Scuola universitaria professionale della Svizzera italiana
Dipartimento ambiente costruzioni e design
Istituto sostenibilità applicata all'ambiente costruito

SUPSI

Recommendations for the planning and management of ground source heat pump systems in an urban environment, considering the effects of reciprocal thermal interference

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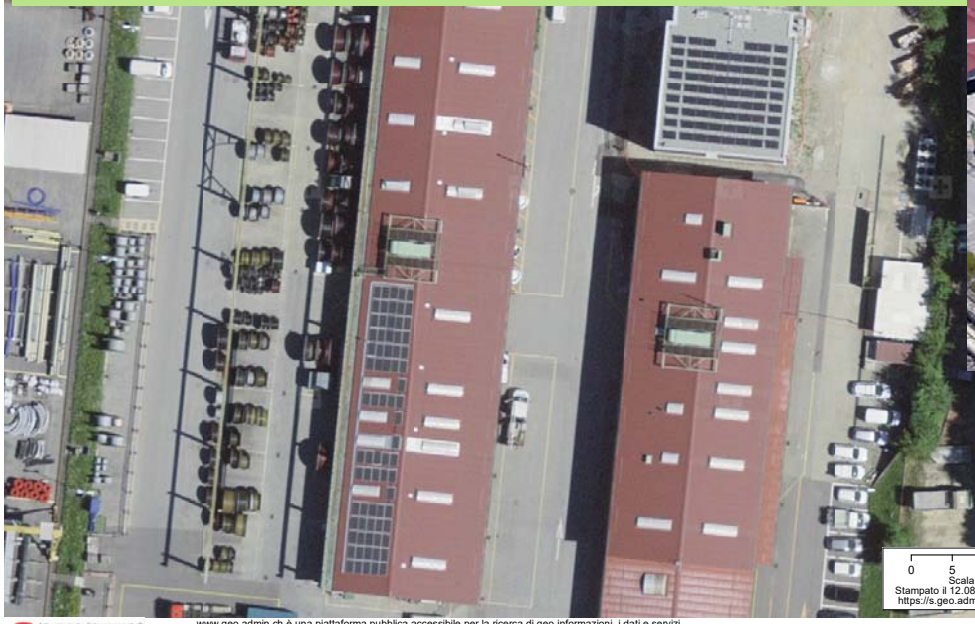
A simple concept with huge implication

Can you see photovoltaics/solar thermal installations?



Can you see geothermal installations?

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Goal

Within the GEO4CIVHIC project we tried to identify recommendations and to solve/prevent possible thermal interferences between nearby geothermal plants, in order to guarantee **maximum efficiency** for all geothermal systems, **even over the long term**.

(GEO4CIVHIC: Most Easy, Efficient and Low-Cost Geothermal Systems for Retrofitting Civil and Historical Buildings. The project is looking at integration of geothermal energy in building renovation. The project also plans to demonstrate the easiest to install and the most cost-effective geothermal energy solutions)

The problems related to interference between neighbouring BHE systems are increasingly debated in countries where the installation density of low enthalpy geothermal systems has increased (Switzerland, Germany, Sweden and Netherland).

