Geothermal Energy in Finland

Does geological differences provide co-operation possibilities for German stakeholders

17th October 2023

Teppo Arola

Der Geothermie Kongress 2023

Geological Survey of Finland (GTK) - geothermal expertise

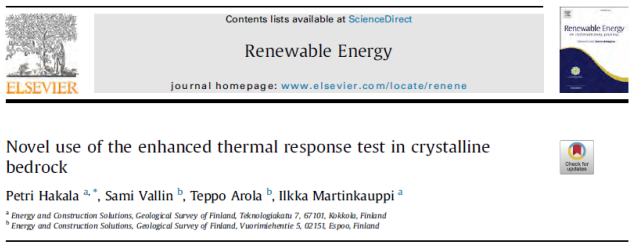
Geothermal group, 13 professionals: currently 3 Ph.D. / 8 M.Sc. / 2 supporting staff

International high level expertise areas:

- geothermal modelling.	- thermogeological measurements (heat flow, conductivity etc.).	- BTES and ATES systems.	- geothermal concultation in international projects.

Geothermal R&D in Finland

- Few doctoral theses published during last 10 years.
- Current research is focused on applied research which aims to deliver solutions to the needs of the business community.


Contents lists available at ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene

Novel use of the enhanced thermal response test in crystalline bedrock

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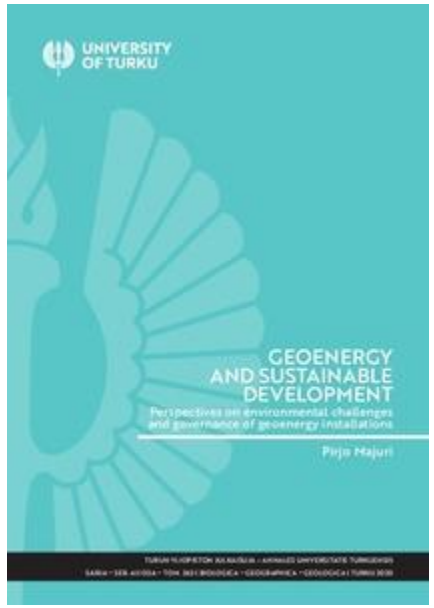

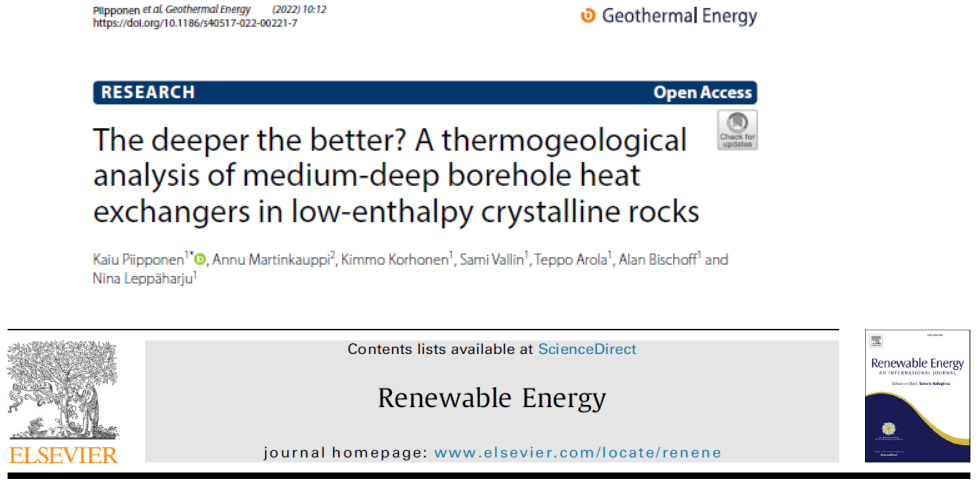
Piipponen et al. Geothermal Energy (2022) 10:12
https://doi.org/10.1186/s40517-022-00221-7

Geothermal Energy

RESEARCH Open Access

The deeper the better? A thermogeological analysis of medium-deep borehole heat exchangers in low-enthalpy crystalline rocks

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Geoenergy permits in Finnish regional administration – Contradictory practices and inadequate judicial regulation

