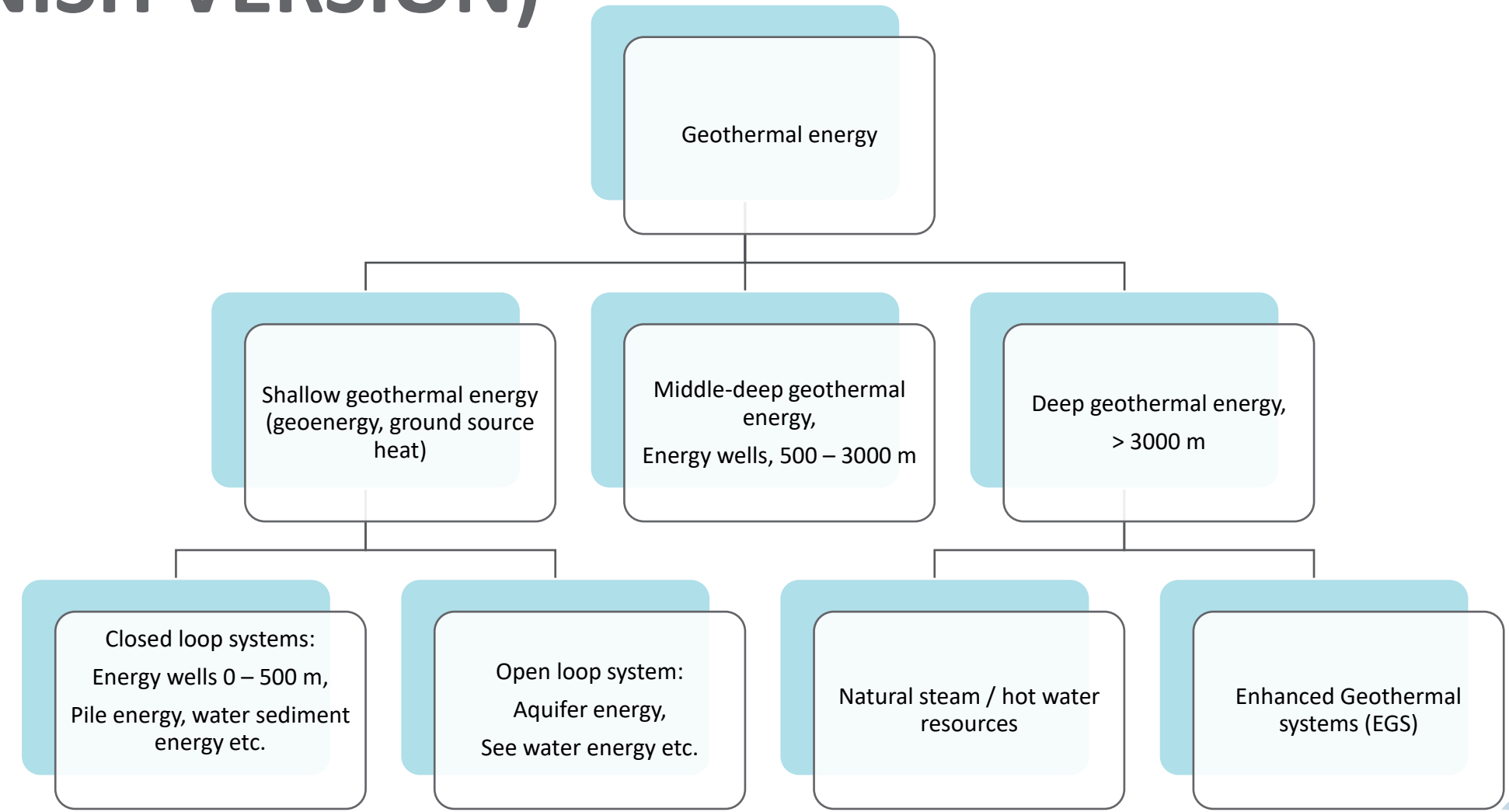


GEOTHERMAL ENERGY IN FINLAND

- Thursday 16th June 2022
- Teppo Arola

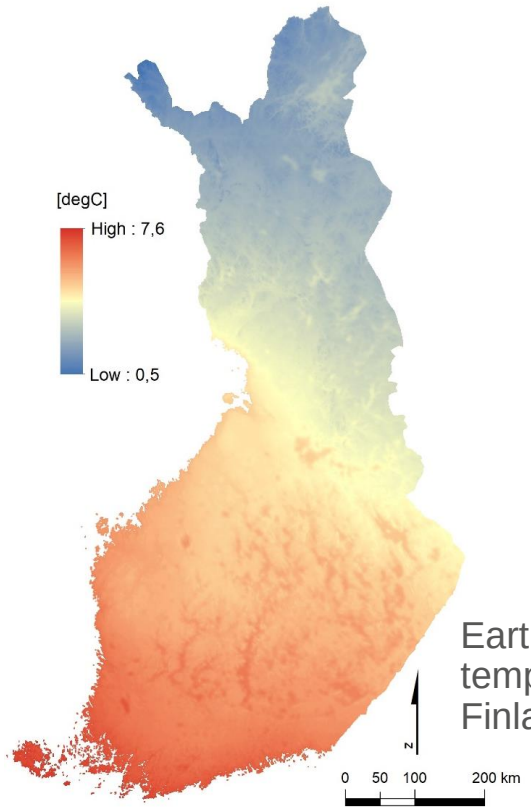
GEOTHERMAL ”FAMILY TREE” (UNOFFICIAL FINNISH VERSION)



