Intelligent Energy Europe

Groundreach Workshop

Athens, Greece, January 24, 2008

Ground Source Heat Pump Technology – more than 60 years of development towards efficiency and comfort

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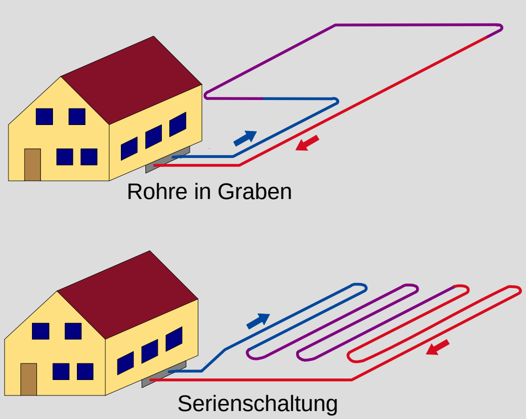
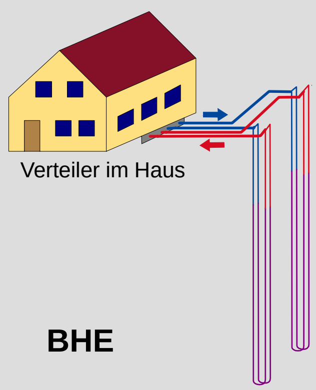
European Geothermal Energy Council, Brussels

Ground Source Heat Pumps

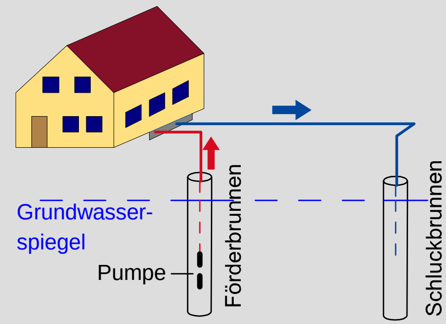
The various methods for ground coupling

• horizontal loops	1.2 - 2.0 m depth
• borehole heat exchangers (vertical loops)	10 - 250 m depth
• energy piles	8 - 45 m depth
• ground water wells	4 - 50 m depth
• water from mines and tunnels	





