

Mapping the techno-economic potential of closed-loop geothermal systems: a Europe-tested method

Rodolfo Perego¹, Sebastian Pera¹, Antonio Galgaro², Giorgia dalla Santa², Matteo Cultrera², Michele De Carli³, Giuseppe Emmi³, David Bertermann⁴, Johannes Müller⁴, Dimitrios Mendrinou⁵, Kostas Karytsas⁵, Jacques Vercruyse⁶, Riccardo Pasquali⁷, Nick O'Neill⁷, Adriana Bernardi⁸

¹ Institute of Earth Science, SUPSI, Campus Trevano, CH-6952 Canobbio, Switzerland (rodolfo.perego@supsi.ch)

² Department of Geosciences, Università degli Studi di Padova, Italy

³ Department of Industrial Engineering, Università degli Studi di Padova, Italy

⁴ GeoZentrum Nordbayern, Friedrich-Alexander-University Erlangen-Nuremberg, Schlossgarten 5, 91054, Erlangen, Germany

⁵ CRES (Centre for Renewable Energy Sources and Saving), Pikérmi, Greece

⁶ GEO-GREEN sprl - Rue de Priesmont, 63 - B-1495 Marbais, Belgium

⁷ SLR Environmental Consulting Ireland Ltd. 7, Dundrum Business Park, Windy Arbour, D14, Ireland

⁸ CNR-ISAC (Institute of Atmospheric Sciences and Climate), Padova, Italy

In order to promote the deployment of low temperature geothermal closed-loop systems at European scale, the definition and quantification of the feasibility and potential for different locations is fundamental. In particular, spatial information presented as thematic maps allow optimization of the decision process, identifying more suitable or unsuitable zones and even quantifying technologic potential. The mapping work described hereafter is related to the HORIZON2020 project Cheap-GSHPs, which aims to reduce the total cost of ownership, composed out of investment and operating costs, increase the safety of shallow geothermal systems during installation and operation and increase the awareness of this technology throughout Europe. The project is in its 4th year: within this timeframe, a huge amount of geological [1], climatic [2] and technological data have been produced.

The work presented here had the aim of merging all of these data into a method to map the techno-economic potential of closed-loop shallow geothermal systems (expressed as €/kW) that could be robust and consistent at European scale. The method started with the collection of geological, climatic, energetic, technological and economic data produced within the project.

These data were the basis for the execution of a large amount of numerical simulations, which allowed us to extrapolate empirical correlations between mappable parameters such as ground surface temperature (GST), thermal conductivity (λ) and required BHE length for given energy demands, in form of different referential building types.

Seven case studies across Europe were considered for the application of the method, in order to test its reliability for different geologies, climates and data availability.

GST maps and λ maps were produced for each of the analyzed case study starting respectively from air temperature climatic normals and from large scale geological maps (from 1:25000 to 1:100000). To estimate a weighted λ , stratigraphic and hydrogeological information were also integrated in the mapping procedure. The identified regression algorithms were then applied on GST and λ maps in order to produce required BHE length maps, which allowed

the creation of €/kW maps by using a previously produced costs database. GST, λ and required BHE length maps were compared against real data (usually thermal response tests), where available.

The estimated specific capital cost €/kW index greatly varies from country to country, ranging from approximately 1100 €/kW in Belgium to 2600 €/kW in Switzerland. The cartographic products were also developed with the integration of political constraints, such as the presence of groundwater protection areas where the installation of closed-loop systems is not allowed or allowed after a case-by-case analysis. The method seems reliable, not only to create €/kW maps, but also semi-quantitative ones related to other techno-economic indexes for different European countries.