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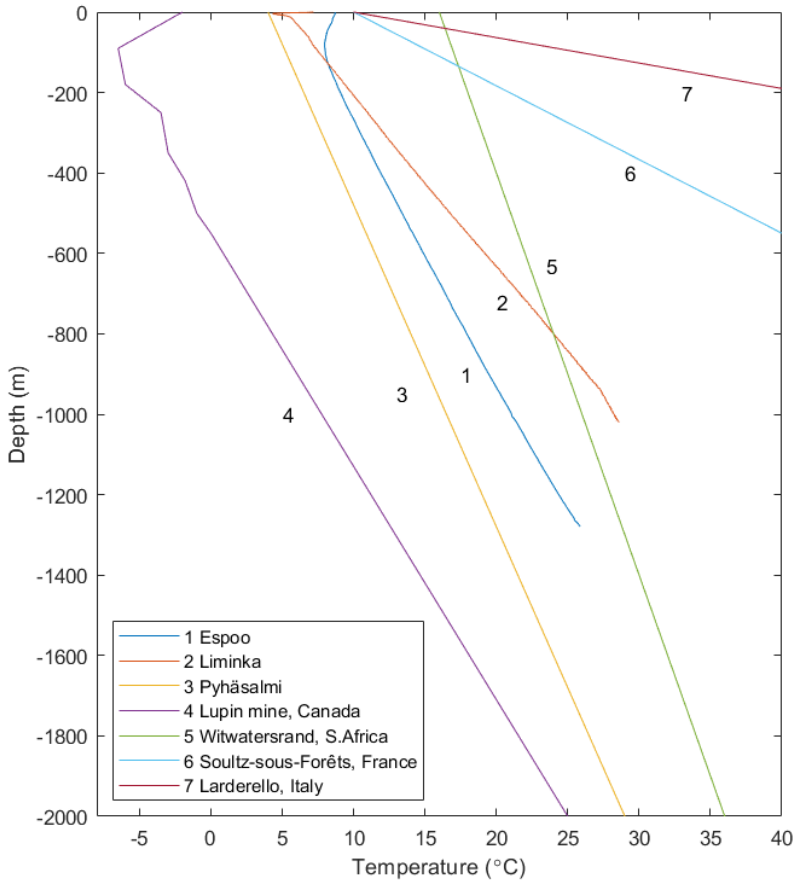
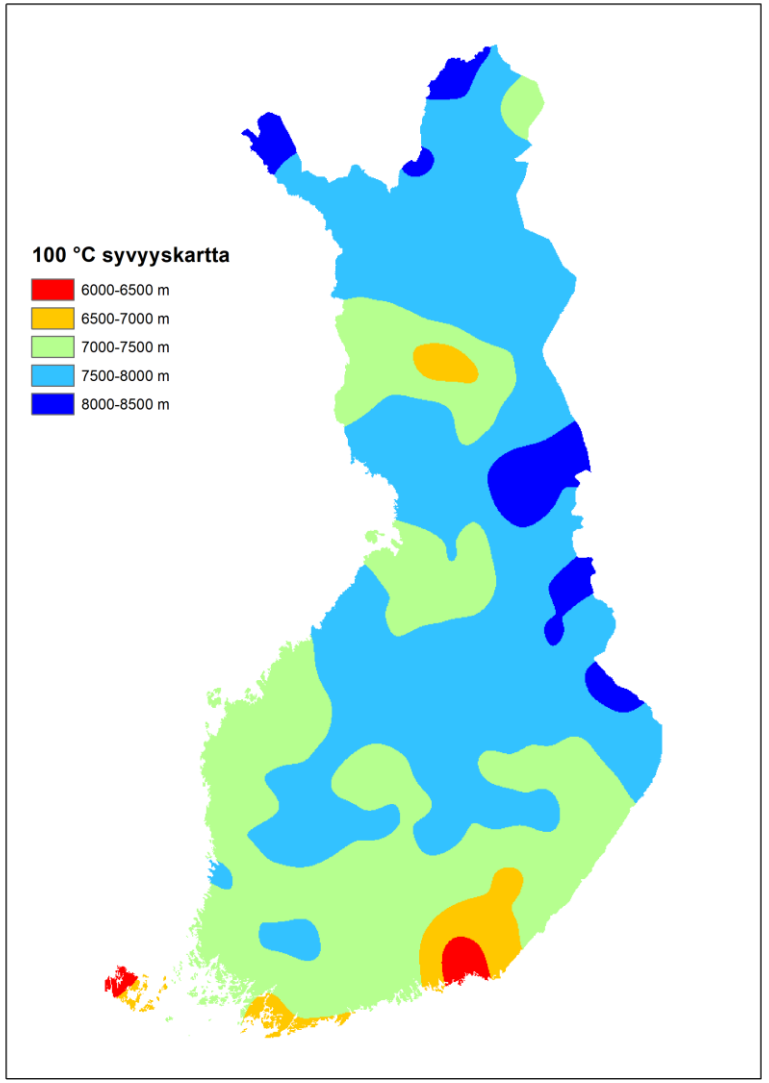
Ground conditions in Finland

Thermogeologically poor environment: cold ground (0.5-7,6 °C), low thermal gradient (8-17 °C/Km) and heat flux (40-60 mW/m^2)