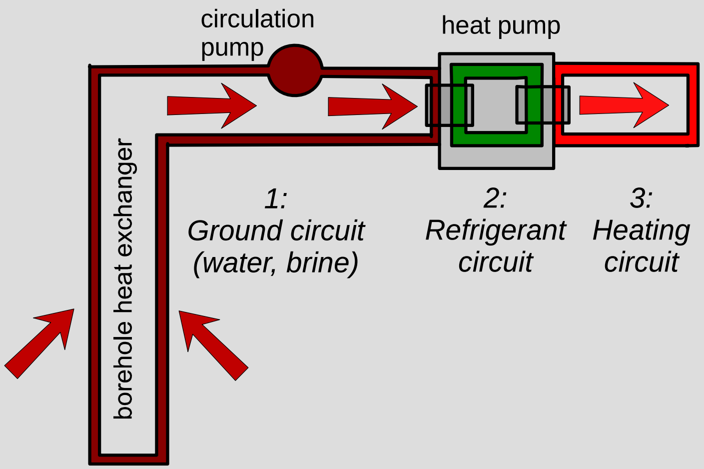
BHE

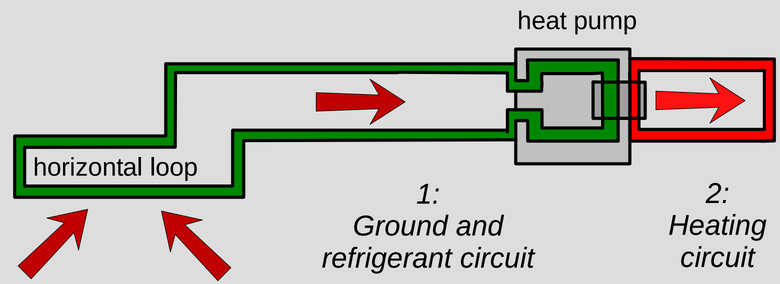


Groundwater wells

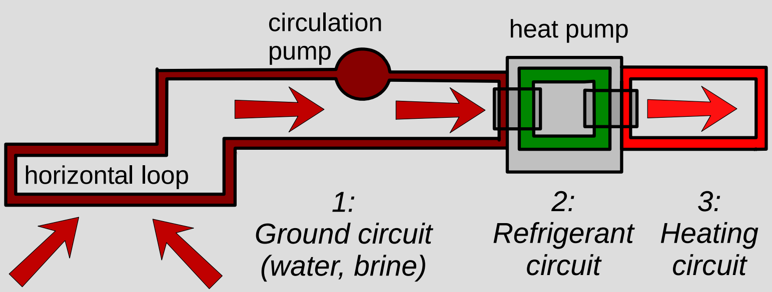
Ground Source Heat Pumps

Ground circuit options

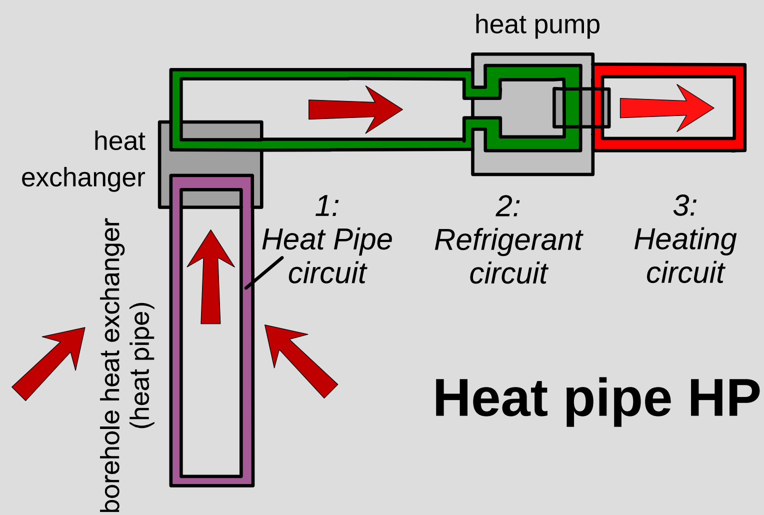




Direct Expansion HP