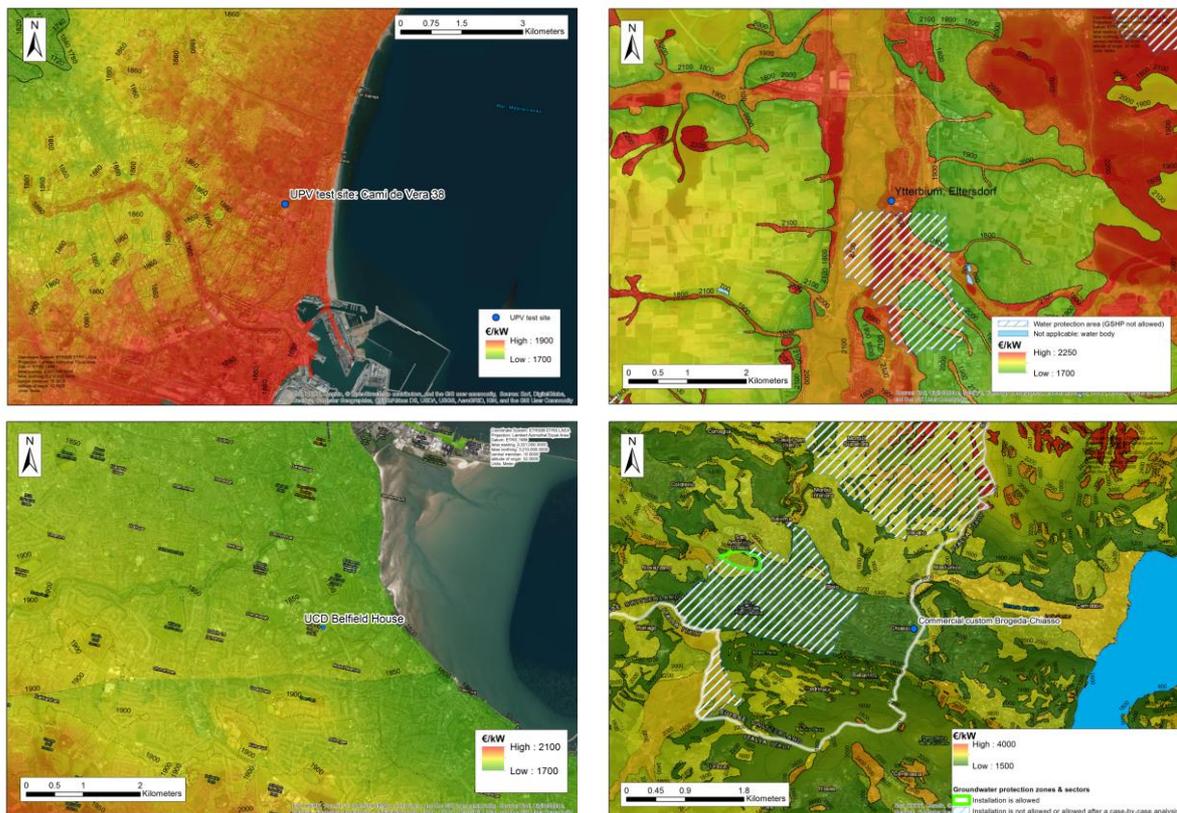


Figure 1. €/kW maps produced for 4 different case studies across Europe: [up-left] Valencia (Spain); [up-right] Erlangen (Germany); [down-left] Dublin (Ireland); [down-right] Chiasso (Switzerland)

REFERENCES

- [1] Müller, J., Galgano, A., Dalla Santa, G., Cultrera, M., Karytsas, C., Mendrinós, D., Pera, S., Perego, R., O'Neill, N., and Pasquali, R., 2018, Generalized Pan-European Geological Database for Shallow Geothermal Installations: *Geosciences*, v. 8, no. 1, p. 32.
- [2] Carli, M. de, Bernardi, A., Cultrera, M., Dalla Santa, G., Di Bella, A., Emmi, G., Galgano, A., Graci, S., Mendrinós, D., Mezzasalma, G., Pasquali, R., Pera, S., Perego, R., and Zarrella, A., 2018, A Database for Climatic Conditions around Europe for Promoting GSHP Solutions: *Geosciences*, v. 8, no. 2, p. 71.