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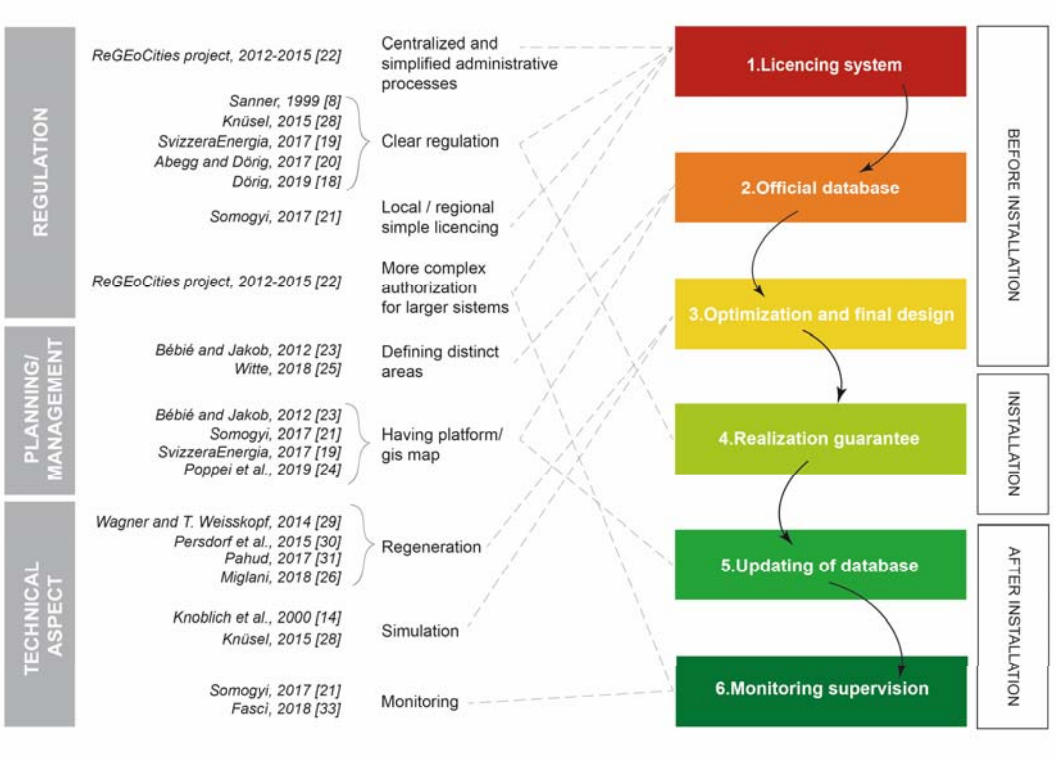
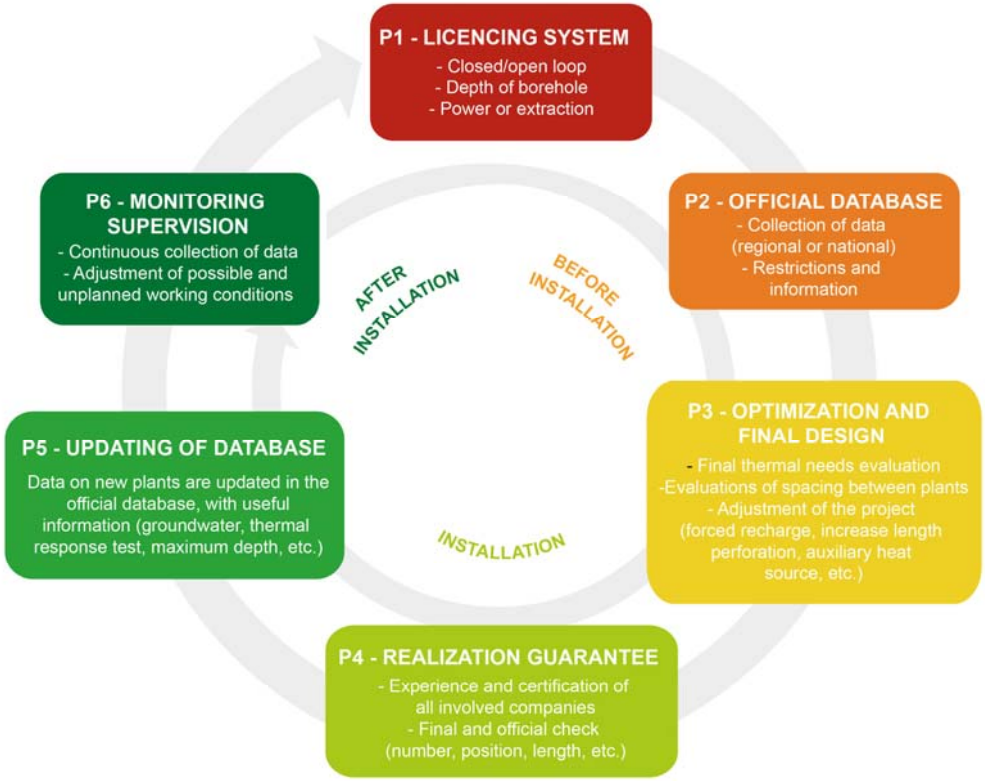
Result of the review analysis





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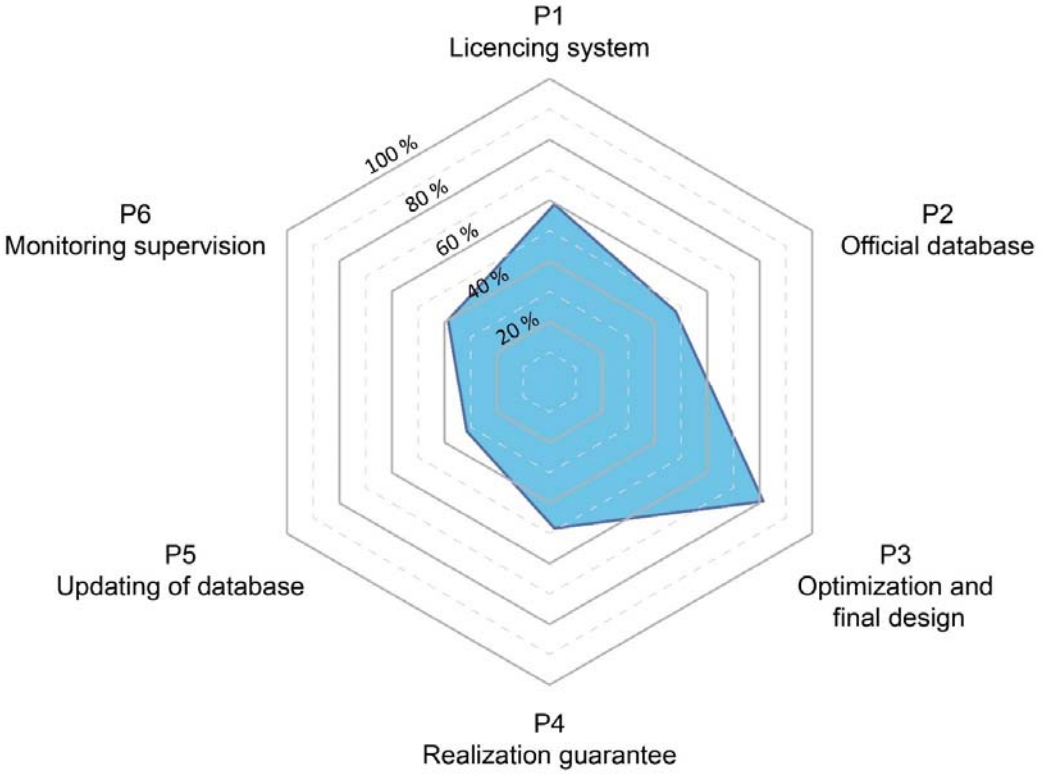
Application of the process at case studies



