EUROPEAN GEOTHERMAL CONGRESS 2025

Integrating the potential of shallow geothermal energy into the information platform Bavarian Energy Atlas

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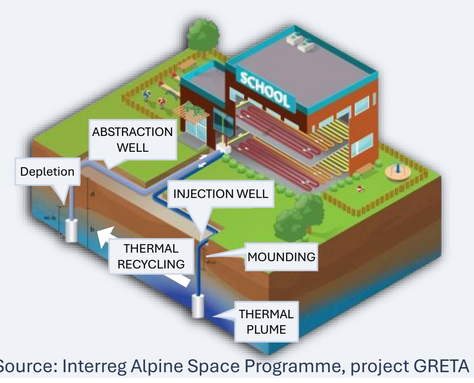
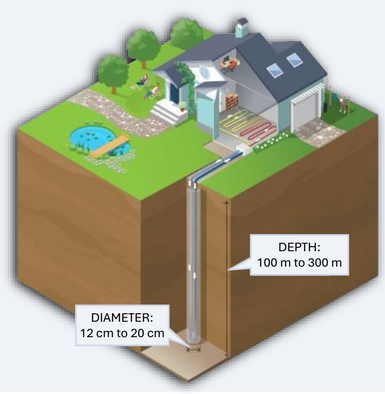
1. Technologies

Groundwater heat pump (GWHP)

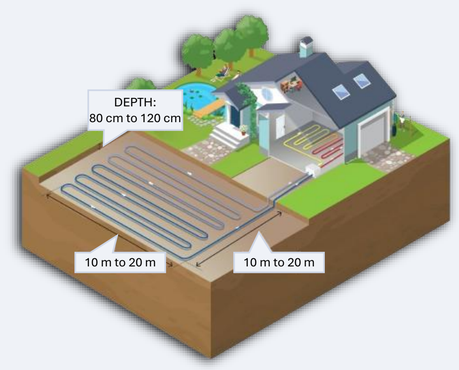


Source: Interreg Alpine Space Programme, project GRETA

Borehole heat exchanger (BHE)



Ground heat collector



Main Steps:

1. Identifying technical and regulatory limitations for each respective technology
2. Defining suitable areas in Bavaria
3. Collecting the necessary spatial and local data
4. Quantifying each potential on a spatial and local scale

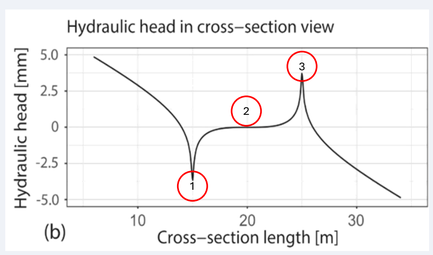
2. Methods of Potential quantification

TAP – Method

(Böttcher et al. 2019)

Minimal **technical extraction rate** [l/s]:

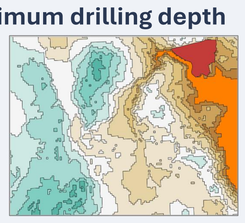
1. $\dot{V}_{dd}$ Drawdown max. 1/3 of GW-thickness
2. $\dot{V}_{br}$ no hydraulic contact between wells
3. $\dot{V}_{in}$ GW-table rise max. 0,5 m under surface



$$\dot{V}_{tech} = min(\dot{V}_{br}, \dot{V}_{in}, \dot{V}_{dd})$$

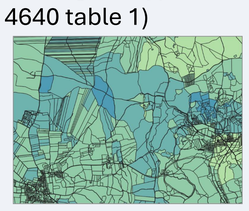
Specific heat extraction of one BHE

Maximum drilling depth



Medium thermal conductivity

Considering soil type over depth (VDI 4640 table 1)

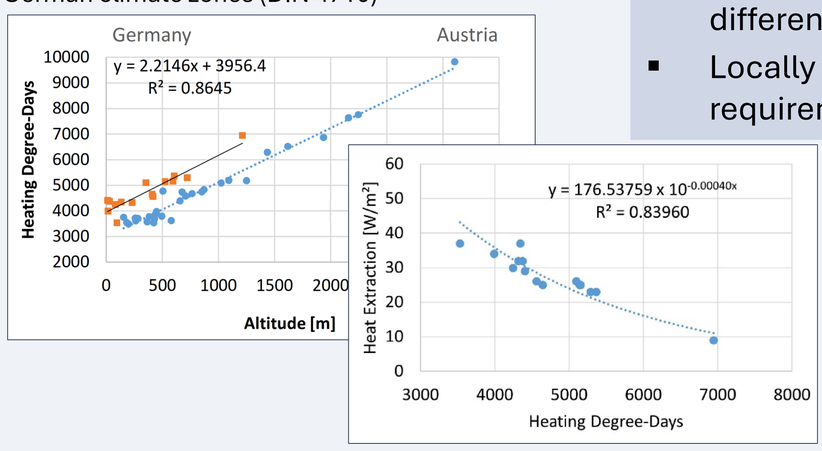


Heat load profile (VDI 4640 table 3)