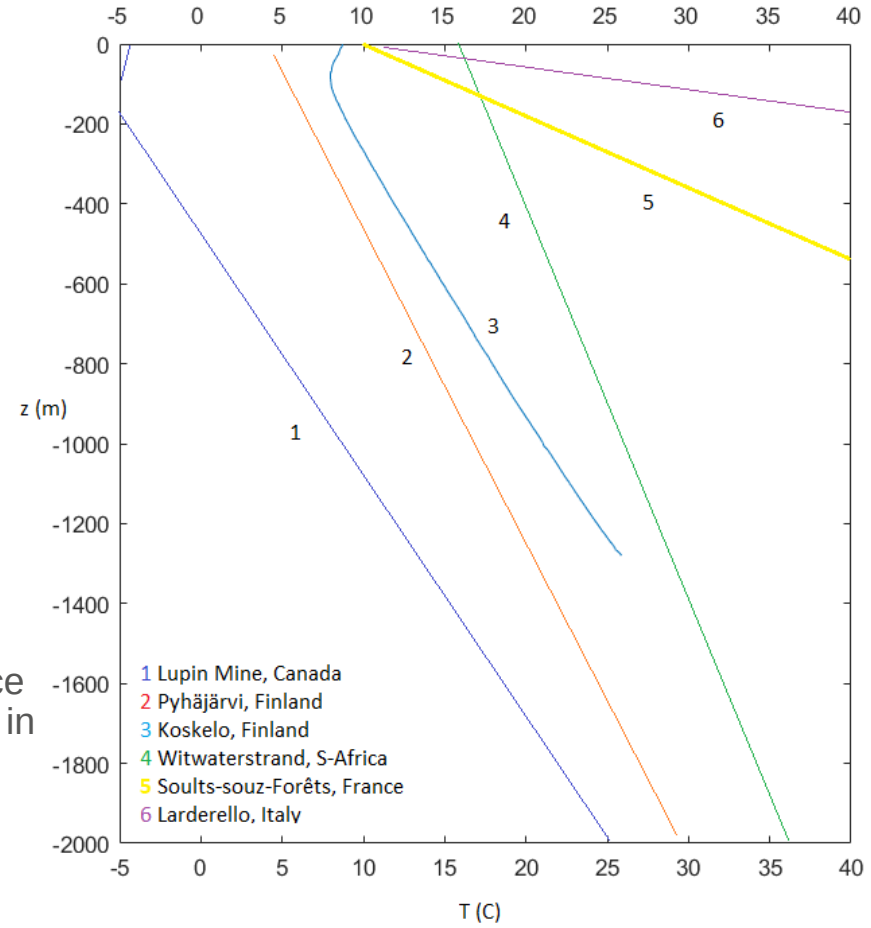
GROUND CONDITIONS IN FINLAND



Thermogeologically poor environment: cold ground,
low thermal gradient and heat flux



Earth's surface temperatures in Finland



Depth (m)	T (°C)
500	15
1000	23
2000	39
3000	54
4000	70
5000	86
6000	102
7000	118
8000	133

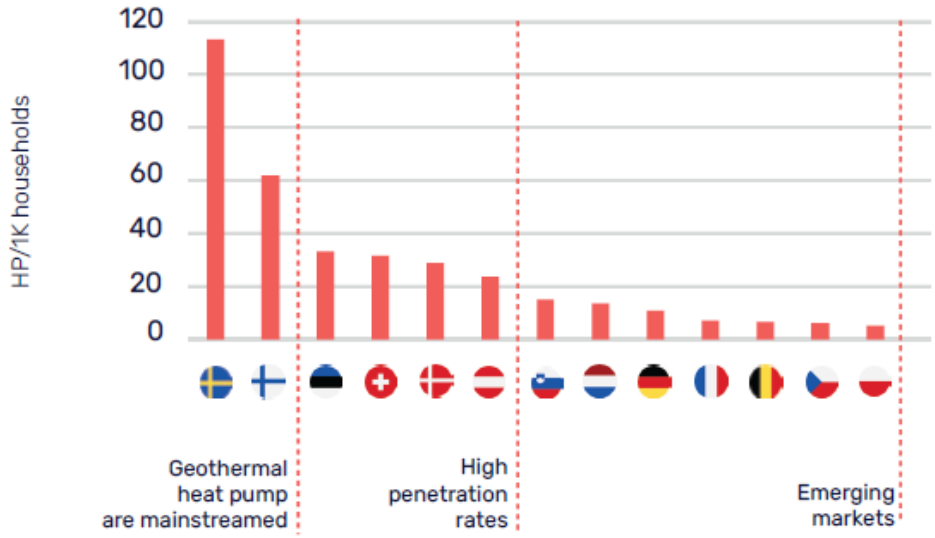
Average temperatures in the ground as a function of depth in Southern Finland

GEOTHERMAL MARKETS IN FINLAND

- Huge demand for heating energy: district heat production in 2021: 39,3 TWh*
- Crowing demand for cooling energy
- Currently 100 % of produced geothermal energy is shallow geothermal (geoenergy).
- Drilled ~ 35 000 km of boreholes (increasing ~ 3000 km annually).

* https://energia.fi/uutishuone/materiaalipankki/energiavuosi_2021_-_kaukolampo.html#material-view

Number of geothermal heat pump systems per 1,000 households



EGEC Geothermal market report 2021

LATEST MILESTONES



- Presently, there are at least 45 shallow geothermal borehole heat exchanger sites where one has drilled over 10 km of boreholes in Finland.
- The first district cooling geothermal site started as a pilot project in 2020. Energy source is groundwater, with a cooling power of 1 MW.
- Strong interest towards medium deep geothermal systems:

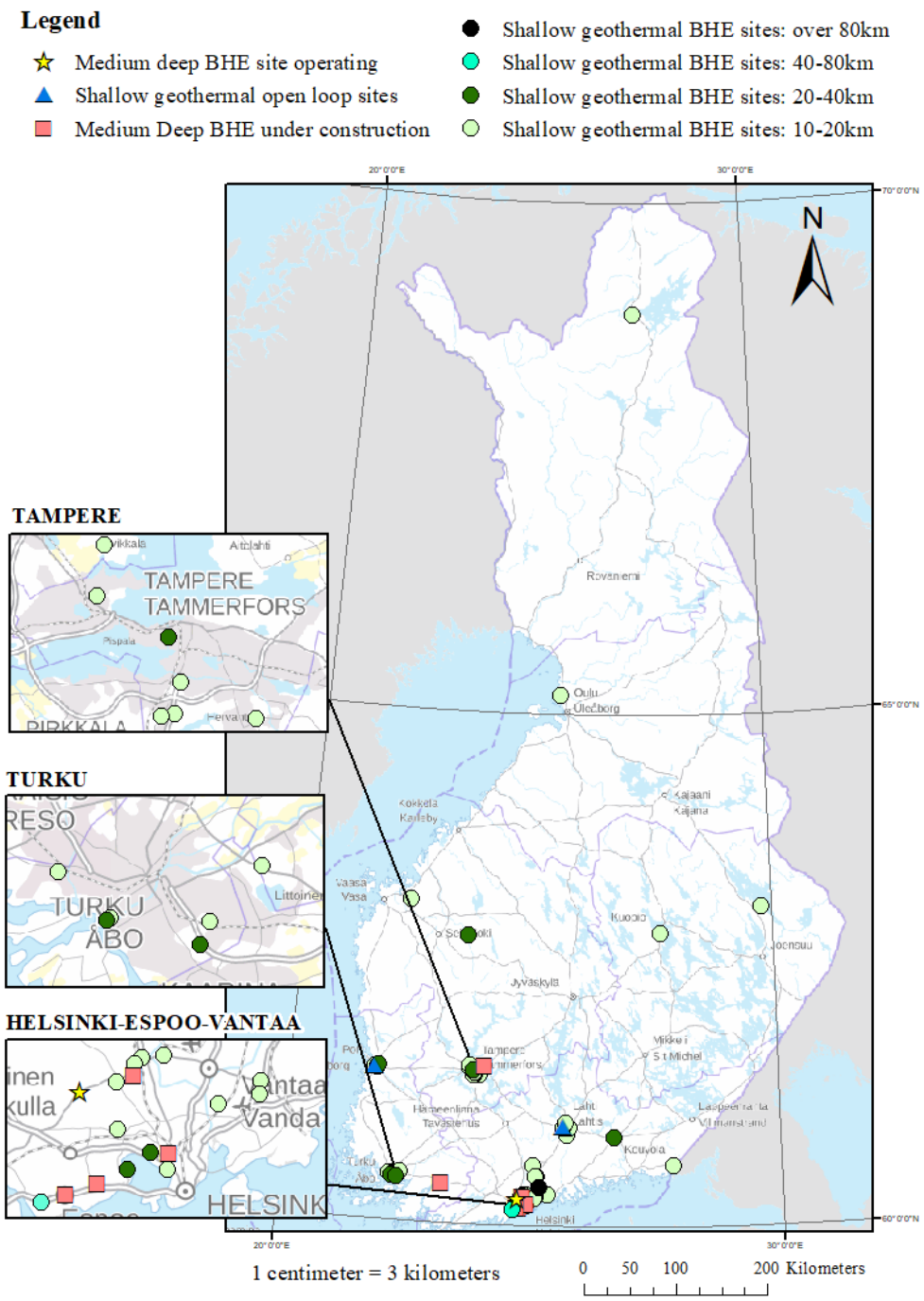
Sites at drilling phase:

Town	Boreholes (No.)	Target depth (km)	Operator
Helsinki	1	2 to 2.5	Helen Oy
Tampere	1	2.5 to 3	Tampereen sähkölaitos Oy
Espoo	3	1,5	Finnoon Syvälämpö Oy
Espoo	3	1,5	Nrep Oy
Vantaa	3	0.8	Vantaan Energia Oy
Salo	6	1,5 to 2	Lounavoima Oy