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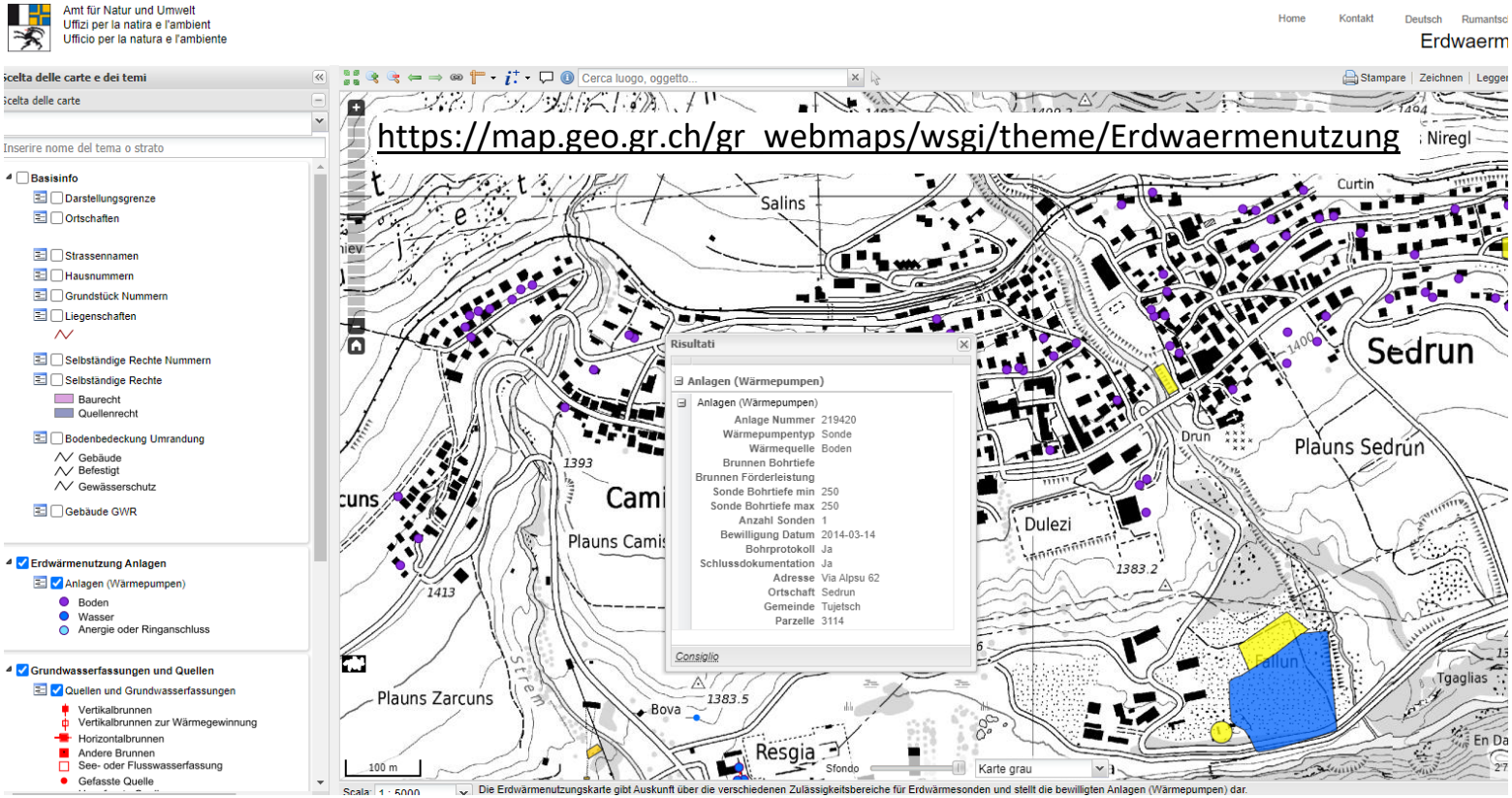
Official data base. An example from Canton Grigioni (CH)

Map and database: all information are collected in a public database, which allows you to know where and how installations are.