Specific heat extraction of horizontal collectors (Schwarz et al. 2022)

Heating degree days (HDD)

depending on location and altitude, referring to German climate zones (DIN 4710)



Correlation between HDD and the **heat extraction values** of VDI 4640 for the local soil type

Critical data properties:

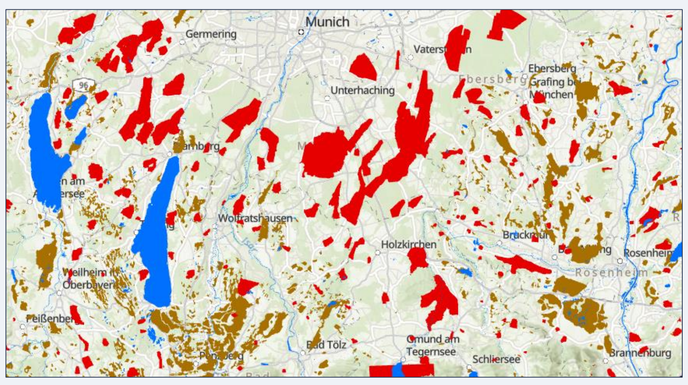
- Availability of extensive spatial data
- Data quality and resolution differences
- Locally varying regulations and requirements

3. Limitations

Spatial limitations

(Bavarian environment agency, LfU)

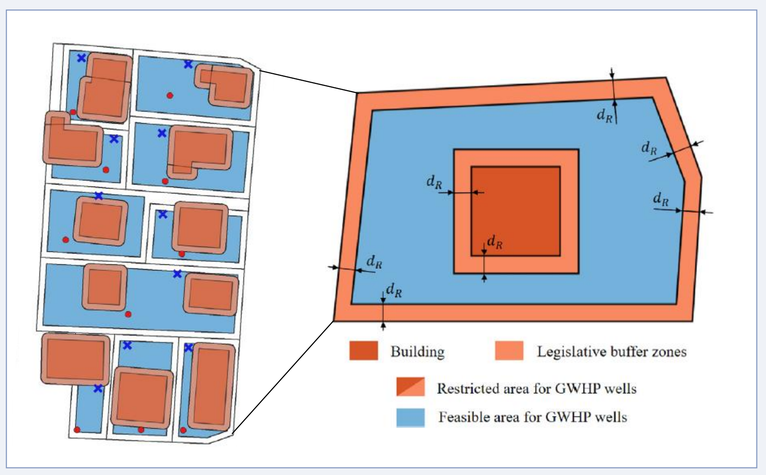
Technology specific **restricted areas** for shallow geothermal energy production (here: GWHP)



Wetlands
Water protection area
Surface water

Local limitations

(Halilovic, Böttcher et al. 2022)



Layout optimization

- Minimum distance to buildings and boundaries: d_R = 3 m
- Minimum distance between two wells: 10 m
- Minimum distance between geothermal probes: 6 m
- Maximum ground level inclination for horizontal collectors: 15 %