Geothermal gradient examples



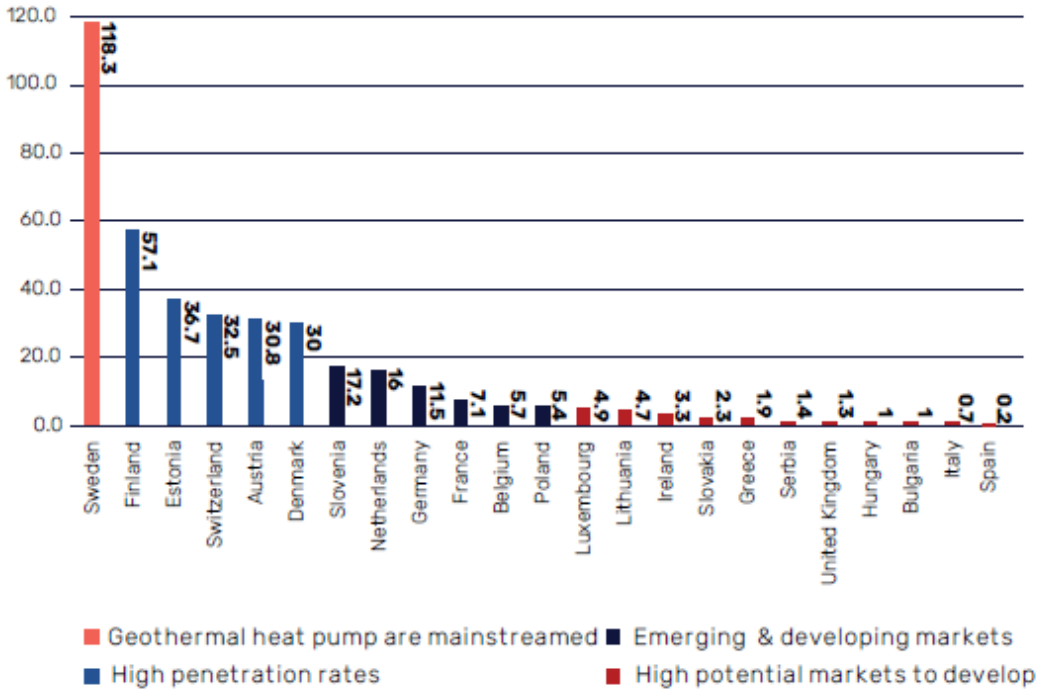
100°C temperature contourline

Geothermal markets in Finland

- Huge demand for heating energy:
  household used 39,2 TWh heating energy in 2021*
- Crowing demand for cooling energy
- Ground source heat pump investments ~
  390 M€, over 3000 people working**.
- Drilled ~ 40 000 km of boreholes (increasing
  ~ 3000 km annually).
- **Natural hydrogen** opens new possibilities?

*Official Statistics of Finland (OSF): Energy consumption in households [e-publication]. ISSN=2323-329X. 2020, [referred: 19.4.2022]. Access method: http://www.stat.fi/til/asen/2020/asen_2020_2021-12-16_tau_002_en.html
**Sulpu (Finnish Heat Pump Association). Heat pump sales statistic for 2022 (2023). Statistics available: https://www.sulpu.fi/lampopumppuja-myyntiin-viime-vuonna-lahes-200-000-kappaletta-kasvu-50/

Number of geothermal heat pump systems per 1,000 households



EGEC Geothermal market report 2022

Shallow geothermal (300m) potential maps

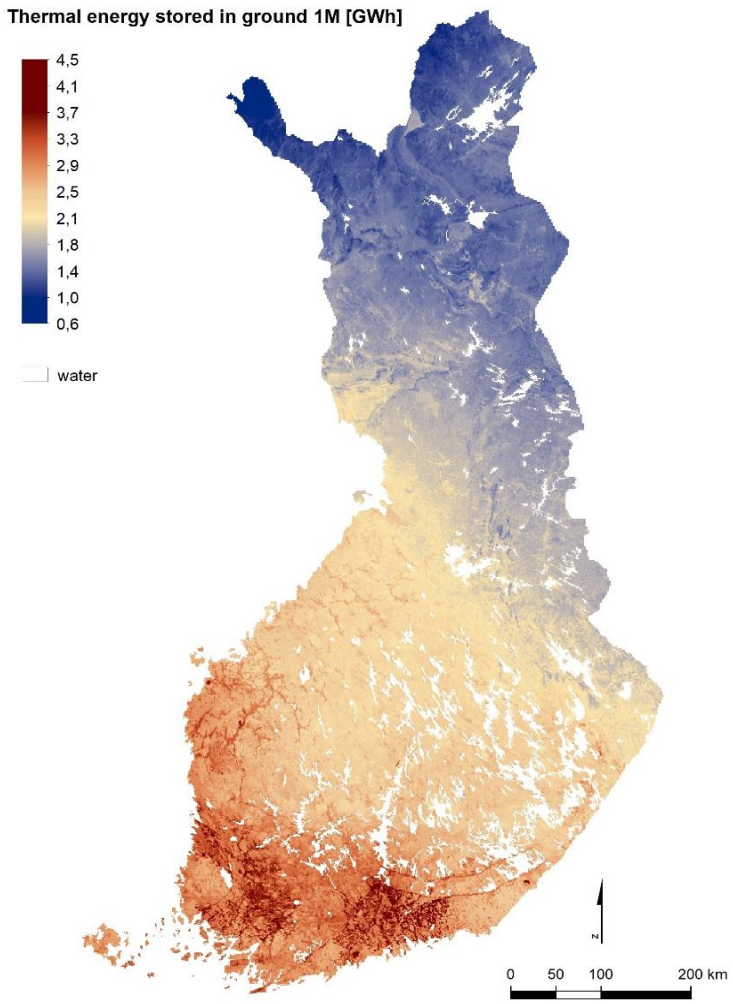
The maps shows the amount of renewable energy stored in the ground and renewable power utilisable from the ground.

