Promising present and future technical concepts for the inclusion of geothermal energy in heating and cooling grids in Europe

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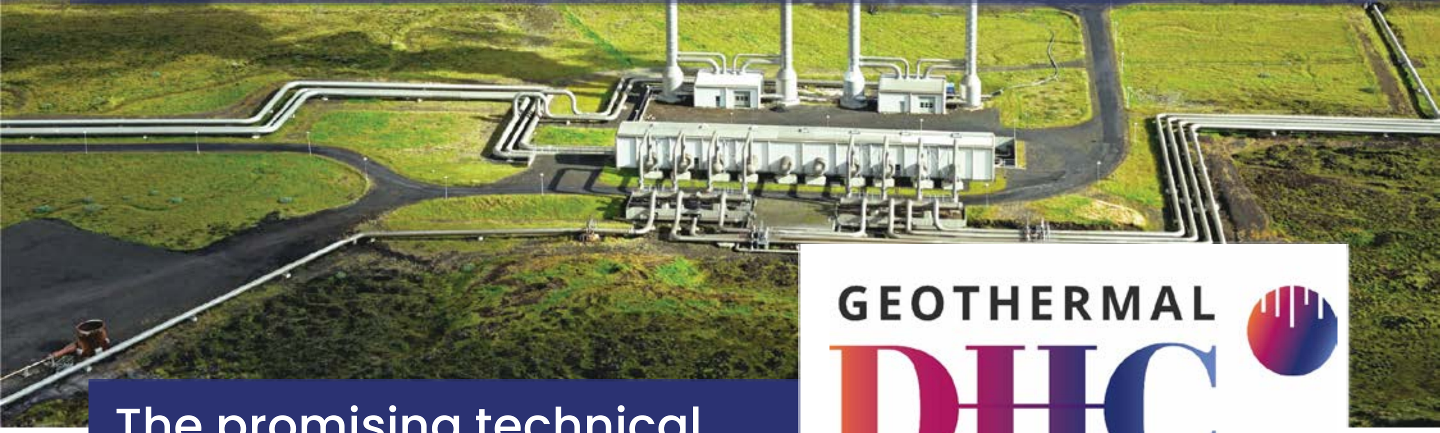

GEOTHERMAL DHC

Towards Decarbonized Heating and Cooling!

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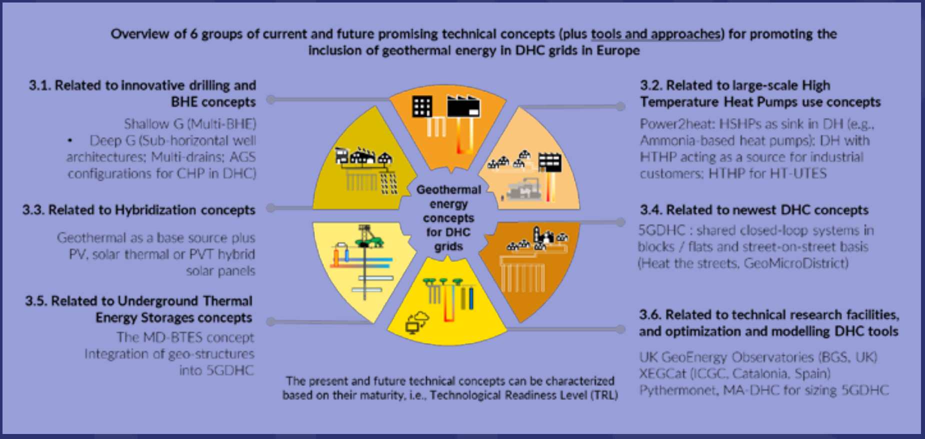
The promising technical geo-concepts in a nutshell

Advanced tech will revolutionize geothermal use in district heating soon



- Directional Drilling & BHE Technologies
- High Temperature Heat Pumps
- Hybridization & Topology Configurations
- Underground Thermal Energy Storage configurations
- 5GDHC: Closed-Loop Systems
- Research Facilities and Optimization Tools

The Geothermal-DHC vision for renewable heating and cooling (H&C) in Europe

- "Integration of new drilling and advanced geothermal exploitation technologies plus underground storage combined with other RES energy sources can create much more resilient and self-sustaining district H&C solutions."
- "Modern, smart 5th generation community geothermal decentralized microgrid systems will improve energy independence and promote local ownership and awareness."

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Advantages of new concepts and technologies for geothermal use in district H&C grid systems

- Angled drilling enhances shallow geothermal systems in dense urban areas, optimizing space for multiple borehole installations, ideal for retrofits.
- Sub-Horizontal Wells (SHW) can optimize deep geothermal extraction, accessing hotter reservoirs with low permeability, enhancing productivity, and reducing required wells in DH grid projects.
- Innovative multi-drain drilling enhances DH geothermal projects by maximizing reservoir interaction, significantly boosting flow rates—a game-changer.
- Deep Advanced Geothermal Systems (AGS) offer game-changing potential without induced seismicity, low exploration risk, and universal applicability in urban areas for deploy innovative DH solutions.
- High temperature heat pump (HTHP) technology provide extra versatility transforming low-quality geothermal heat to high-quality useful heat, powering industry, and enabling Power-2-Heat and thermal storage in networks.
- Hybridization of decentralized GSHP in 5GDHC using also modern concepts like closed-loop, street-by-street or tower-blocks configurations with PV/T and storage can achieve net-zero consumption, enhancing autonomy and efficiency in smart DHC grid-connected buildings.
- Research field facilities together with the open source 5GDHC modeling tools improve geothermal knowledge and its integration in DHC, based on sensors and data in real time, allowing to improve pre-sizing, evaluate the feasibility for decision making and optimize existing systems.

