Shallow Geothermal Energy use in district heating and cooling systems

João Figueira, IST-UL, Lisbon

GEOTHERMAL DHC

Towards Decarbonized Heating and Cooling!

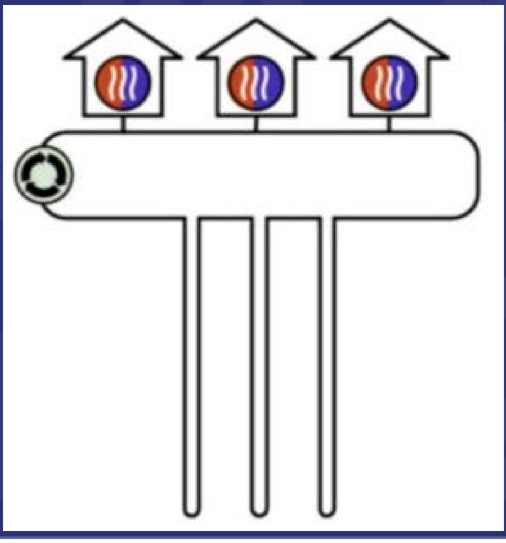
www.geothermal-dhc.eu

CA18219 Geothermal-DHC Fact Sheet No.3

The thermal energy retained in surface underground reservoirs is known as

Shallow Geothermal Energy (SGE)

It offers an immense potential for Heating, Ventilation, and Air-Conditioning (HVAC) of buildings and other heating and cooling needs. When highly efficient heat pumps are coupled with SGE reservoirs (Ground Source Heat Pump, GSHP), the resulting technology becomes of significant energy performance for space heating, cooling and hot water production[1].



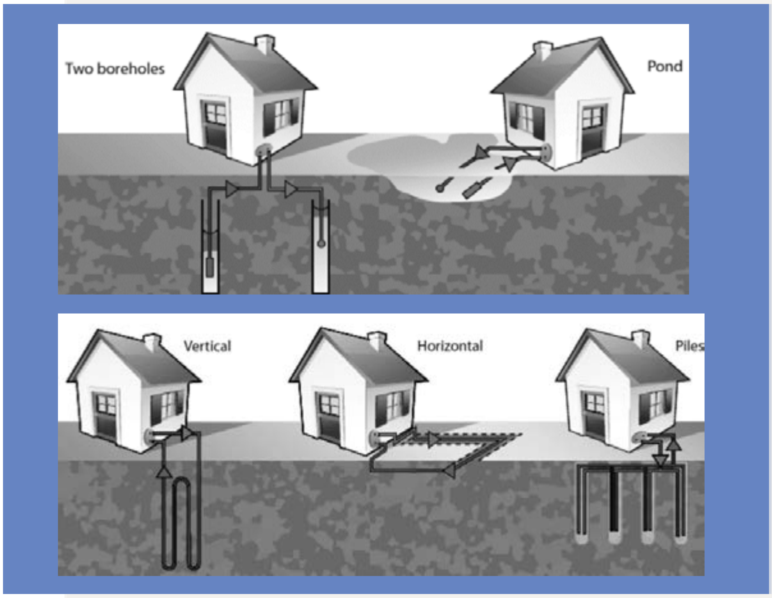
The substantial reduction in energy consumption and low GreenHouse Gas (GHG) emissions are the most important reasons why SGE is increasingly promoted as a promising technology for climate change mitigation.

Date of publishing: November 2023

Shallow Geothermal Energy use in district heating and cooling systems

November 2023

Two main categories of SGE systems can be found depending on the type of Geothermal heat exchanger (GHEs): open or closed loop systems, respectively in the figure[2].



Open loop systems are characterized by the direct use of a thermal fluid available locally. These systems typically use of ground or surface water to directly extract or reject heat, depending on the working cycle, and then the water is reinjected in the same or adjacent reservoir.

Closed loop systems are characterized by the indirect use of the underground medium via a closed-loop system of GHEs with the aid of an intermediate heat carrier fluid. They can present different configurations, horizontal or vertical, also called Borehole Heat Exchangers (BHEs). If the GHEs are embedded in structural elements are called energy piles, energy walls or slabs, and energy tunnels.

SGE is an endogenous and ubiquitous resource able to contribute to climate change mitigation

District Heating and Cooling (DHC) systems have evolved in such way that the trend is clearly towards lower distribution temperatures, increased flexibility and the use of digital technologies for monitoring and control, increasing its energy performance and economic feasibility. The 4th and 5th generation of DHC systems represent the technological improvement in which, now, SGE can be included in these systems as a thermal source/sink and/or balancing unit[3].

- SGE reservoirs present stable temperatures of approx. 2 °C above the average local air temperatures, which are within the range of -5 to 28 °C[4].
- From 2015 until 2019, the world's total capacity of GSHP installed increased at an annual rate of 10,86%, up to 77,5 MWt[5].
- In 2008, the use of 879,000 GSHP systems in 19 European countries saved 3.7 × 106 tCO_2 (eq.) in comparison to conventional heating practices[6].