LARGE GEOTHERMAL SITES IN FINLAND



Shallow geothermal bedrock energy potential in Finland

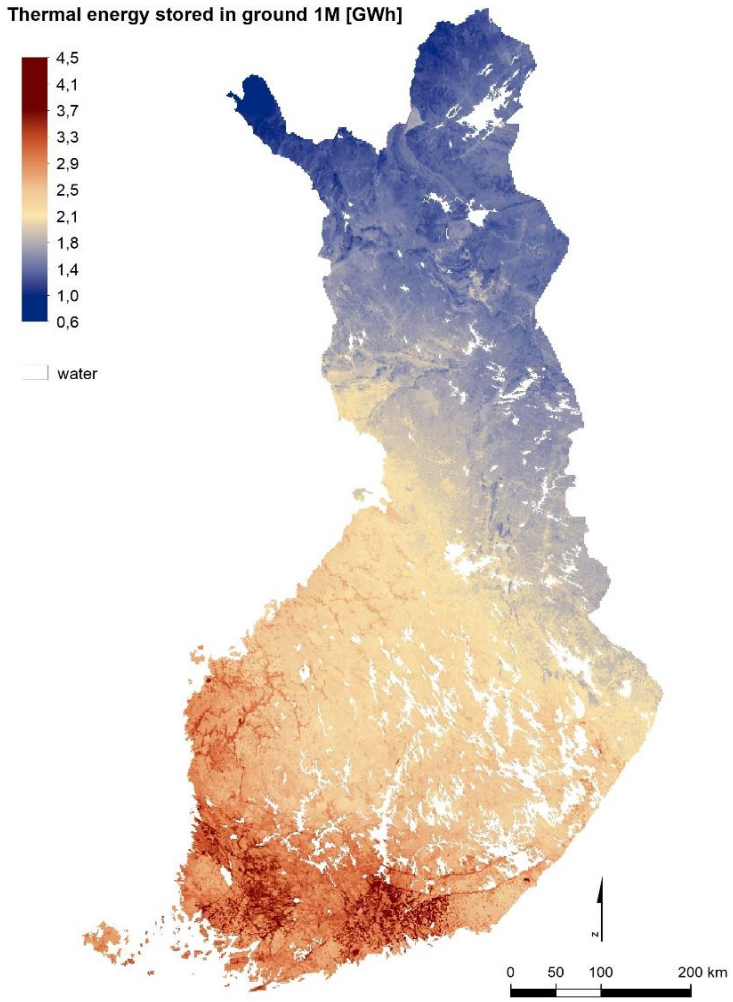
The maps shows the amount of renewable energy stored in the ground and renewable power utilisable from the ground.