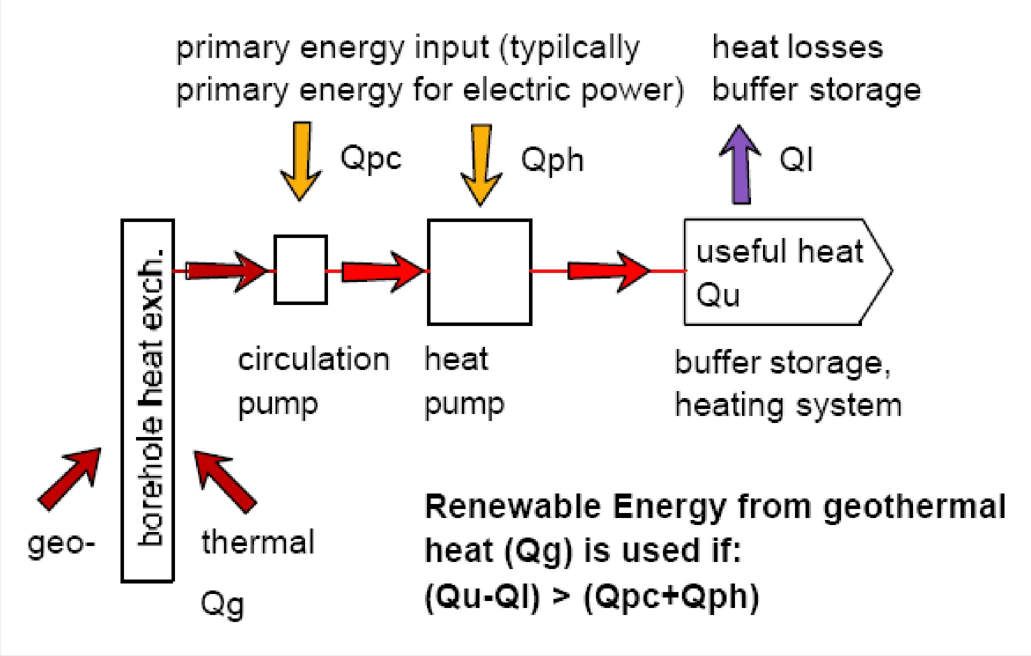
Brine/water HP



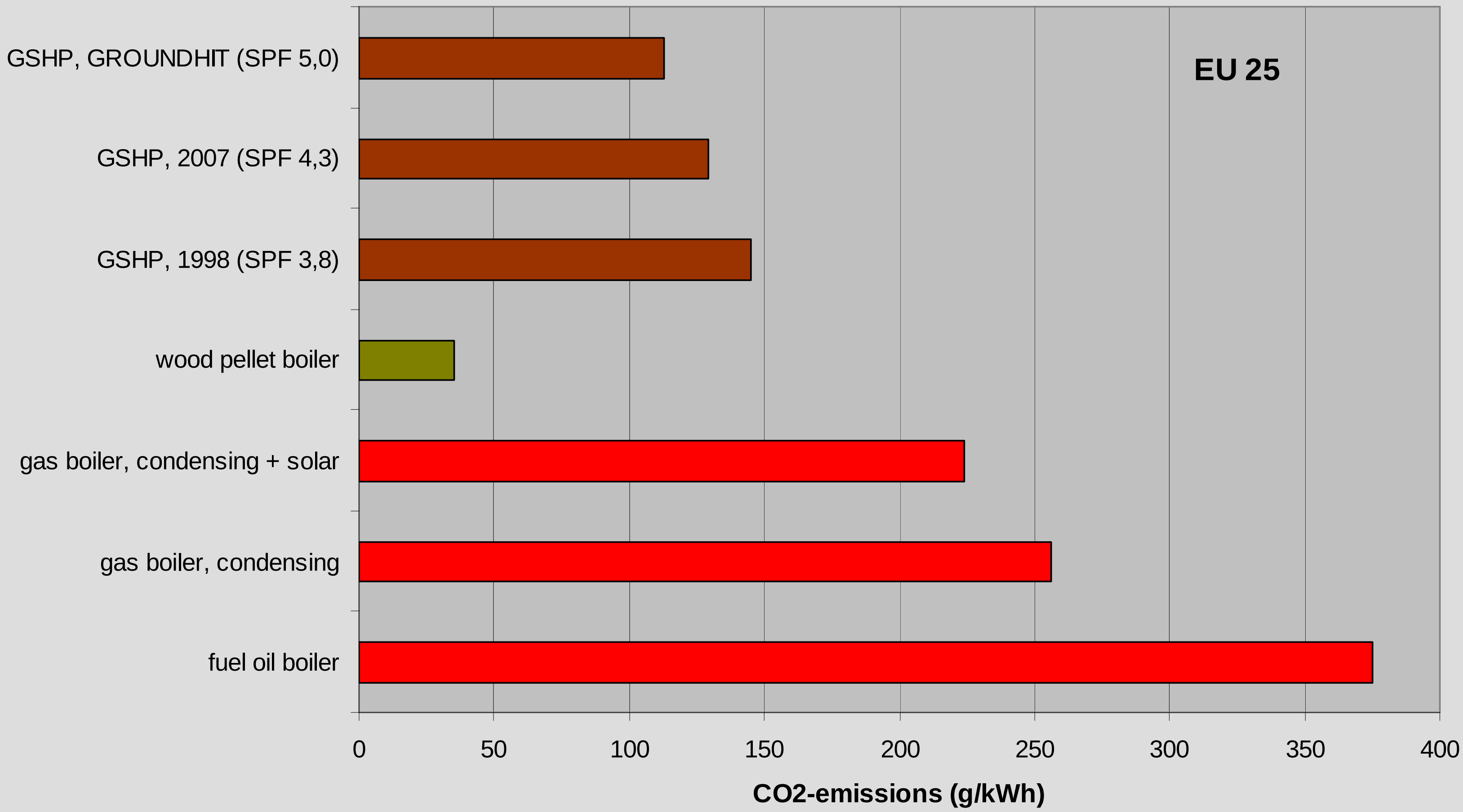
Heat pipe HP

Ground Source Heat Pumps

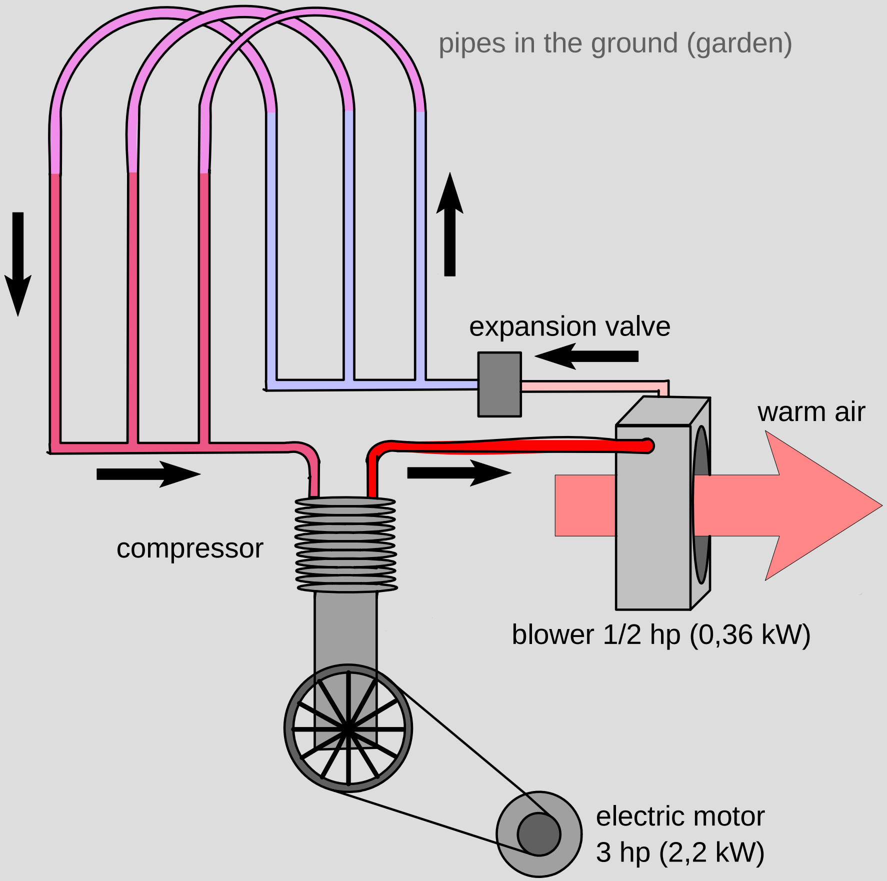
In all ground source heat pump systems (GSHP), there is a basic difference between the heat output to the heating system, and the geothermal heat input into the system (Qg). The auxiliary energy (mainly Qph) is always higher than 5 %, and is typically in the order of 20-30 % of the final energy output. Thus it cannot be neglected.