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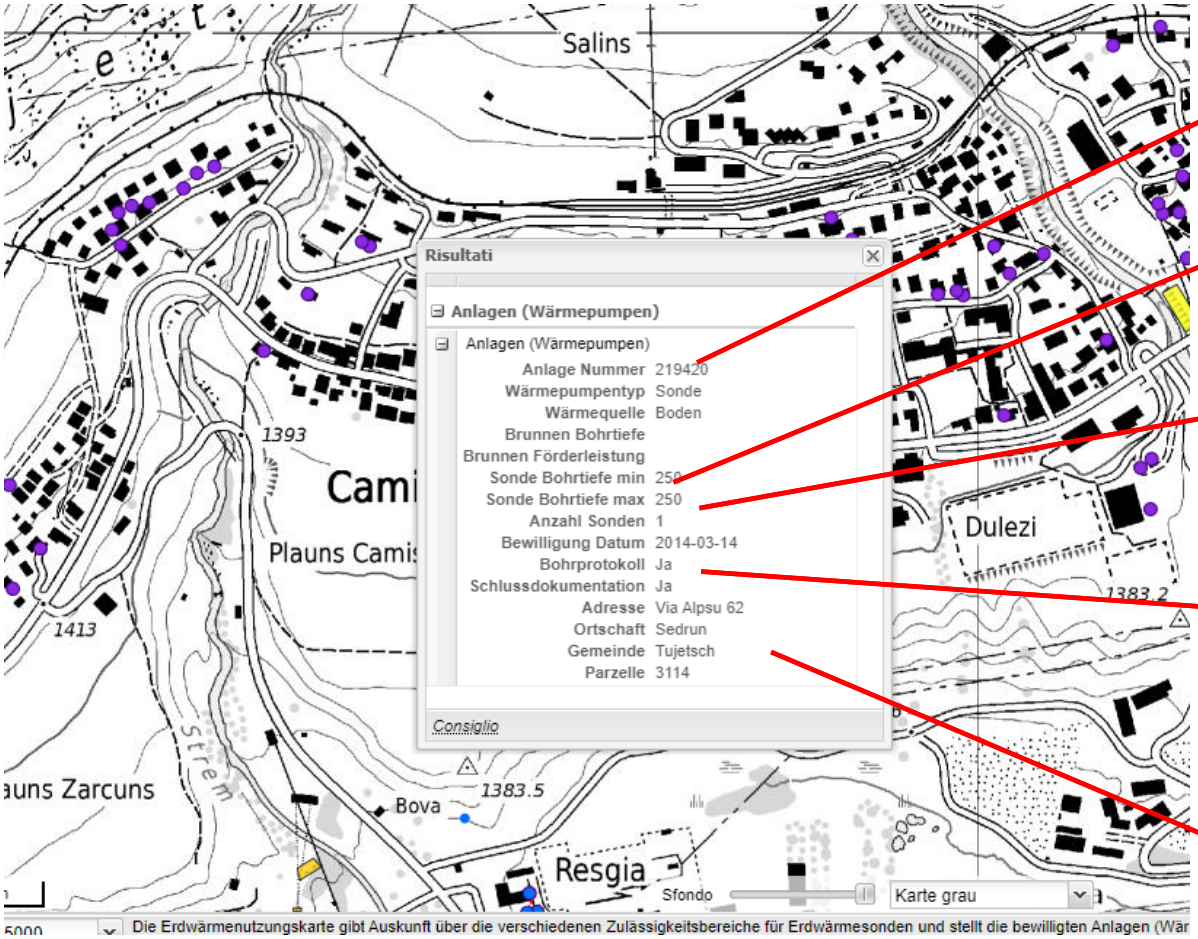
Data base. An example from Canton Grigioni (CH)



