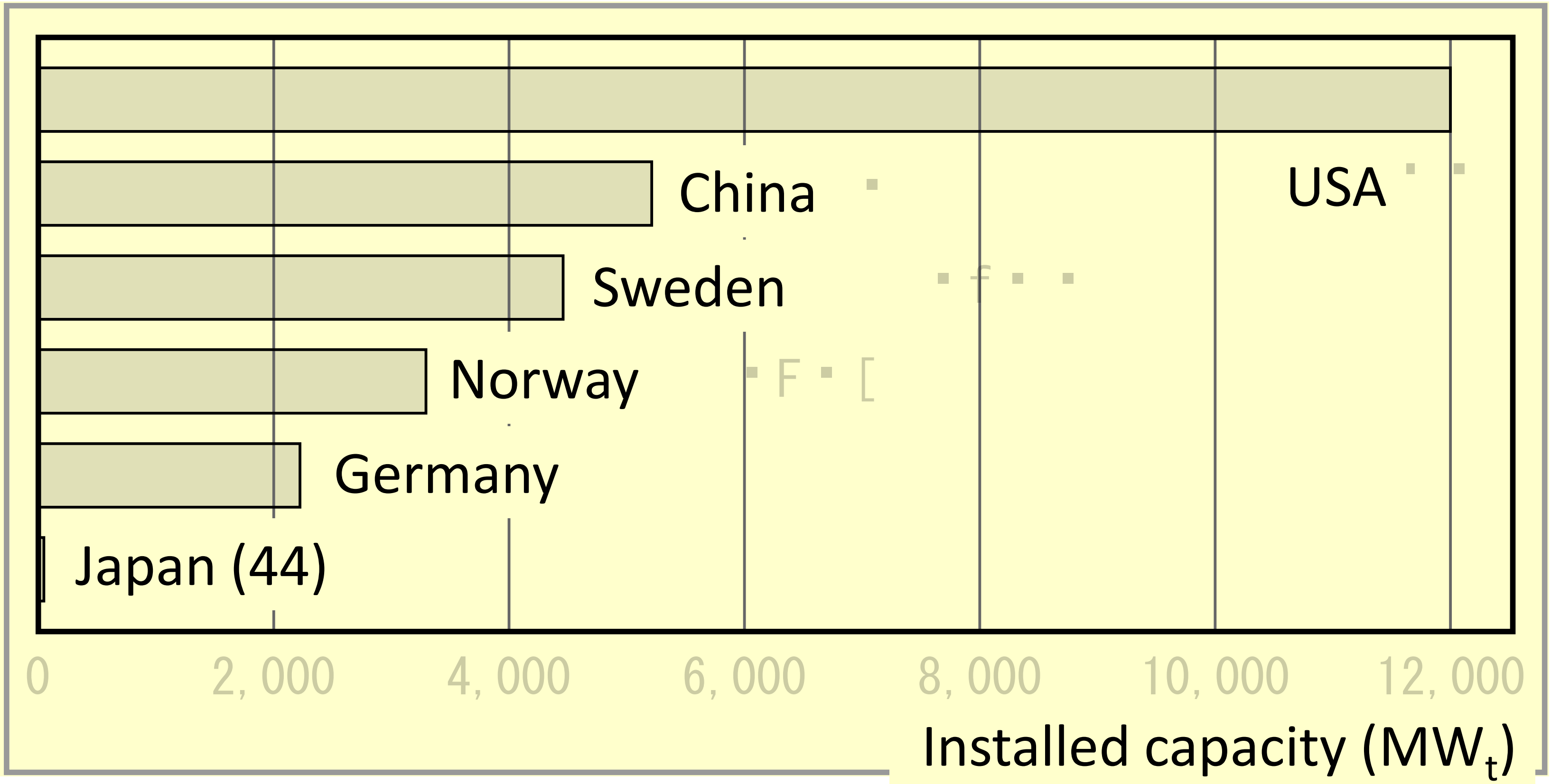
A Kalina cycle, which uses mixture of water and ammonium as the second fluid, enables power generation by ~85 C water. Hot spring owners may have small scale binary plants for their own use. AIST makes a model plant in Niigata.

It’s good for local energy security in case of emergency such as earthquake!!!