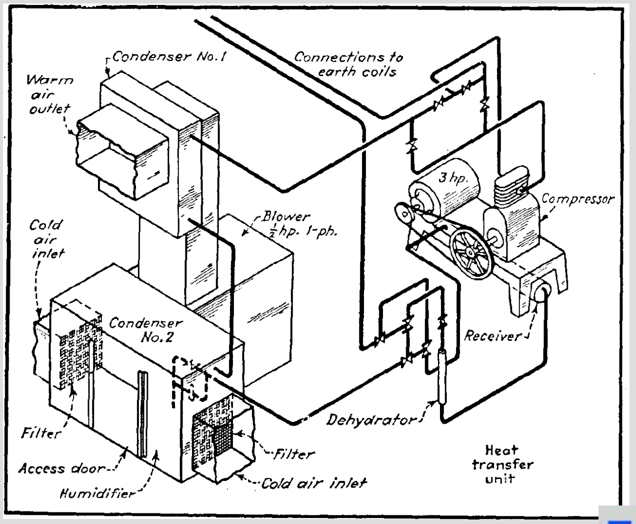
Ground Source Heat Pumps



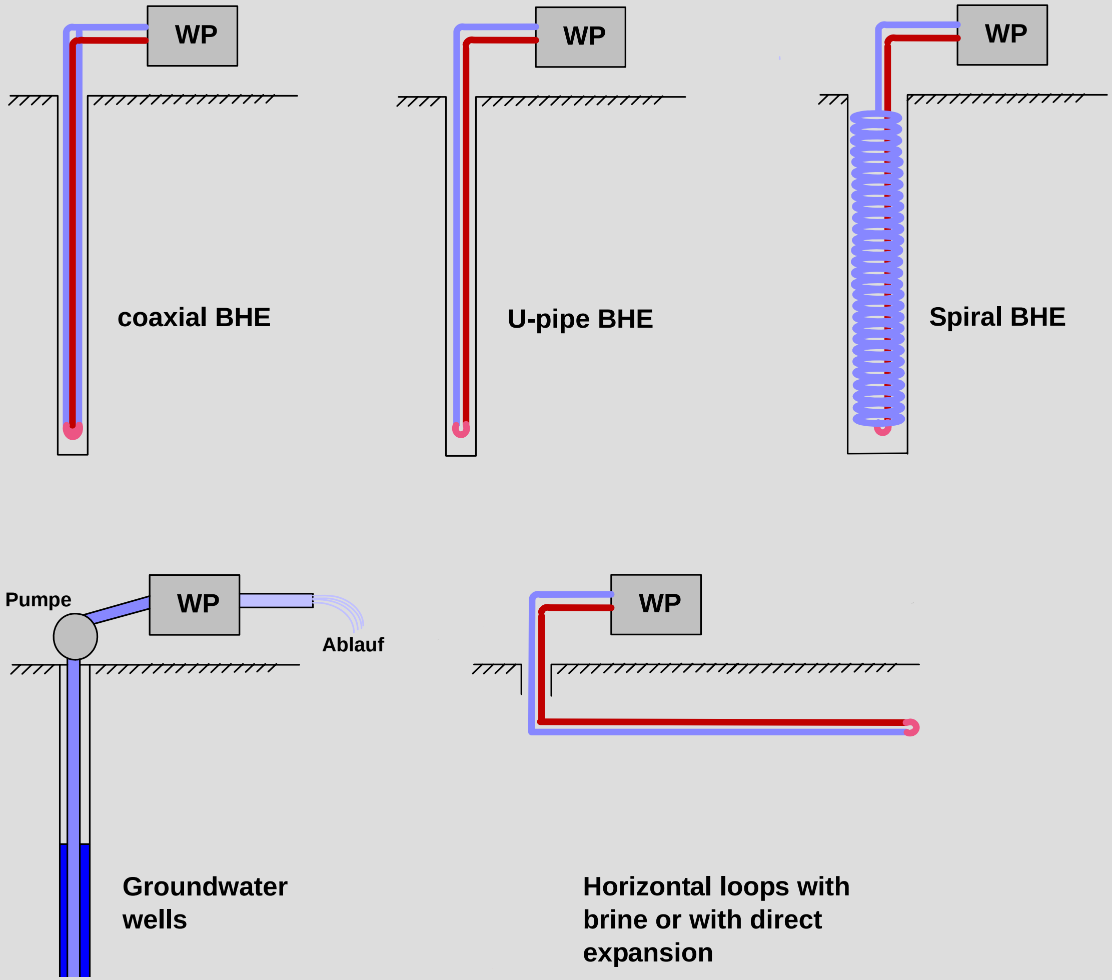
GSHP history



Early GSHP in USA: GSHP with horizontal pipes in the Webber house, Indianapolis, 1945



