



Geothermal energy in Finland

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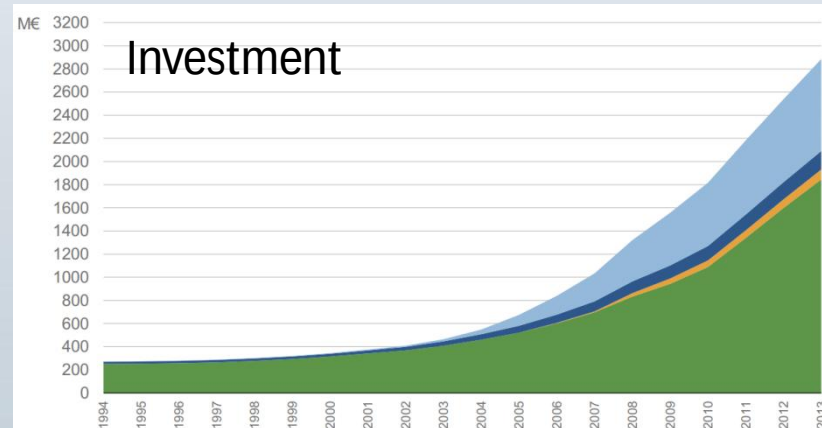
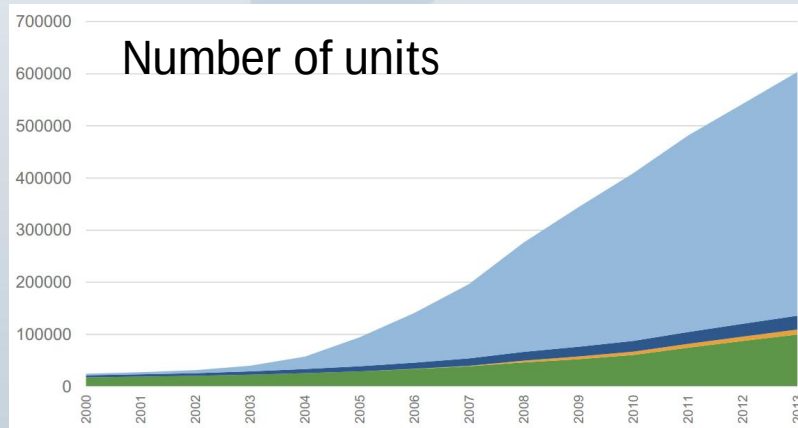
■ VTT Technical Research Centre of Finland

- A multitechnological research organisation providing high-end technology solutions and innovation services, largest applied research organisation in Northern Europe
- Founded in 1942 with a mission to practice scientific, technological research
- Main purpose was to support Finnish industry and public decision making, currently very much involved in international research activities
- Research portfolio includes bio economy, low carbon economy, clean environment, digital world, resource efficiency, health and well-being solutions
- For more information, visit www.vtt.fi.



- Background information on Finland
 - Located on Fennoscandian (also known as Baltic) shield
 - Precambrian geology, a very thick lithosphere (150-200 km)
 - Average heat flow of 0.037 W/m², well below the continental average of 0.065 W/m²
 - Temperature near the surface from 2 °C to 5 °C, depending on the latitude
 - Geothermal gradient 8-15 K/km
 - In order to reach temperatures of around 100 °C, depth of 6 to 8 km is required

- Ground source heat pumps (GSHP)
 - Main form of utilising geothermal energy in Finland, 4.2 TWh of heat (in 2012) with an average COP of 2.85
 - A required number of 100-300 m boreholes as a source of heat, typically providing a temperature of around 5 °C
 - Borehole investment costs have decreased, making GSHP systems especially attractive for individual dwellings

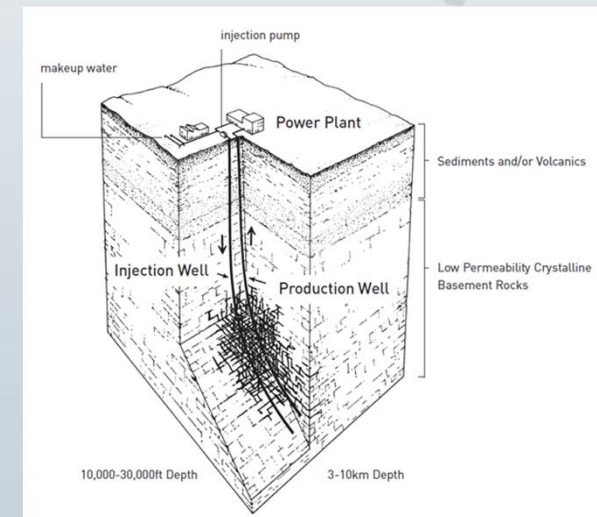


Air-to-Air (light blue), exhaust air (blue), air-to-water (yellow) and ground source (green) heat pumps in Finland. (SULPU 2013)

- Enhanced Geothermal System (EGS)
 - Opportunity for regions without suitable naturally occurring heat, water and rock permeability enabling energy extraction
 - Cost-effectiveness improved by recent advances in drilling technology with Korean manufacturers offering a product taking advantage of the development

On right: Schematic of a two-well system.

On left: Depth of 100 °C isotherm in Finland.





- EGS pilot project in Finland
 - Started in 12/2014 by energy companies Fortum and St1
 - Producing heat (only) for city wide district heating system
 - Up to 40 MW in capacity, can cover 10 % of heat yearly
 - Operational in 2016
 - Very interesting option considering the Finnish energy system as a whole with a large market share in district heating (50 % in total, 90 % in larger cities)
 - A pilot project; uncertainties in drilling costs and connecting the wells, i.e. creating a permeable heat exchanger
 - <http://www.fortum.com/en/mediaroom/pages/fortum-and-st1-to-start-a-pilot-project-for-geothermal-heat-production-in-espoo.aspx>

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