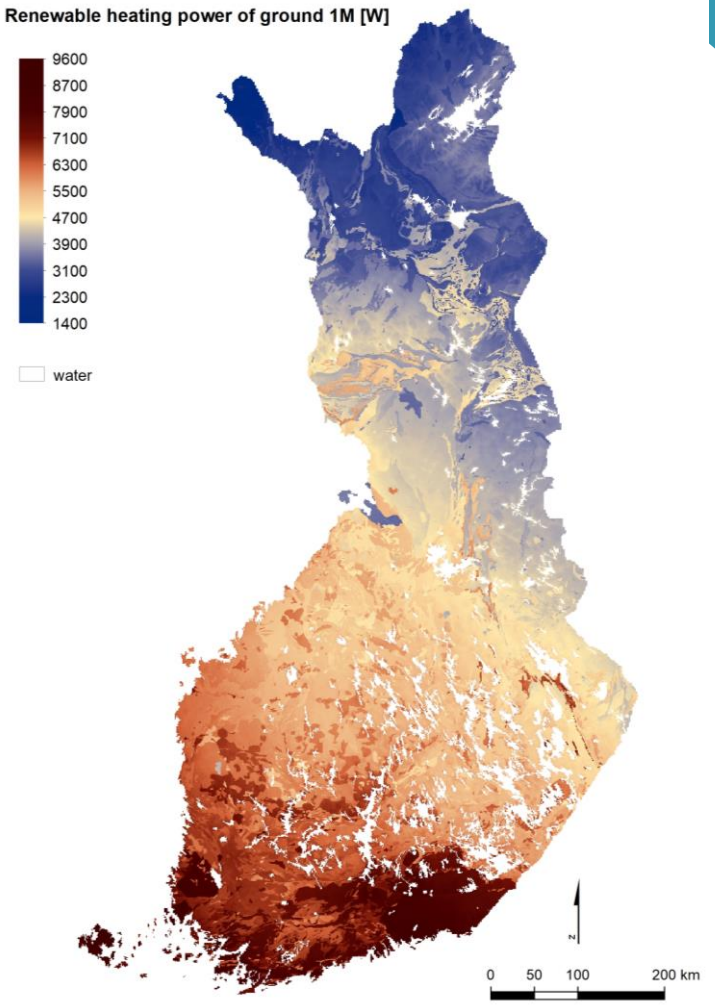
The calculation is based on thermogeological conditions, e.g.:

- Thermal conductivity of soil and bedrock
- Average temperature level in ground and bedrock

Machine learning is used for calculations

The best potential is located in Southern parts of Finland where the thermogeologically best conditions are also found





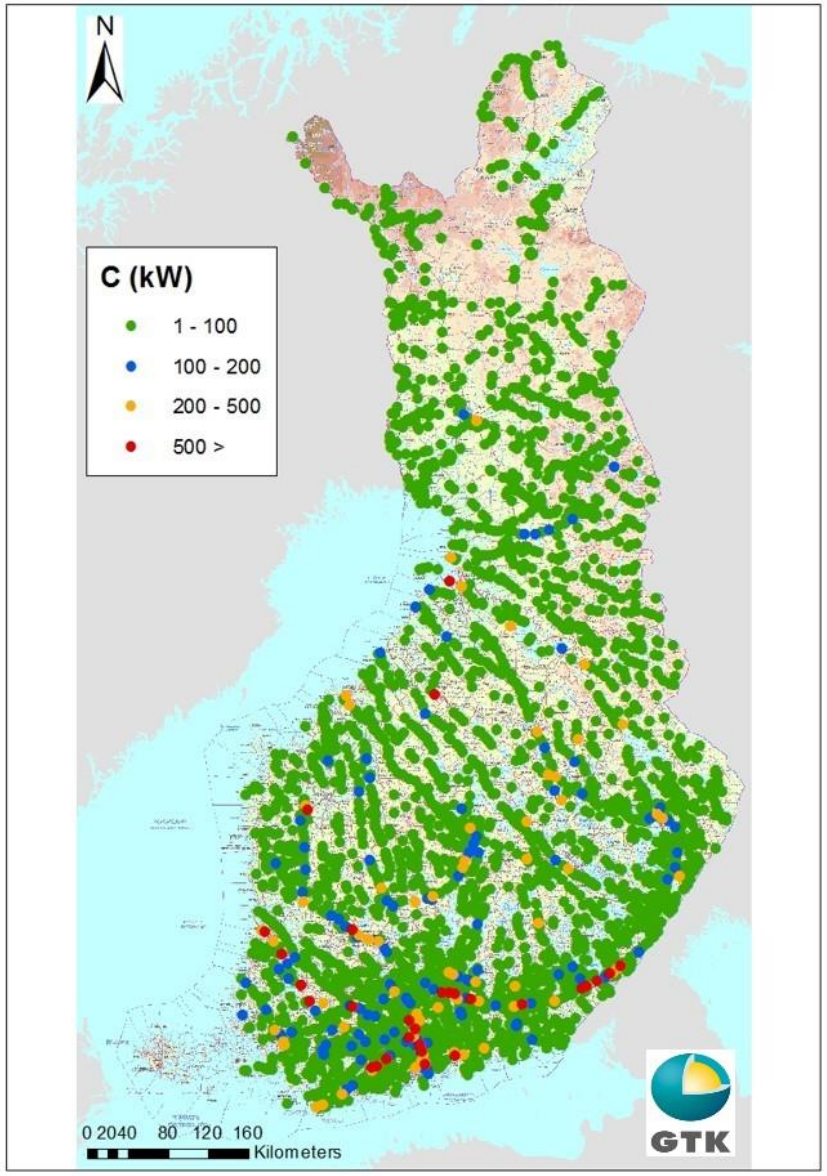
http://gtkdata.gtk.fi/maankamara/

https://hakku.gtk.fi

Groundwater energy potential in Finland

The map indicates continous heating power potential of Finnish aquifers.

One dot presents one aquifer already planned for residential or industrial use.