ID number of installation

Depth of drilling

Authorization date

Documentation availability

Localitazion

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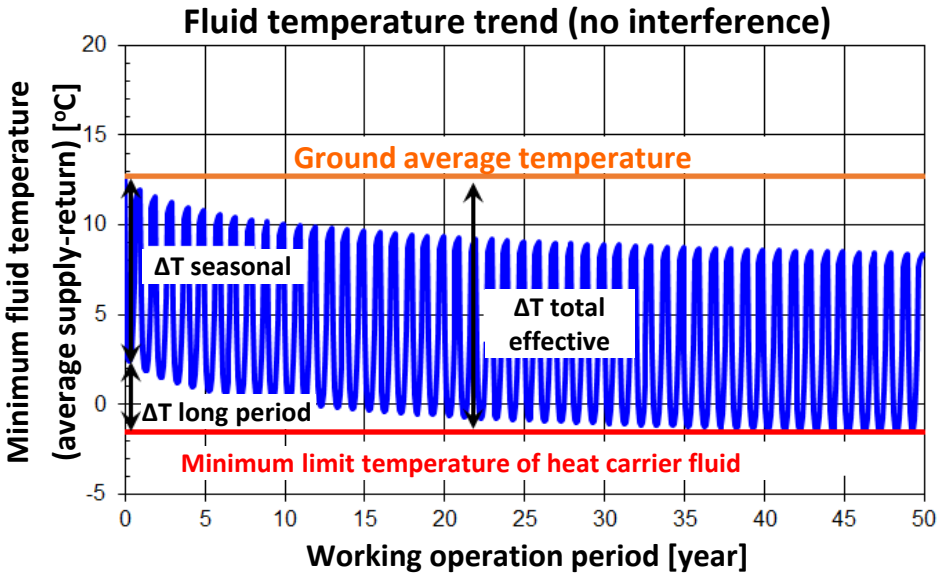
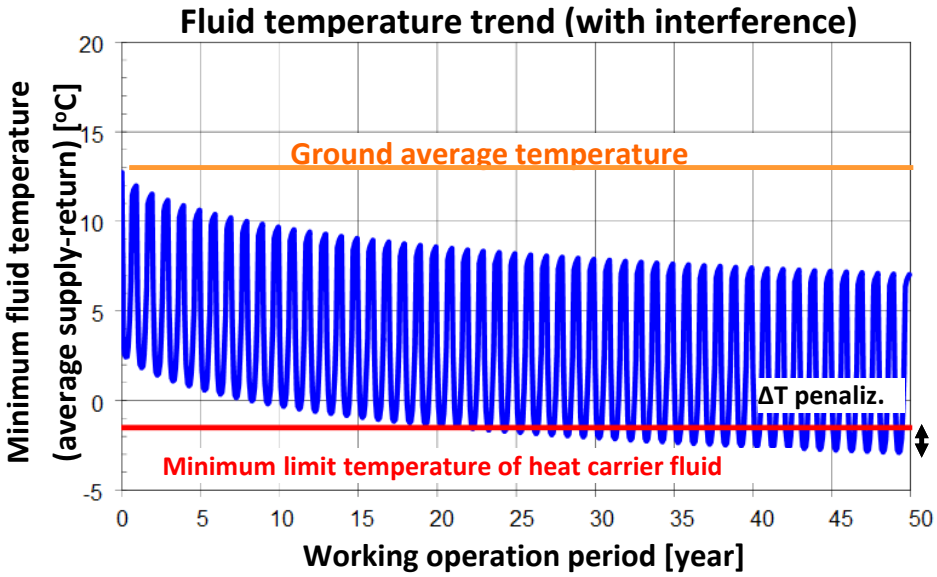
How to evaluate the thermal effect on a single sizing

The sizing generally considers the installation as if it was unique, without the presence of adjacent systems, as stated in the most European standards and norms (typically minimum -1.5° C for the average forward-return fluid temperature in the BHEs during a few working decades). If it is possible to predict the over decreasing temperature ($\Delta T_{penalization}$), the minimum temperature limit must be corrected by the effect of long term neighboring systems (-1.5°C + $|\Delta T_{penalization}|$). This method can avoid the freezing of the surrounding ground, or the stop of the GSHP system.