2. Geothermal heat pump systems

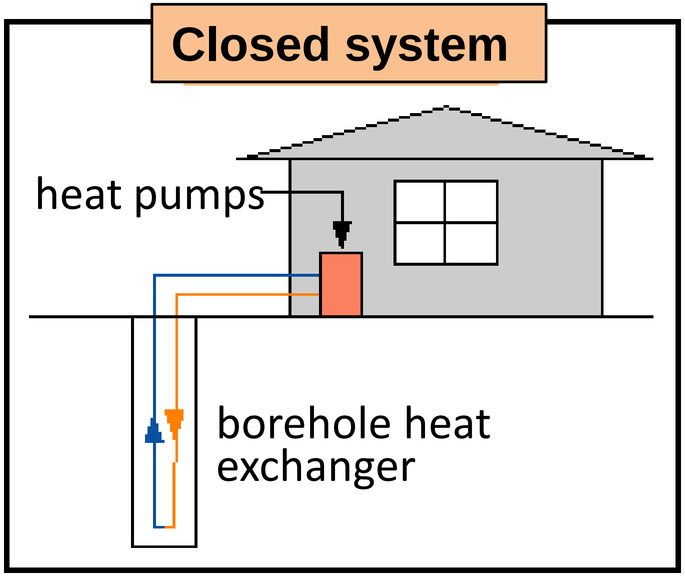


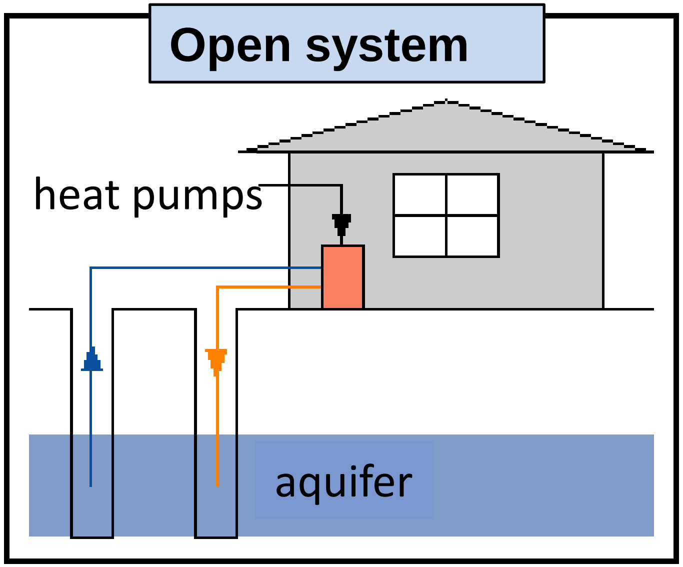
Installed capacity of geothermal heat pump systems of the world (Lund, 2010)



12,000MWt (USA) is equivalent to a million installations of 12kWt systems.
The total number of installations in Japan by 2009 is merely 580 (MOE, 2010).
WHY? People just haven't known about it and installation cost is still very high.
MOE and METI began giving incentives to geothermal heat pumps recently.

Closed system and Open system





Closed system (borehole heat exchanger)