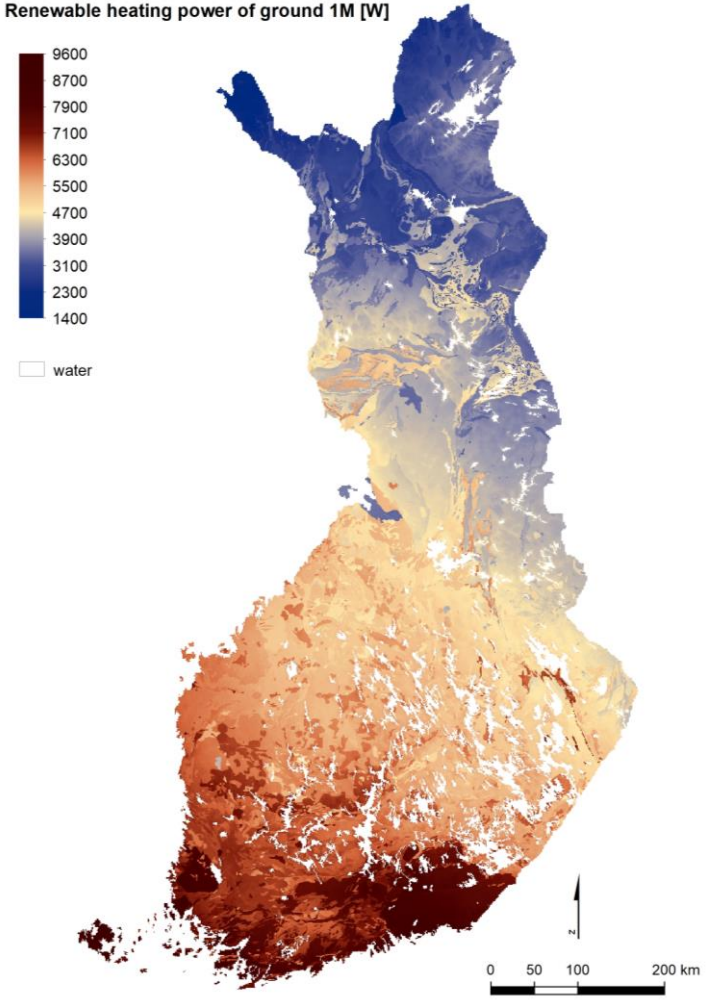
The calculation is based on thermogeological conditions, e.g.:

- 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





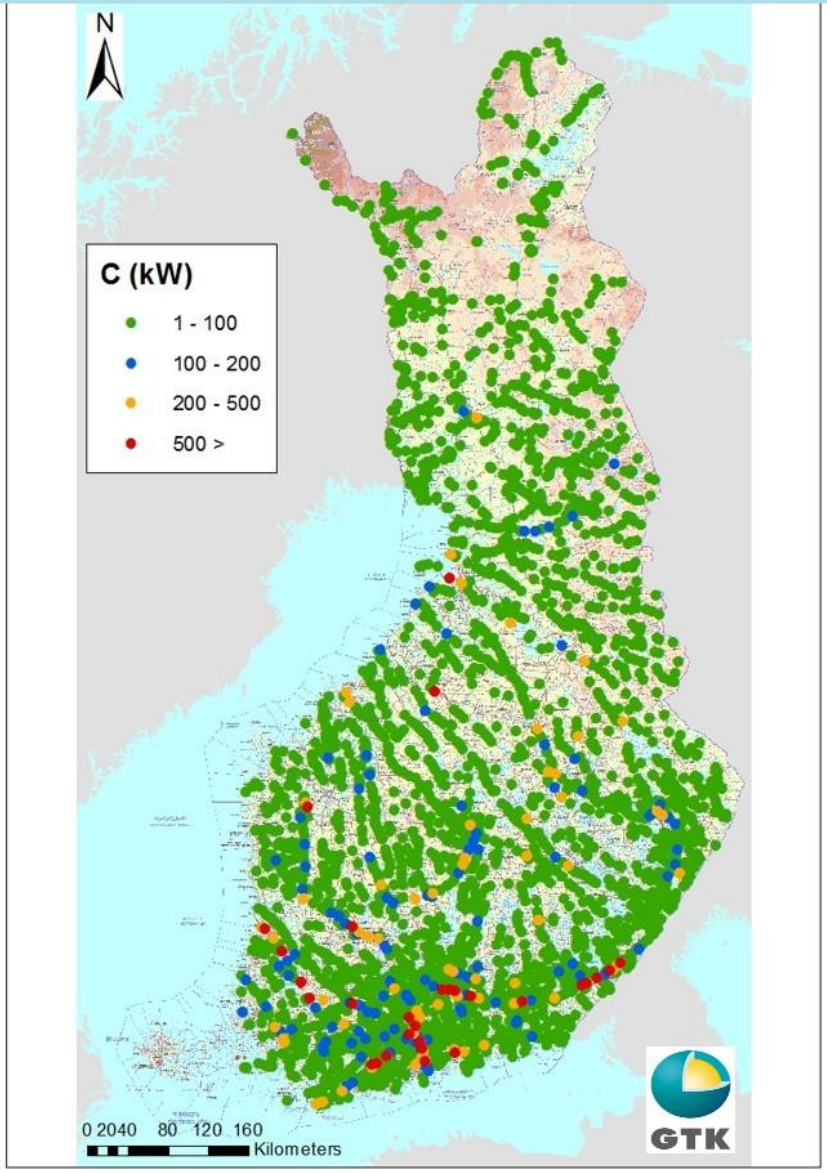
http://gtkdata.gtk.fi/maankamara/

https://hakku.gtk.fi

Groundwater geothermal 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.