Barriers, obstacles and difficulties still to overcome

- Precise knowledge of the occupation of urban space by underground infrastructure restricts the feasibility of executing multi-inclined BHEs for shallow geothermal deployment.
- Sub-Horizontal Wells (SHW) and multi-drain drilling concepts in deep geothermal face more risks and higher costs due to more complexity during the drilling execution.
- AGS tech if success and commercially attractive, could be a real game changer allowing deep geothermal anywhere in DHs, but still in demo phase with limited providers globally.
- Adopting HTHP with eco-friendly refrigerants such ammonia poses operational challenges due to toxicity and flammability risks. HTHP above 120ºC is still hindered by limited experiences, slowing real practical implementations.
- Medium and high temperature Underground Thermal Energy Storage (UTES) are mostly still in demonstration phase. It requires A good hydrogeological understanding.
- Combining decentralized ground source heat pumps (GSHP) in 5GDHC with PV/T and storage achieves net zero consumption in the building but requires sufficient rooftop space to implement collectors.
- Deploying shared closed-loop systems for 5GDHC on a per-street or apartment block basis can faces challenges in cities with restrictions on drilling, permits, space, and hydraulic tube installations inside tower blocks.

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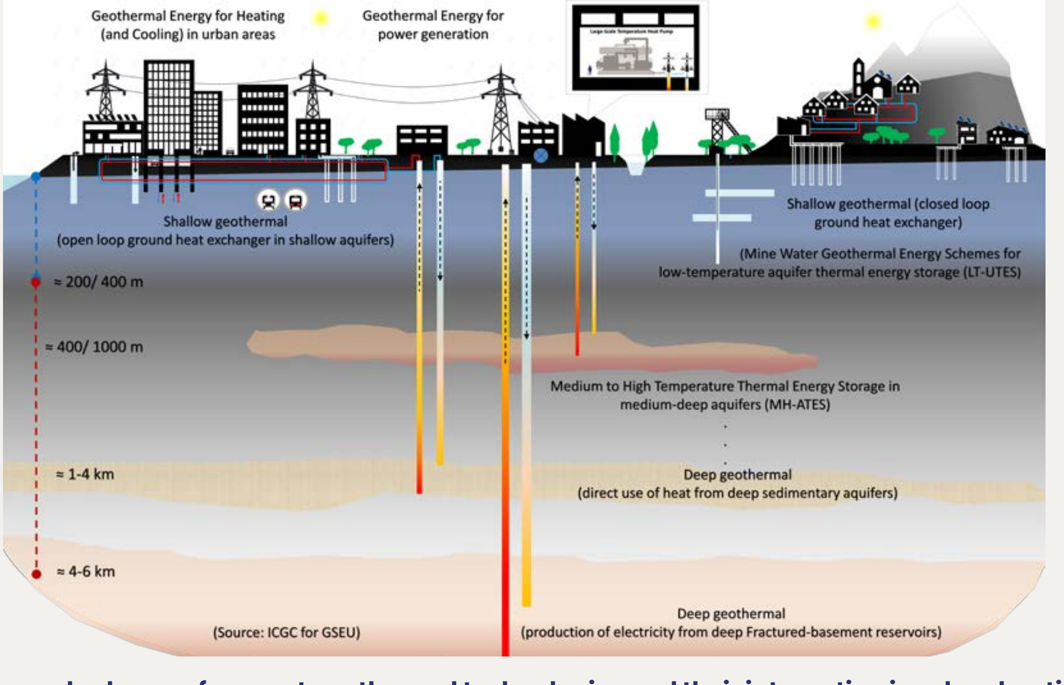
Overview of benefits and challenges of 6 groups of current and future tech concepts:

1. **Directional Drilling & BHE Technologies:** Benefits: Efficient, precise geothermal extraction. Challenges: High upfront investment costs.
2. **High Temperature Heat Pumps:** Benefits: Scalable, harnessing water's consistent temperature. Challenges: Infrastructure adaptation, environmental considerations.
3. **Hybridization & Topology Configurations:** Benefits: Integrating diverse energy sources. Challenges: System complexity, compatibility issues.
4. **Underground Thermal Energy Storage:** Benefits: Enhanced grid flexibility, reliable supply. Challenges: Technological complexity, potential subsurface impacts.
5. **5GDHC: Closed-Loop Systems:** Benefits: Shared, efficient heating and cooling. Challenges: Technological infrastructure development, regulatory hurdles.
6. **Research Facilities and Optimization Tools:** Benefits: Accelerated innovation, improved efficiency. Challenges: Funding constraints, evolving technology landscape

These concepts collectively offer promising solutions for integrating geothermal energy into European heating and cooling grids, addressing both potential benefits and challenges across various technical domains for the energy transition in cities and towns.



General scheme of present geothermal technologies and their integration in urban heating and cooling networks[1]

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[1] Ignasi Herms, ICGC. GeoEnergy Resources – Geothermal Energy. Meet the GSEU Webinar – Mapping and Managing Sustainable GeoEnergy Capacities in Europe. https://www.geologicalservice.eu/events/

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