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Medium deep (2 km) geothermal potential in Finland

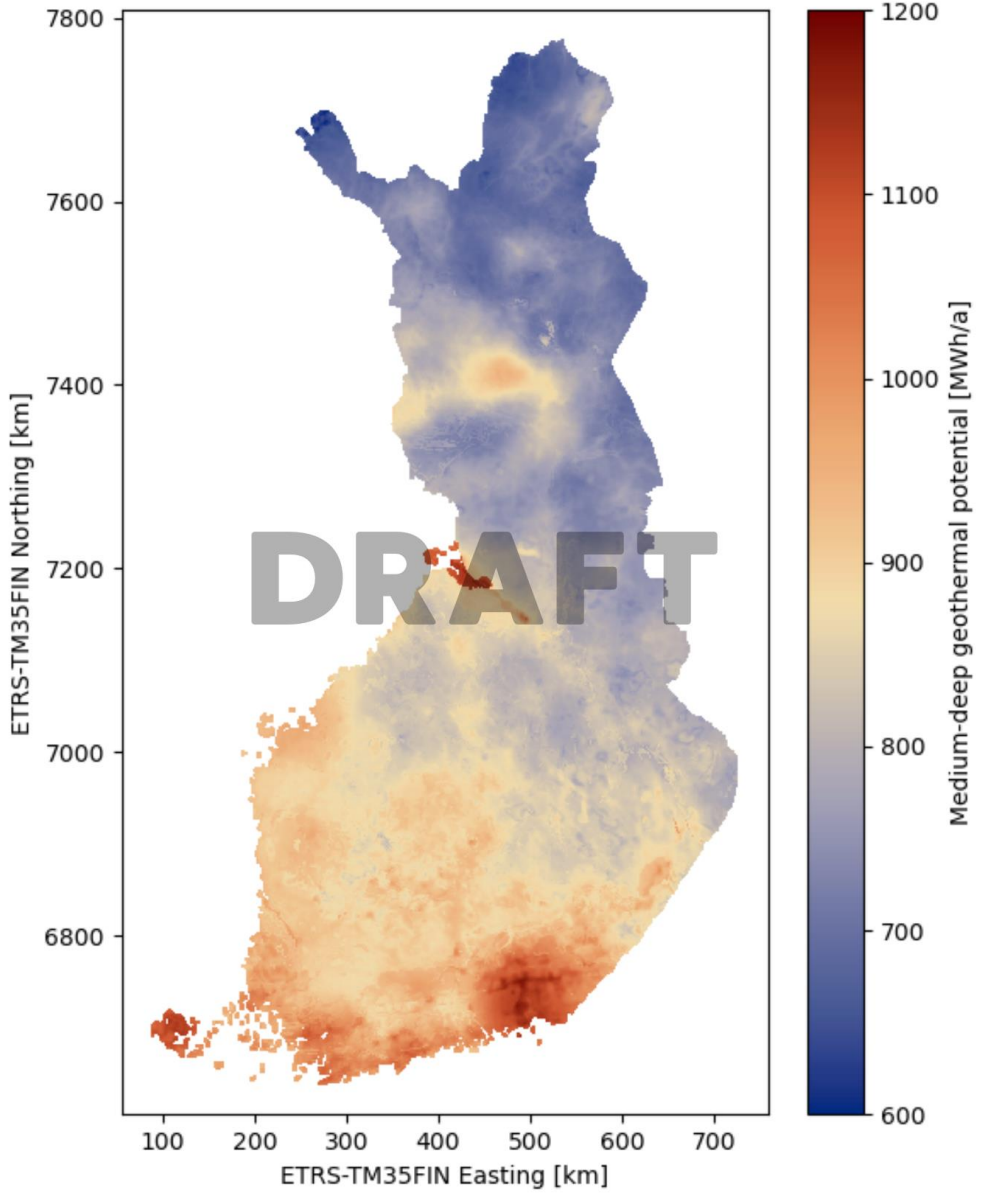
Technical geothermal potential map.

One 2 km deep co-axial (VIT pipe) well in every pixel (1 km^2 area).

Machine learning is used for calculations

Constant amount of energy utilisable during 50 years of well operation.

Flow rate 5 l/s and fluid temperature is zero at the end of 50th year.