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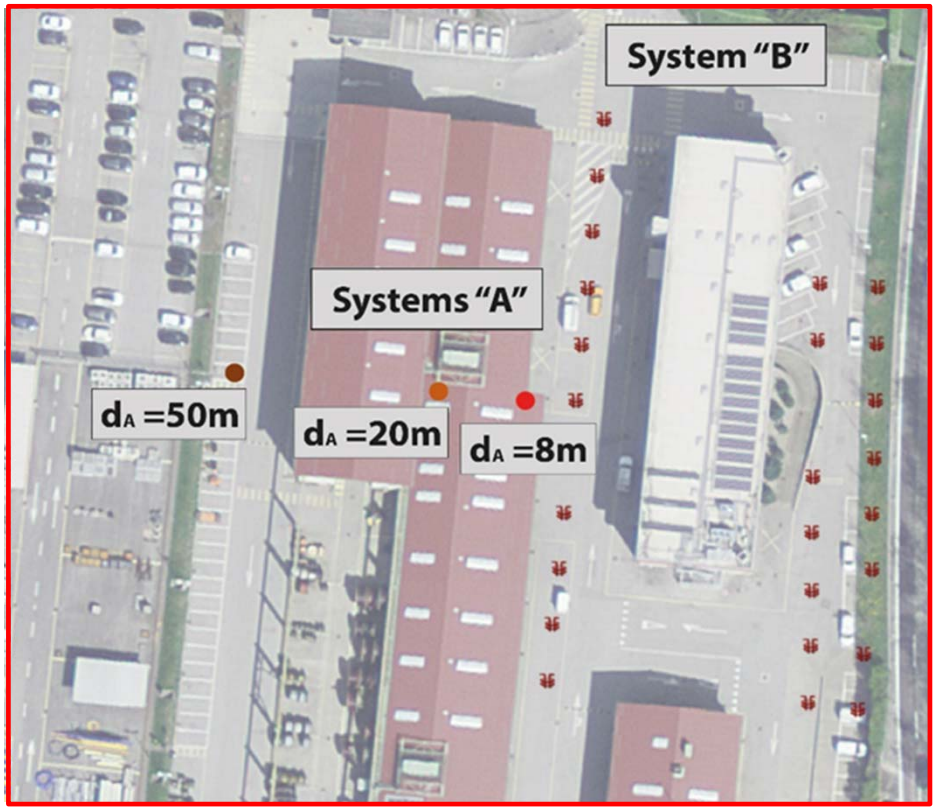
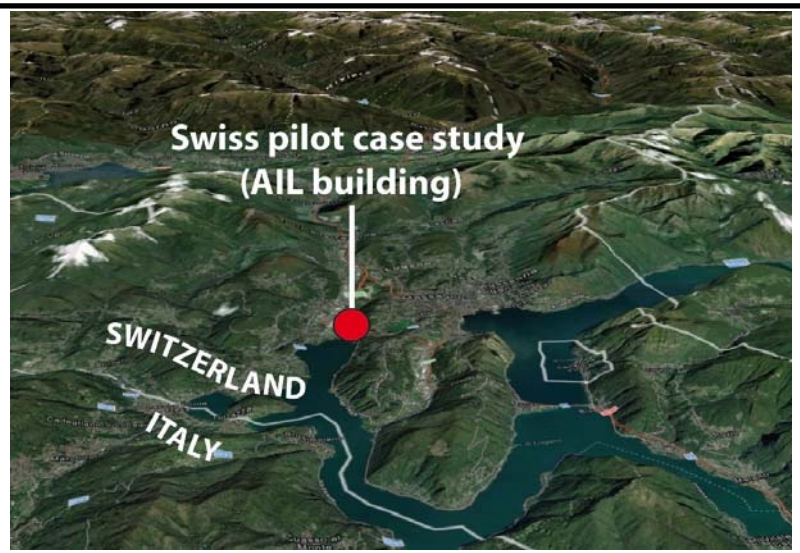
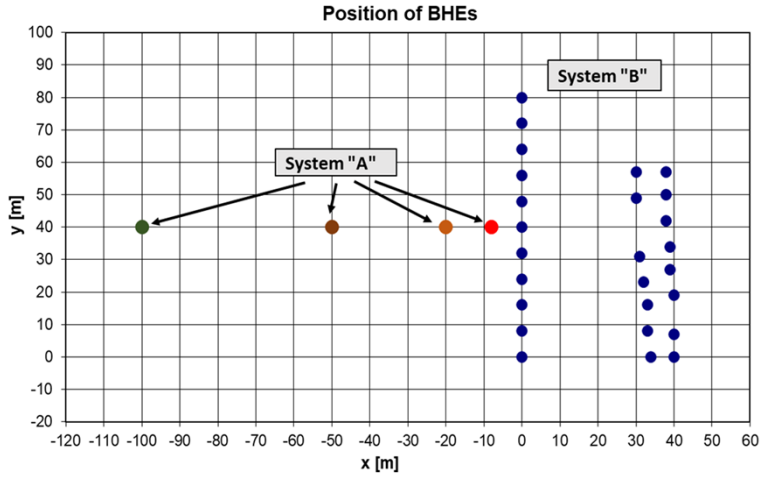
Simulation applied to a case study:

simulations based on the Swiss pilot case study – AIL building







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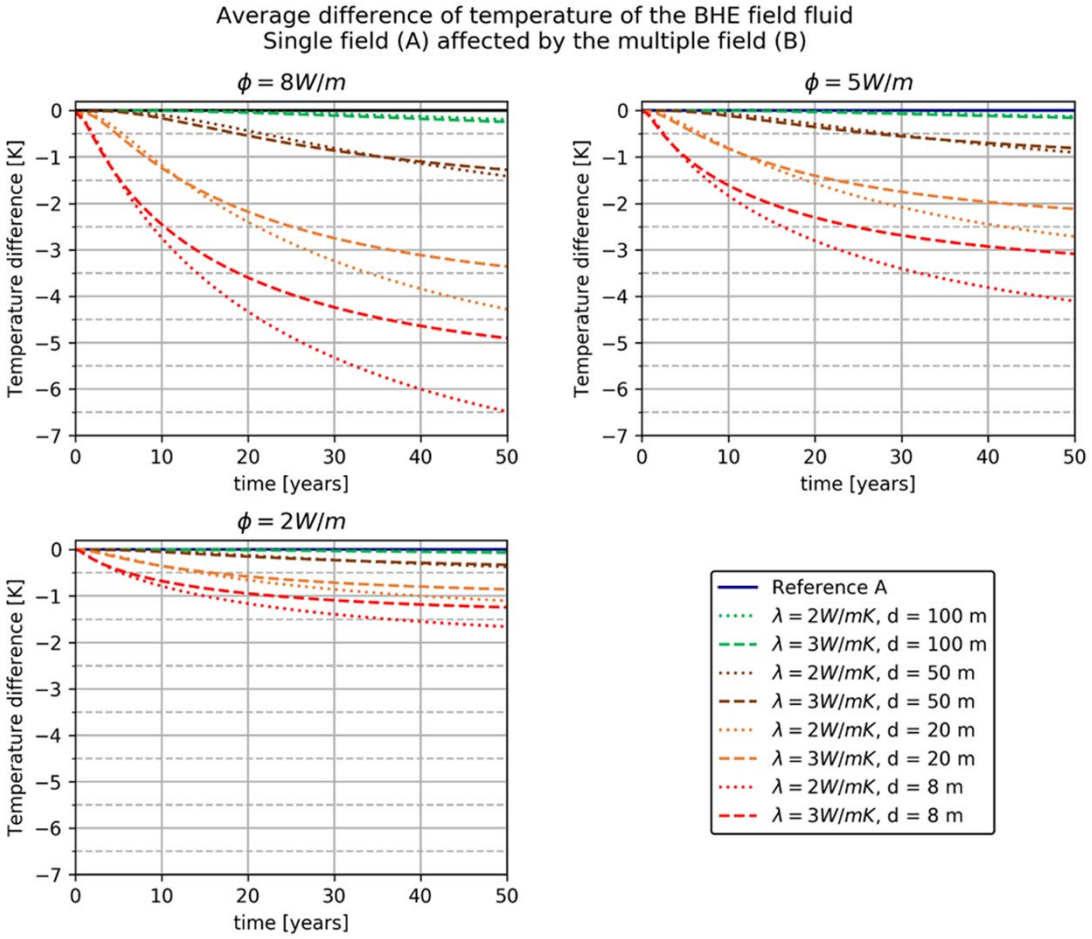
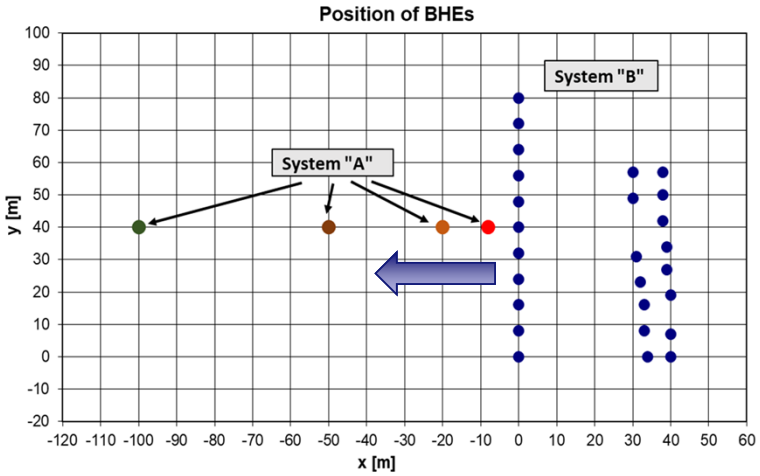
Results: single field (A) affected by multiple field (B)





$$\emptyset[W/m] = \frac{E_{gr}[Wh]}{8760[^{h}/_{y}] * L[m]}$$ → Specific heat exchange rate or linear heat source

Where:

E_{gr}: thermal energy exchanged with the ground ($E_{gr} = E_{ext} - E_{inj}$)

L : drilling length (depth per number of BHEs)

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Recommendations

1. **Important to limit a minimum distance between different geothermal systems**. If systems are closer less than 50% of the drilling depth (distance calculated as the closest point between probes), it is still possible to have some negative effect on geothermal systems;
2. **Augment the total drilling length** to increase the minimum fluid temperature (easier to do during the sizing phase);
3. **Limit the annual heat extraction** of the geothermal resource (per installation). This must be done annually recharging the ground.

→ points 2 and 3 should be implemented and evaluated together during the sizing phase)

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How do you can evaluate interference in a easy way?

With **ETHICAL** (Easy THermal InterferenCe evALuation tool), developed by UNIPD (University of Padova) together with SUPSI.

UNIVERSITÀ DEGLI STUDI DI PADOVA

It is:

- easy to use;
- without a computer code or complex setting calculations;
- useful for tackling the problem (limit and prevent eventual thermal and technical problems at urban scale between nearby geothermal systems);
- Recommended for both technical companies and public administrations.

→ Download these tools from the following link:

geo4civhic.eu/files/ETHICAL_WithoutMovingAquifer.xlsm
geo4civhic.eu/files/ETHICAL_ActiveMovingAquifer.xlsm