Shallow Geothermal Energy use in district heating and cooling systems

November 2023

SGE use in DHC systems - Case Studies

Ombria Resort

Querença, Portugal

The largest closed-loop geothermal system and the only DHC system using SGE technology in Portugal.

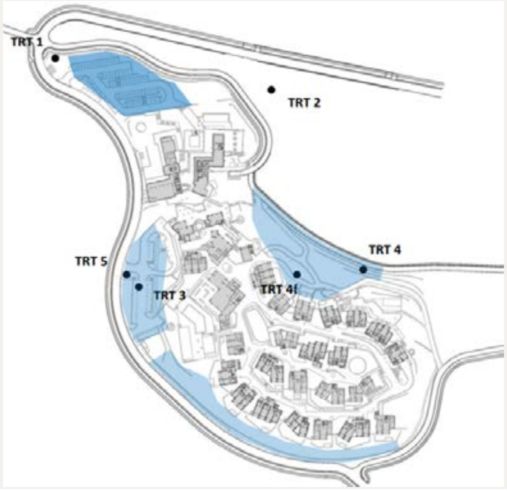
The resort features a hotel, a golf course, several individual residences, a clubhouse, and a spa. Space heating, space cooling, domestic hot water are going to be supplied by a highly efficient HVAC system based on SGE and solar thermal energy. It is comprised by 4 main loops made of: i) 40 BHEs of 100 m depth, ii) 60 BHEs of 125 m depth, iii) 72 BHEs of 115 m depth, and iv) 72 BHEs of 115 m depth.

Munich Cooling GRID

Munich, Germany

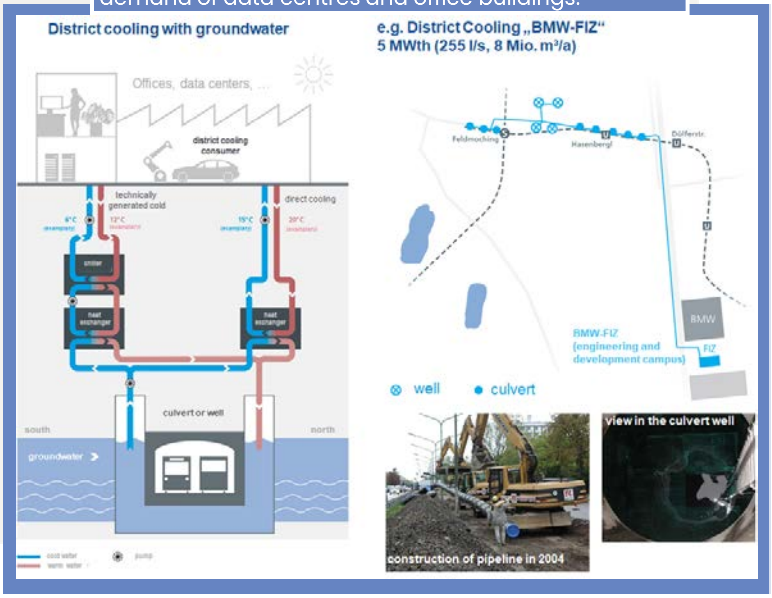
Operated by the City Energy supplier (SWM Services GmbH), it is implemented to cover the cooling needs mainly of data centres, office buildings and industrial buildings.

An inner-city cooling grid was set up using different source components, turbo compressor and hybrid cooling units, ice storage, and deep geothermal wells are planned. But the main grid source is an open-loop SGE system with usage of surface water and groundwater.



Ombria Resort - location of the four loops of BHE (blue zones) and the location of the thermal response tests (TRT) performed for its design.

Example for a part of the Munich Cooling Grid using culvert wells for direct cooling to cover a large cooling demand of data centres and office buildings.



CA18219 Geothermal-DHC Fact Sheet No.3

List of Authors

- João Figueira, IST-UL, Lisbon
- Apostolos Michopoulos, University of Cyprus
- Jannis Epting, University of Basel
- Kai Kosseder, Technical University of Munich

Contact: joao.figueira@tecnico.ulisboa.pt

GEOTHERMAL DHC

Towards Decarbonized Heating and Cooling!

References

[1]EHPA (2018), European Heat Pump Association

[2]Manzella (2017), EPJ Web Conf. Volume 148

[3]Goetzl et al. (2023), EFGJ, Volume 54

[4]Jones et al. (1999), Reviews of Geophysics 37

[5]Lund & Toth (2021), Geothermics 90

[6]Bayer et al. (2012), Renewable & Sustainable Energy Reviews 16

Visit our web portal

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the European Union

COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation.

This publication is based upon work from COST Action Geothermal-DHC, CA18219, supported by COST (European Cooperation in Science and Technology).