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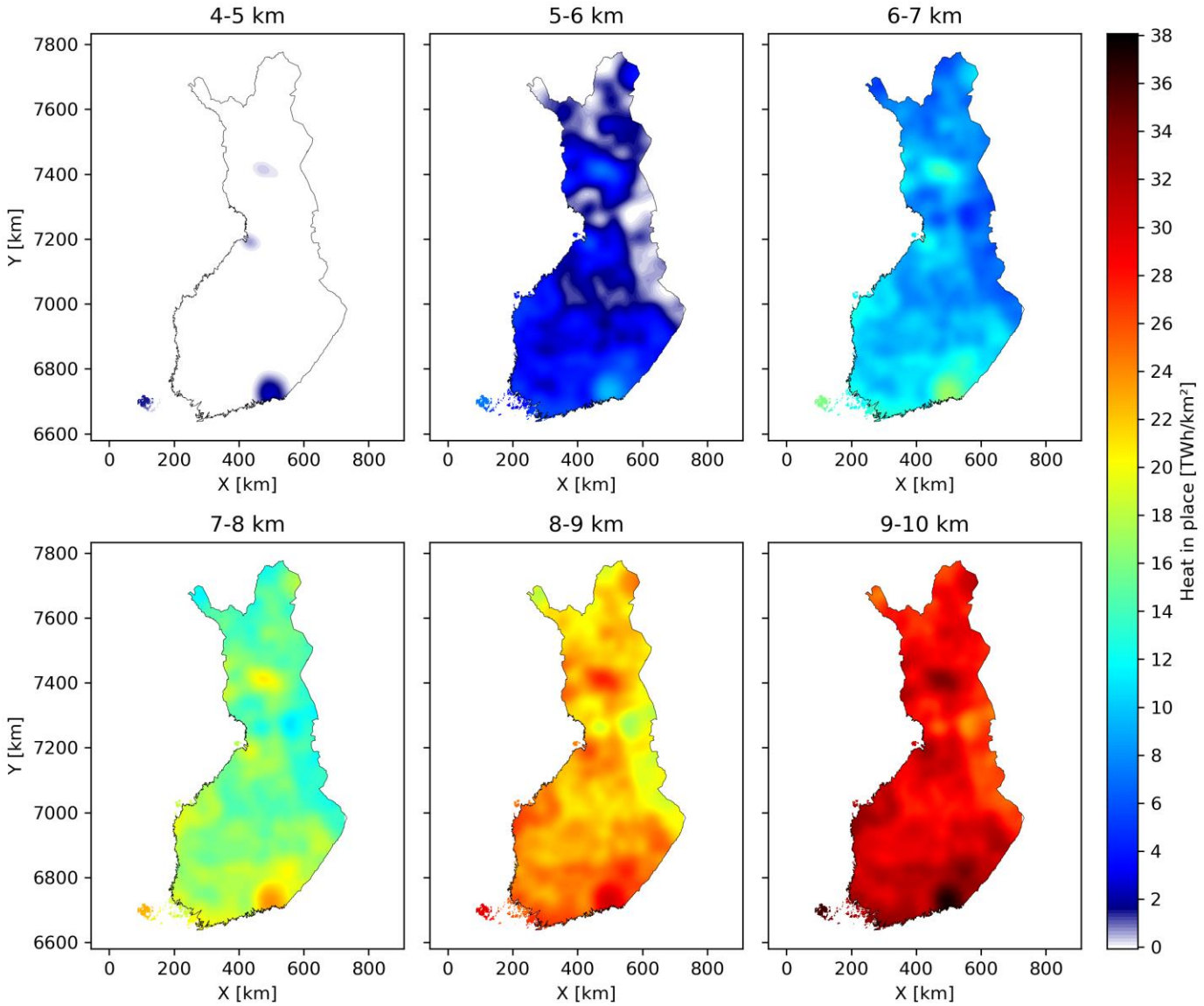
Deep geothermal potential in Finland

”Heat in place” calculation – theoretical amount of heat.

Starting point: depth where T_{ground} = 70 °C

Calculated how much energy can be utilised to achieve a level of 70 °C in different depth.

Results presented in 1 km depht ”slices”.