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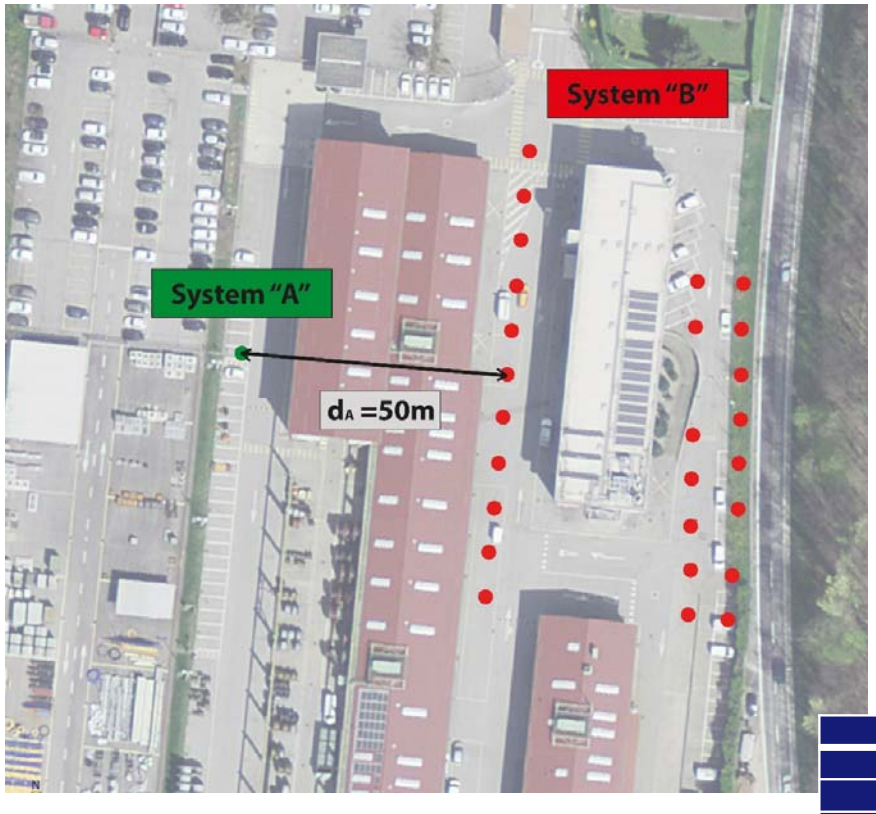
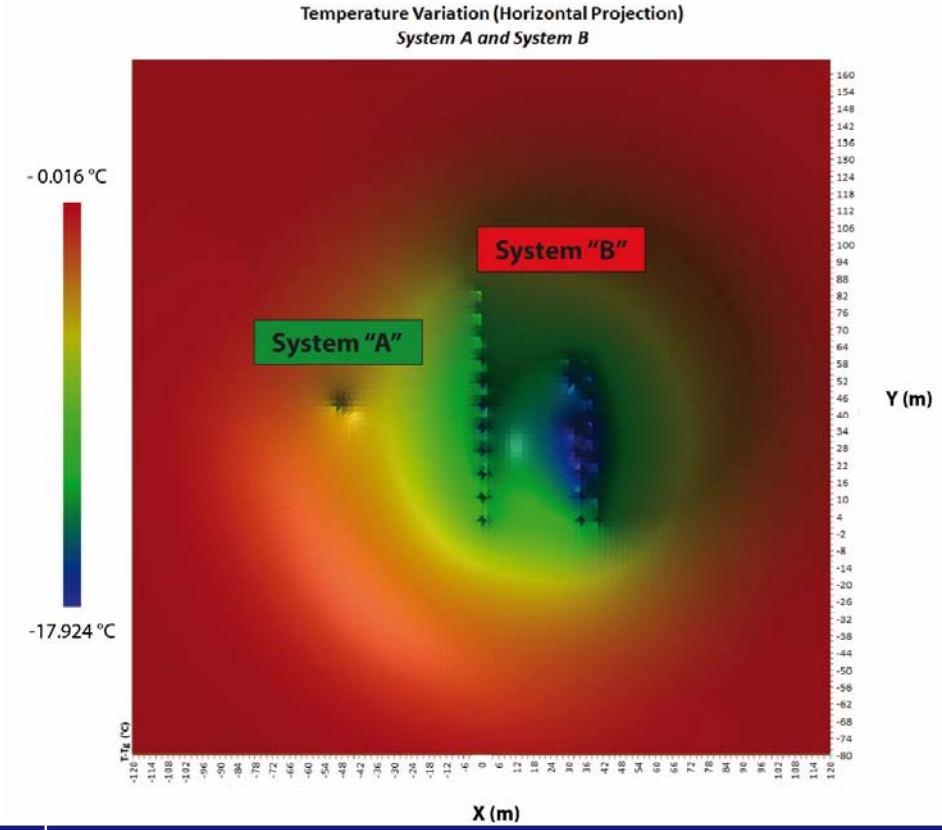
Results with ETICHAL





	Distance between different geothermal systems							
	8 m		20 m		50 m		100 m	
	Fluid temperature drop - comparison between TRNSBM and ETHICAL [K]							
	TRNSBM	ETHICAL	TRNSBM	ETHICAL	TRNSBM	ETHICAL	TRNSBM	ETHICAL
8 W/m	-4.4	-6.2	-2.5	-3.5	-0.5	-0.6	0.0	0.0
5 W/m	-2.8	-3.8	-1.6	-2.2	-0.3	-0.4	0.0	0.0
2 W/m	-1.2	-1.5	-0.7	-0.9	-0.1	-0.2	0.0	0.0

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