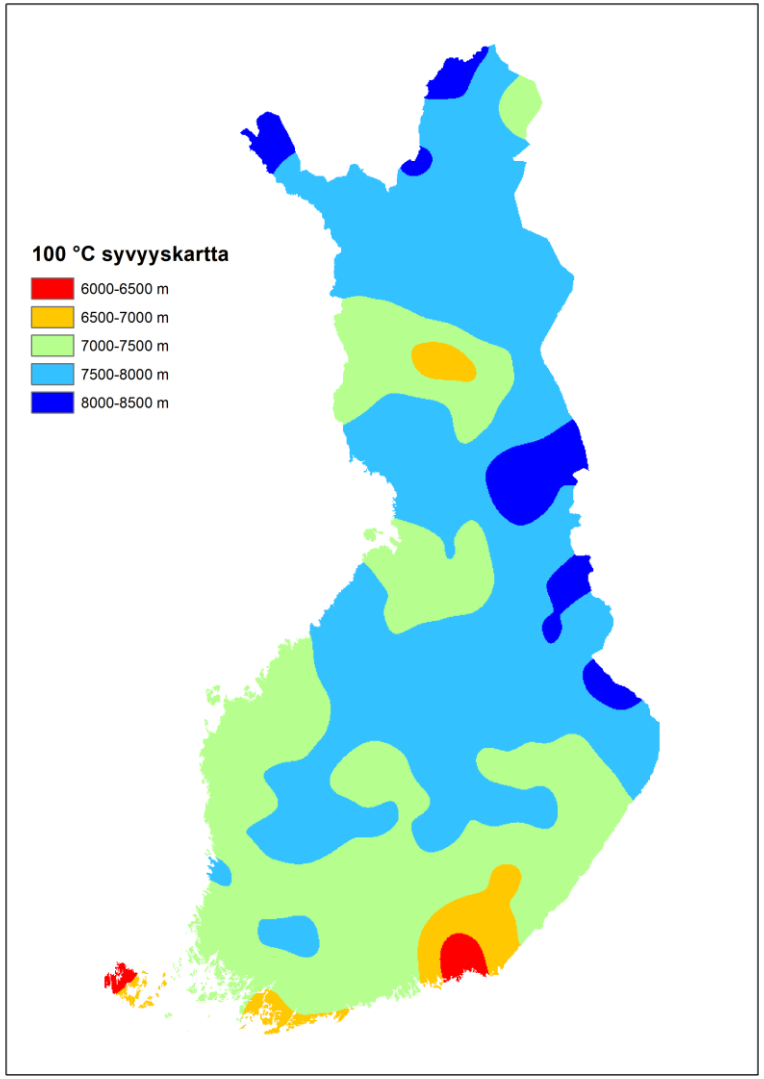


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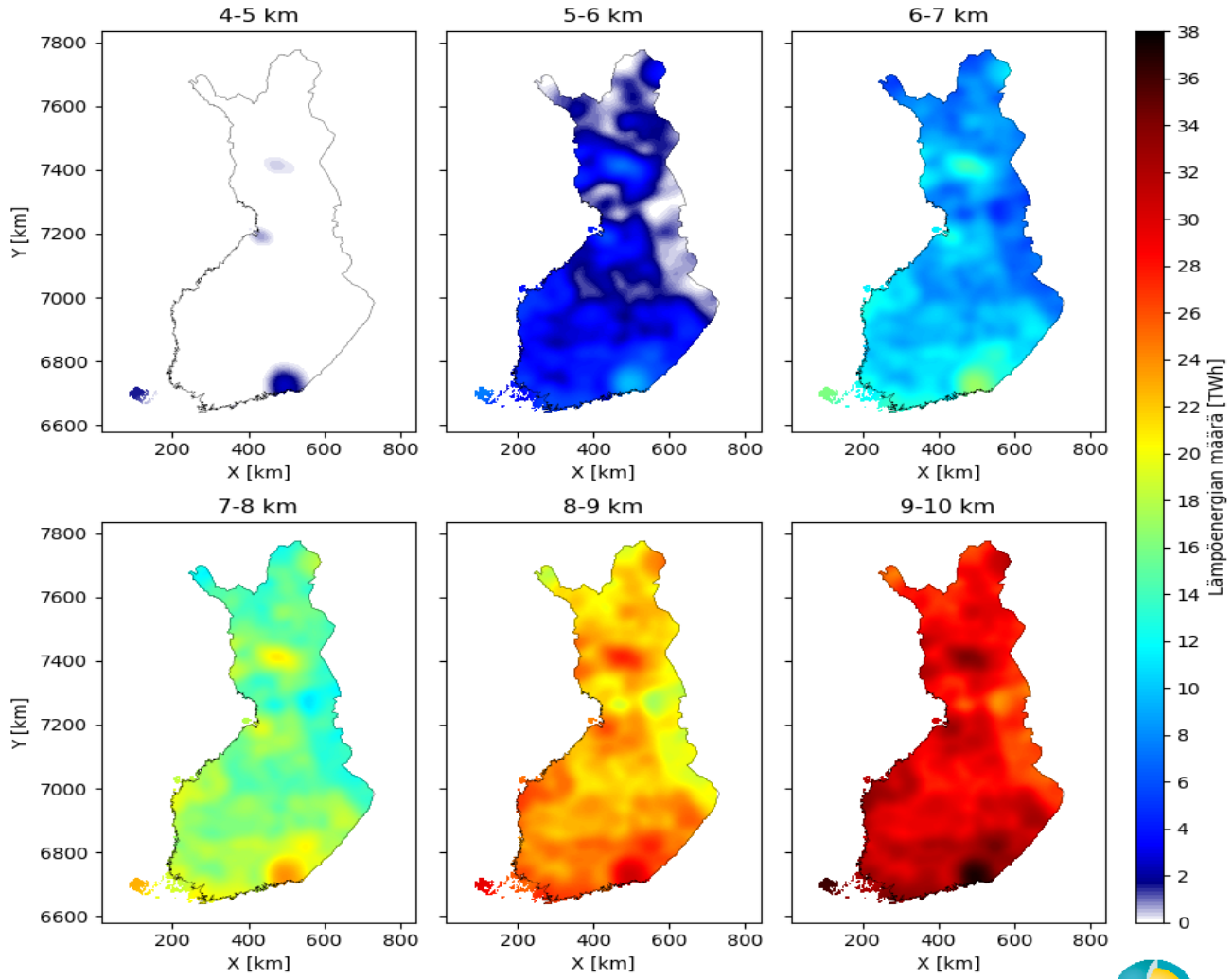
Deep geothermal energy potential in Finland

The map shows the 100°C temperature countourline in Finland.



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

Deep geothermal energy potential in Finland



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GTK

GEOTHERMAL MARKET FUTURE TRENDS

Strong interest to middle deep geothermal (1-3 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.

Deep geothermal market is challenging as St1 deep heat project showed.

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

Co-operation with other renewable energy areas (solar, biomass, wind) should be increased.





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