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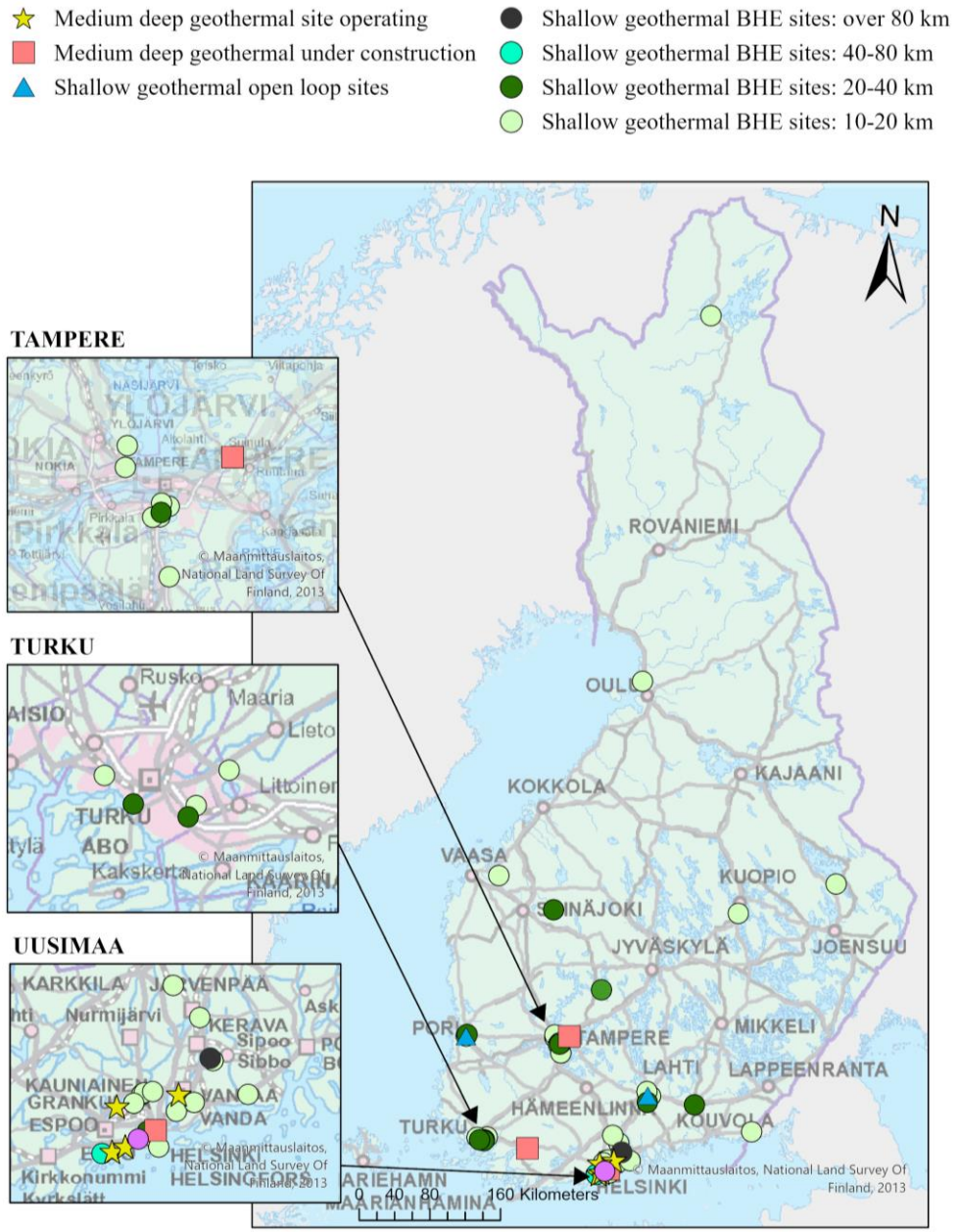
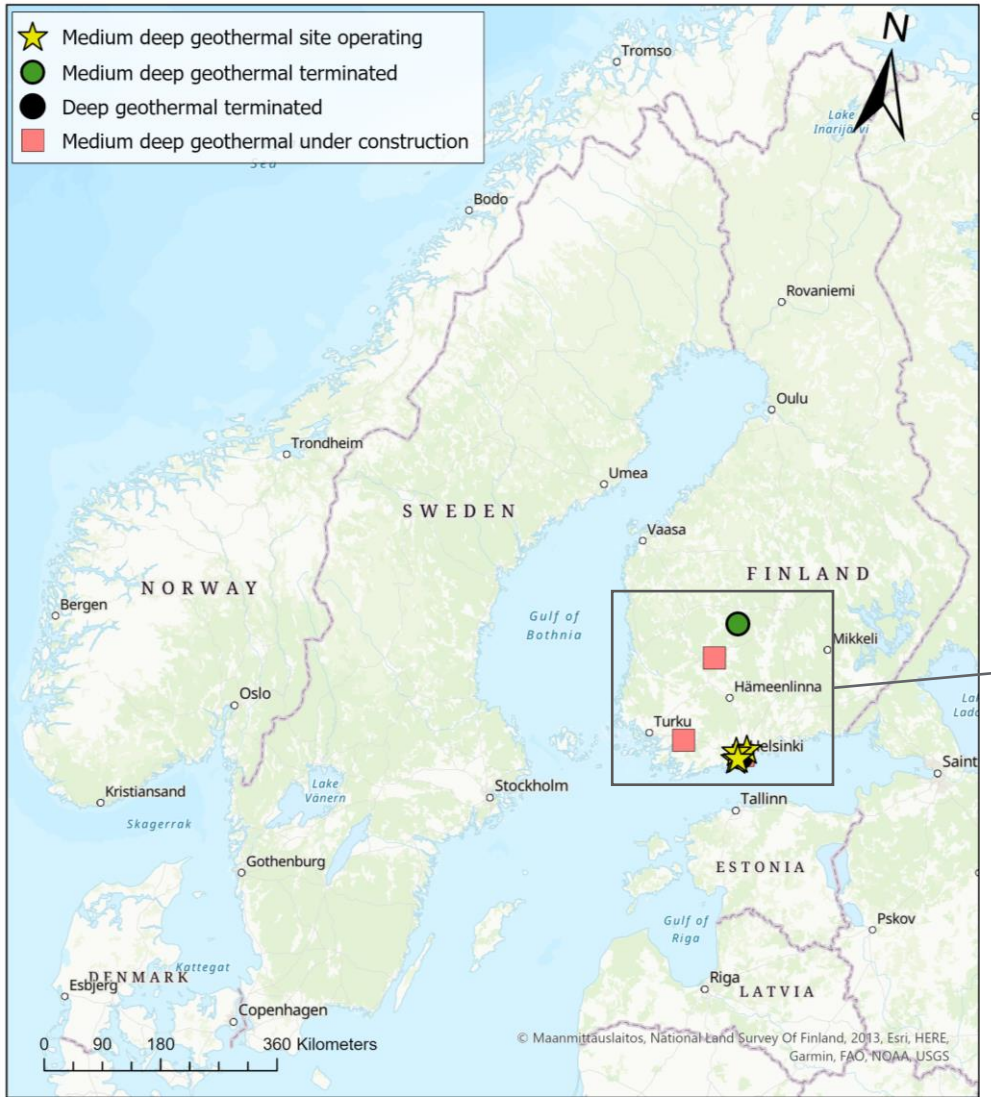
Large shallow geothermal sites in Finland