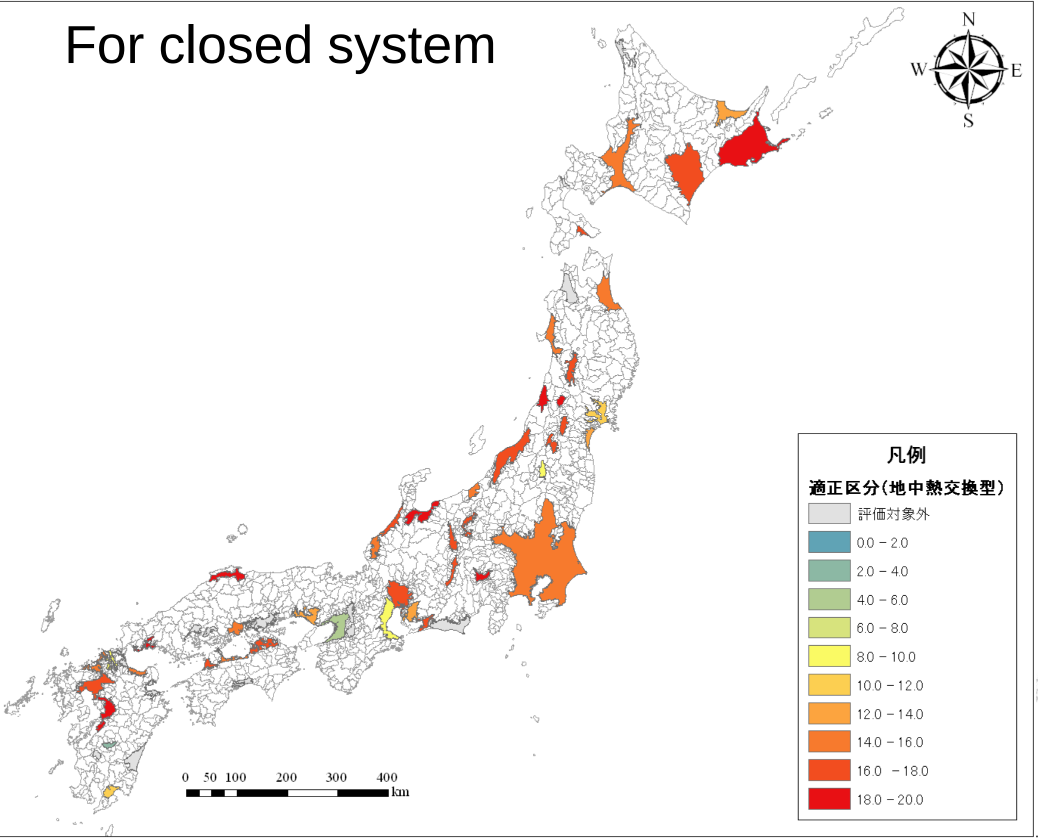
- may be used everywhere
- has different heat exchange rate according to the heat conductivity of the ground.

Open system (using groundwater)

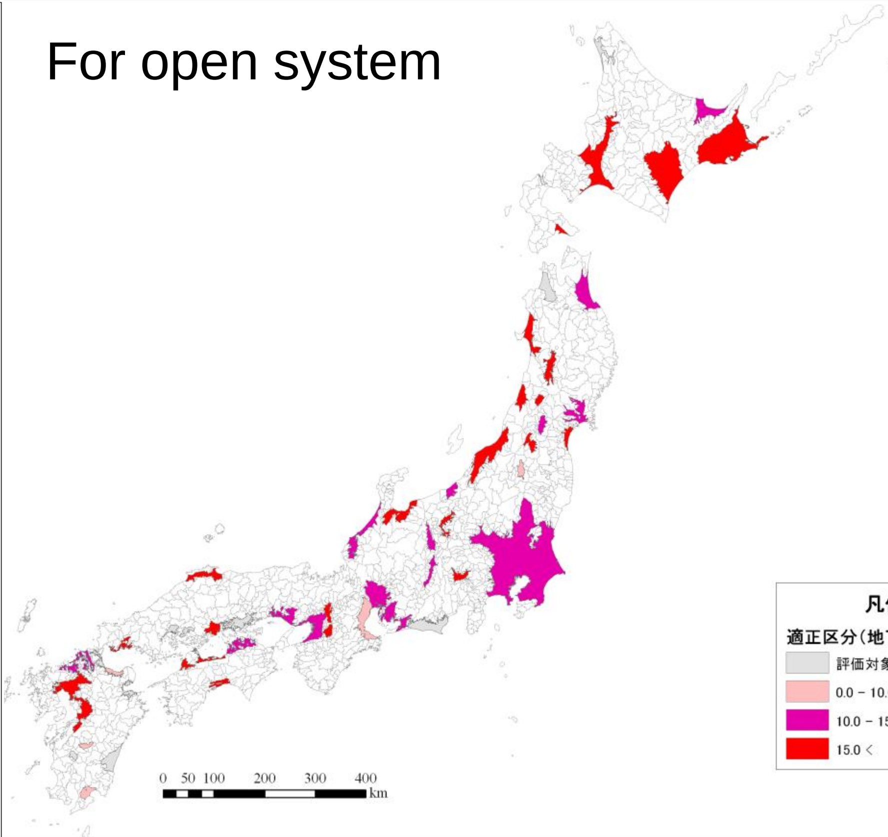
- may not be used if there exist legal restriction for water protection.
- requires aquifer existence. Shallower aquifer is preferred.
- may not be economical for a small system because initial cost may be high.
- has high heat exchange rate: low running cost.
- economical if the conditions are suitable.