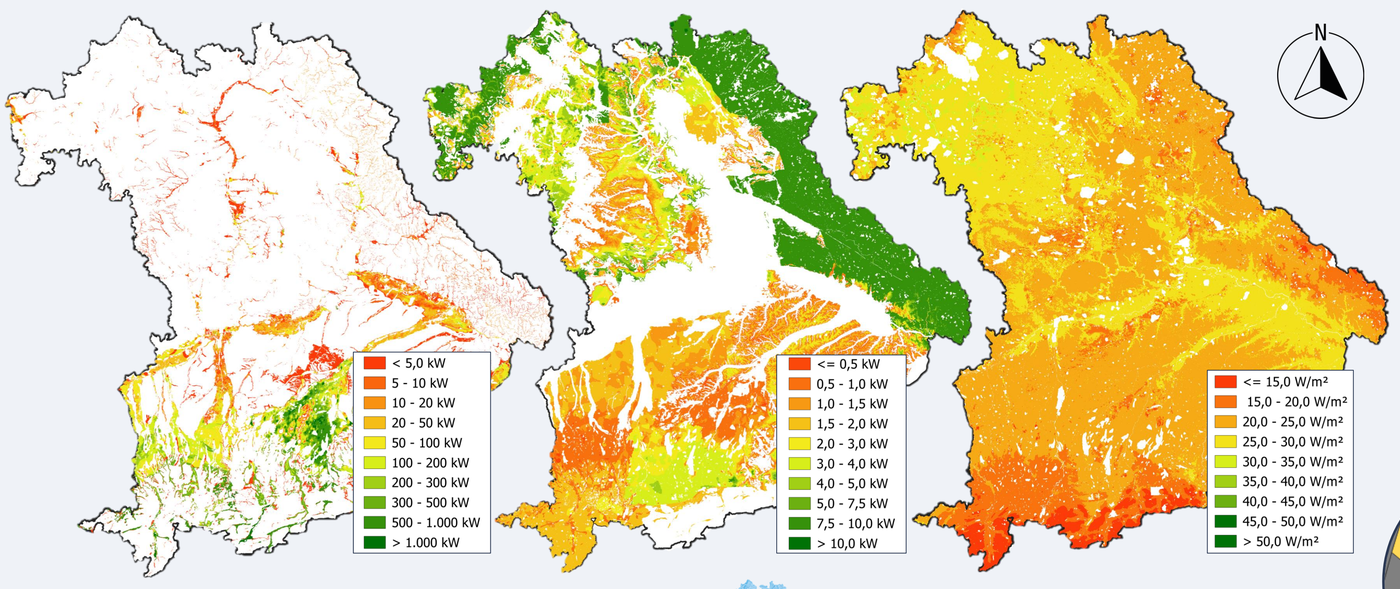
4. Results

Spatial approach: 10 m x 10 m raster data

Thermal output GWHP [kW]
Well distance: 100 m

Thermal output BHE [kW]
One geothermal probe per raster cell

Thermal output collectors [W/m²]
Horizontal collector



➢ Publicly available on:
https://www.karten.energieatlas.bayern.de

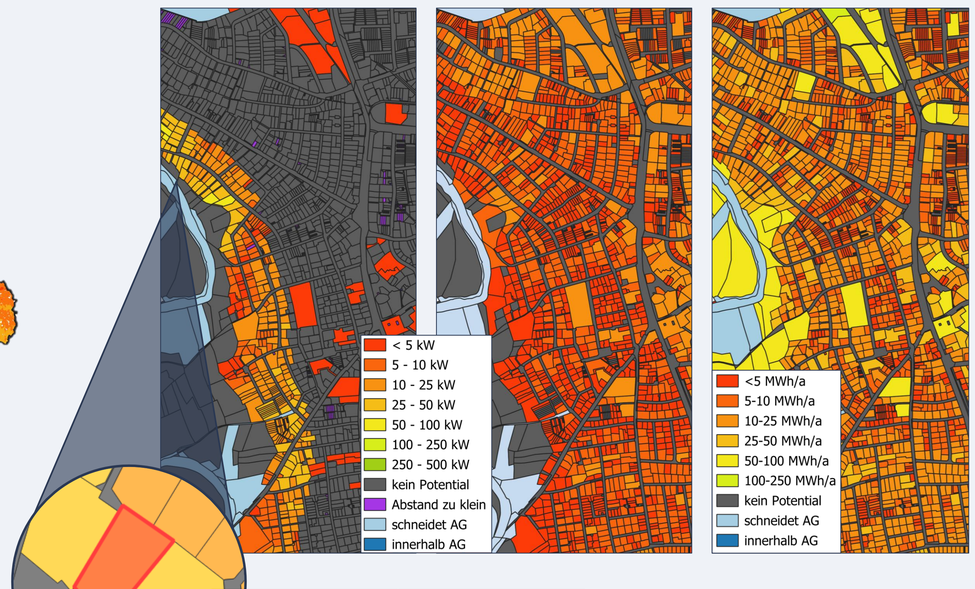
ENERGIE-ATLAS BAYERN

Local approach: plot data

GWHP [kW]
Max. possible well dist.

BHE [kW]
N-probes per plot

Heat quantity [MWh/a]
Horizontal collector



Attribute	Feature Info
Type	GWHP
Category	25-50 kW
Max. well dist. [m]	31
v-tech [l/s]	1,6
GW-thickness [m]	35
GW-distance [m]	7,2

Attribute	Feature Info
Type	BHE
Category	<5 kW
Nr. of probes	16
Probe length [m]	10
Thermal conductivity [W/(m K)]	2,1

➢ Available for each municipality via „secure box“
➢ Data protection compliant service by Bavarian authority (StmuV)

Final Conclusions:

- Minimum realisable potential by conservative quantification approach
- Full spatial coverage of Bavaria with shallow geothermal energy potential
- Locally high potentials with suitable underground conditions

→ High suitability as heat source for district networks

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Böttcher, F., Casasso, A., Götzl, G., **Zosseder, K.** (2019): TAP - Thermal aquifer Potential: A quantitative method to assess the spatial potential for the thermal use of groundwater, Renewable Energy, Volume 142, https://doi.org/10.1016/j.renene.2019.04.086

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