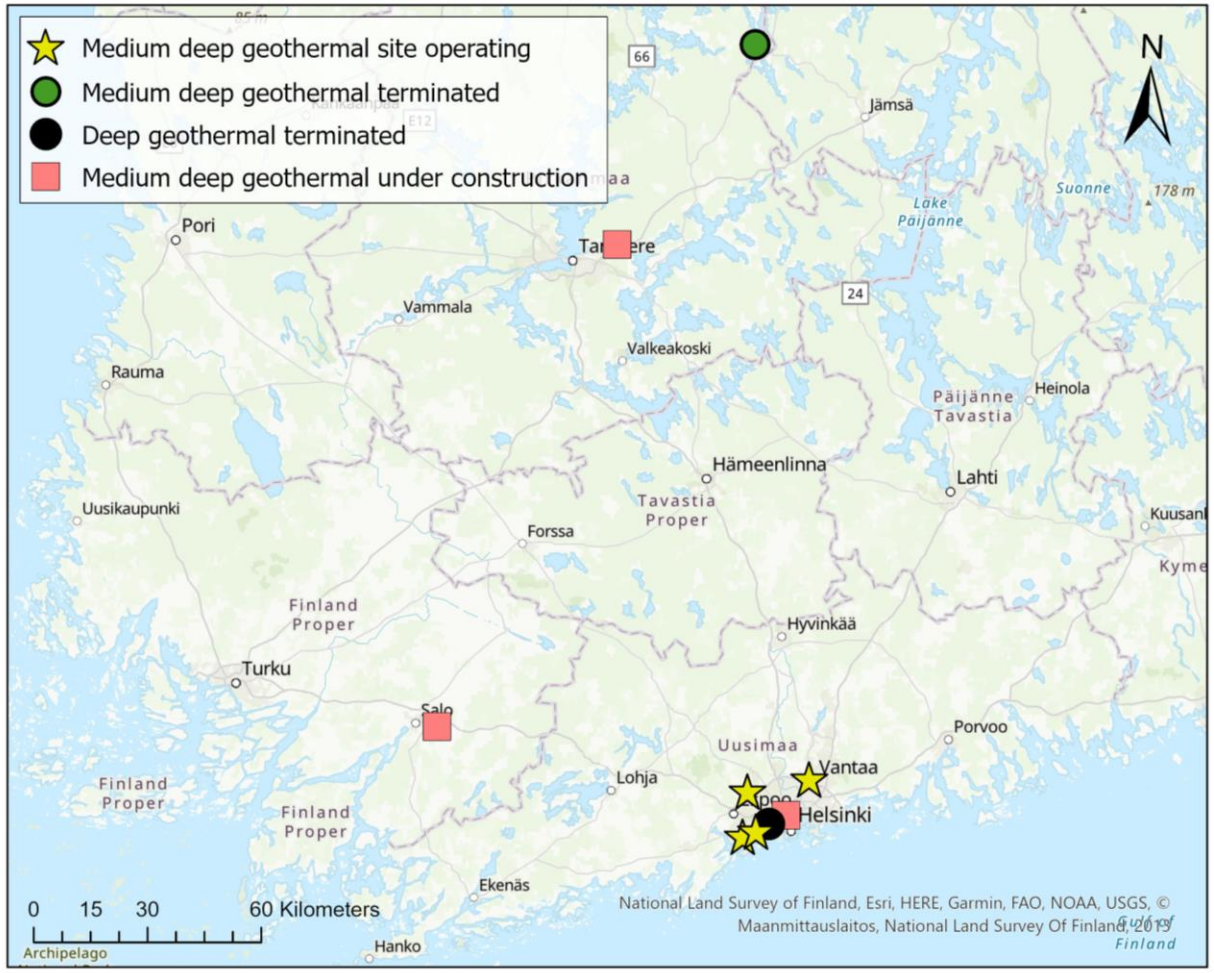
There are at least 53 shallow geothermal borehole heat exchanger sites where one has drilled over 10 km of boreholes (until 2023).

The first district cooling geothermal site started as a pilot project in 2020. Energy source is groundwater, with a cooling power of 1 MW.



Medium deep (500-3000 m) and deep geothermal sites





Medium deep (500-3000 m) and deep geothermal sites

Site	Mänttä – Vilppula	Koskelo	Vantaa	Finnoo	Niittykumpu	Ruskeasuo	Salo	Otaniemi	Tampere
Drilling plan	1 x 2 km	2 km	1 x 2km	2 x 1,5 km	3 x 1,5 km	1 x 2 – 2,5 km	6 x 2 km	2 x 6-7 km	1 x 2,5 – 3 km
Realization	1 x 1480 m 1 x 500 m	1 x 1 300 m	3 x 800m 1 x 400 m	1 x 1 500 m 1 x 530 m 1 x 1 305 m	1 x 1 290 m 1 x 1 070 m 1 x 423 m 1 x 300 m	1 x 865 m	1 x 1 600 m 1 X 2 008 m, drilling continues	2 x 6 700 m	1 x 2230 m
Status	Terminated	In operation	In operation	In operation	In operation	Under construction	Under construction	Terminated	Under construction

Medium deep geothermal market – to be developed

- Medium deep geothermal needs more expertise and experience – especially in planning and drilling.
- Investment costs, especially drilling cost of over 600-700m deep wells, are too high currently.
- Well design expertise need to be added to the projects.
- Geological studies must be added to design process.
- International networking is needed.

Geothermal market future trends

Shallow geothermal continuous to crow – especially on large sites (shopping centres, industrial, local heating network etc.).

Strong interest to middle deep geothermal (0,5-3 km deep wells) energy utilisation – change in geothermal marker players. Urgent need to increase cost-efficiency.

Underground heat storages need to be included for carbon free heating energy production.

The future for deep geothermal (3 to 8 km) is not realistic now

Barriers caused by unawareness of environmental risks should be removed.

Co-operation with other European research centres and renewable energy players (solar, biomass, wind) should be increased.

KIITOS / DANK

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