Sustainable energy supply and storage with enhanced geothermal energy systems

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Primary Energy Consumption
Distribution of the Energy Consumption in the Residential Sector

- Heating: 77%
- Warm water: 11%
- other electrical appl.: 7%
- Cooking: 4%
- Lighting: 1%
Geothermal Energy

Which chances does Goethermal Energy offer?

Our Earth:

• > 98 %: hotter than 1.000 °C
• < 0,1 % colder than 100 °C

• quasi-infinite
• basically everywhere available
• base-load suitable
• decentral
Geothermal

• Deep Geothermal
  • Power generation
  • Thermal use

• „Shallow“ / Low-Enthalpy Geothermal
  • Heating and cooling of buildings
  • Energy storage
Geothermal use of the Subsoil

For **heating** and **cooling** purposes energy can be extracted from or stored in the subsoil by e.g.:

- Borehole heat exchangers
- Ground loops
- Energy Piles & other earth-contacting massive absorbing elements
- Groundwater wells
Energy Piles

Energy piles and other foundation elements

Structural function
Thermal function for heating and cooling

- Heat exchanger tubes integrated in the concrete
- Energy transfer through circulating heat exchanger fluid
Examples of Application
- Frankfurt am Main / Germany -

- Geothermal use of subsoil
Skyline of Frankfurt am Main, Germany
Example of Application
- PalaisQuartier, Frankfurt am Main / Germany -

- Construction in cut-and-cover-method
- Primary columns and piles reach into the limestone layers

Subsoil and building cross section

Frankfurt Clay
Frankfurt Limestone
quaternary
Zeil-Galerie
Example of Application
- PalaisQuartier, Frankfurt am Main / Germany -

Installation of Heat Exchanger Pipes

Installation of connection through raft

Emplacement of primary columns
Example of Application
- PalaisQuartier, Frankfurt am Main / Germany -

Foundation piles
- Ø up to 1.86 m,
  Length up to 27 m
- 262 of 302 piles built as Energy piles

Retaining wall
- Ø 1.5 m,
  Length up to 38 m
- 130 of 543 piles built as Energy piles (almost every second reinforced pile)

overall: 392 Energy piles
Example of Application
- PalaisQuartier, Frankfurt am Main / Germany -

Seasonal Thermal Storage

Winterbetrieb

Sommerbetrieb

max. power: 913 kW
winter operation: 2.350 MWh
summer operation: 2.410 MWh
Coupled Numerical Simulation
- PalaisQuartier, Frankfurt am Main / Germany -

Temperature distribution after summer operation

Temperature distribution after winter operation

- Largest amount of thermal influence in the areas with high energy pile density
- Largest spreading of thermal influence in groundwater flow direction
Coupled Numerical Simulation
- PalaisQuartier, Frankfurt am Main / Germany -

Calculation results · vertical cross sections

Transition winter to summer operation
(after 5 cooling periods)

cross section A-A

unaffected groundwater

20,5°C

8,5°C

cross section B-B
CO₂-Geothermal Heat Exchangers
- R&D-Project -

- Heat carrier fluid: CO₂ : easy to handle, free of environmental hazards
- Steel/copper pipes (plus corrosion protection)
- Closed system

Research project: Numerical Simulation of Heat Pipe Energy Transport (Dipl.-Ing. Jie Zheng)
New De-Icing-System QuaWiDiS
- R&D-Project -

Development of the new, qualified snow-removal-system for passengers transport areas based on the use of renewable energy: QuaWiDiS

R&D-project funded by the German Federal Ministry of Education and Research
R&D-Projects
- Enhanced GRT and Backfill Material-

Research Project: Geothermal Responsive Test
Development of a Transient Test Evaluation

- Reduction of testing time
- Cost reduction
- Economic usage also for small projects possible

Research Project:
Freeze-Thaw Stability of Borehole Heat-Exchanger backfill material
(Dipl.-Ing. Solenne Rochée)
Thank you for your kind attention!

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