Research project by AIST: Mapping of suitability of ground-coupled heat exchange systems

For closed system

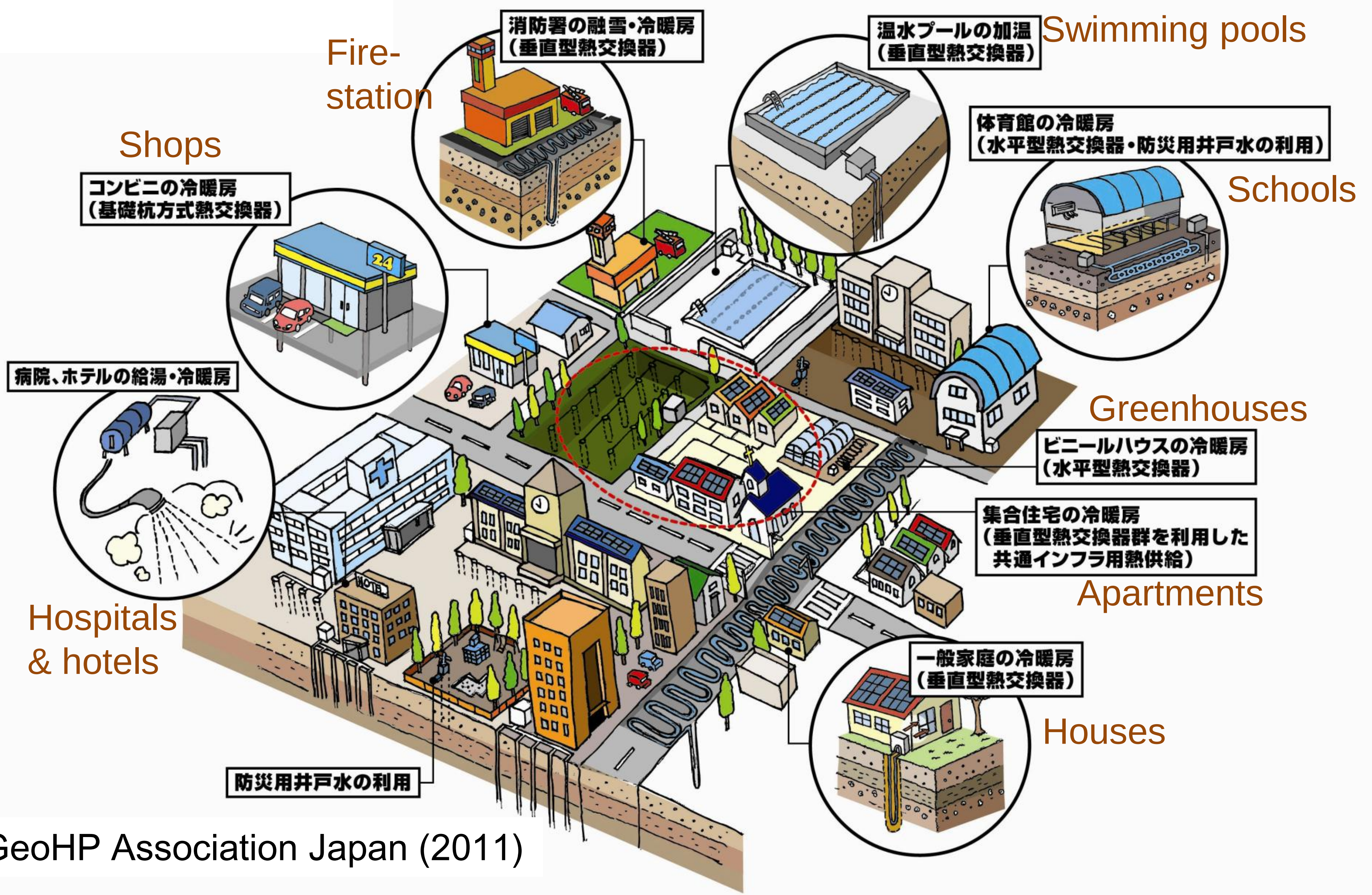


For open system



Using integrated hydro-geological information, index parameters (permeability, aquifer depth, groundwater flow rate, etc.) were evaluated for 62 Groundwater basins. Based on these index parameters, suitability of open and closed systems for each basin are indicated in these maps

Smart Community with Geothermal Heat Pumps
- for recovery from disaster, by saving energy -



GeoHP Association Japan (2011)