GSHP history

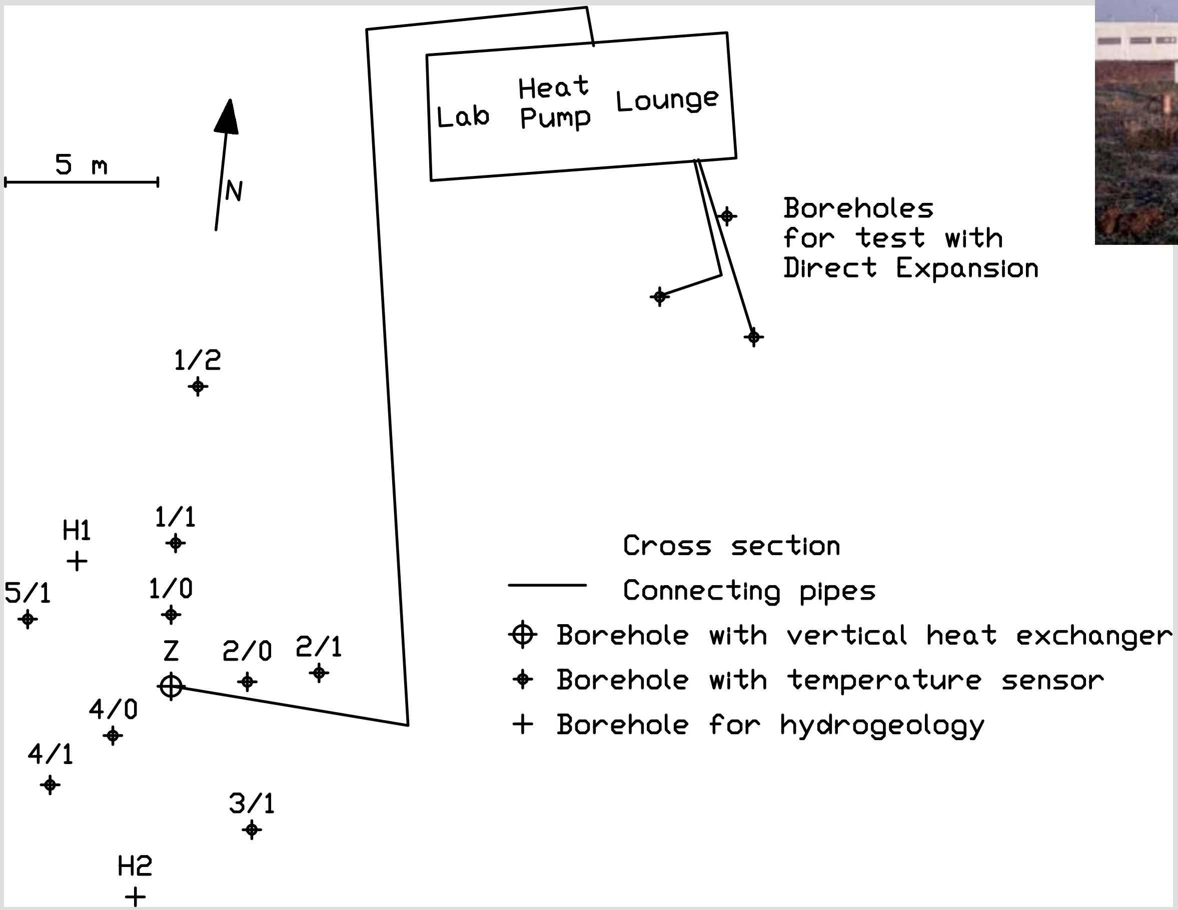


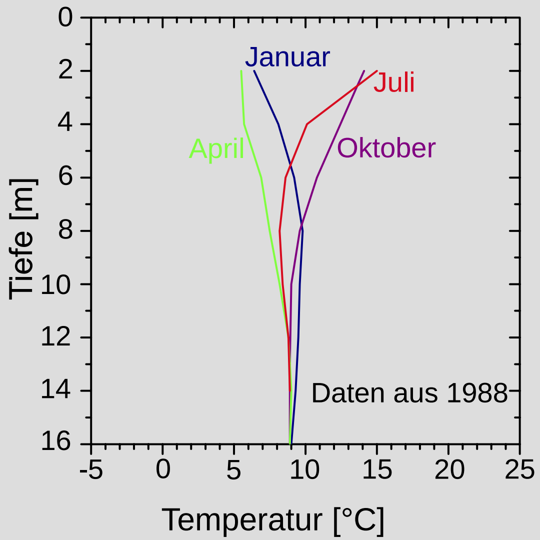
Early GSHP in USA: Examples from a newsletter article by Kemler, 1947

In Europe (Germany, Sweden, Switzerland) first groundwater HP around 1970 and first BHE around 1980

GSHP history

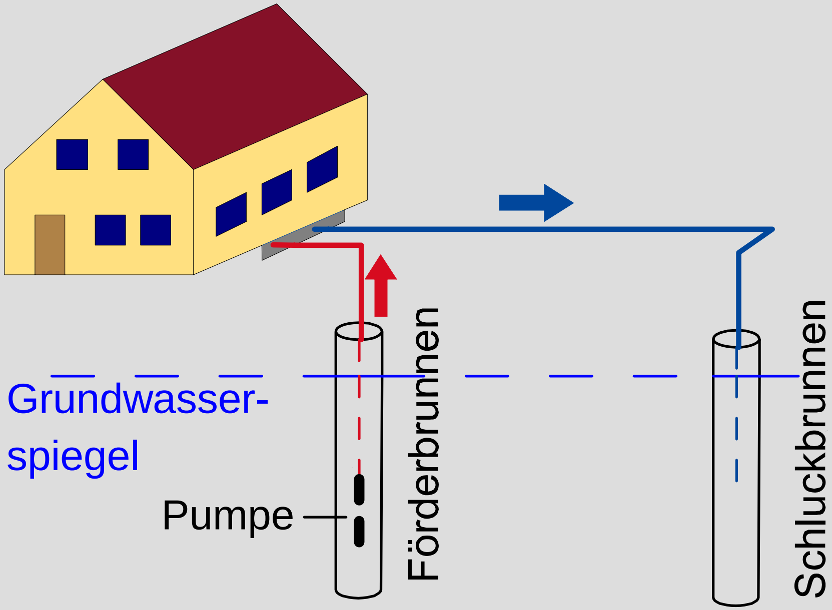
BHE research plant Schöffengrund-Schwalbach (1985)





Ground Coupling

Groundwater wells



Advantage:

- high capacity with relatively low cost
- relatively high temperature level of heat source

Disadvantage:

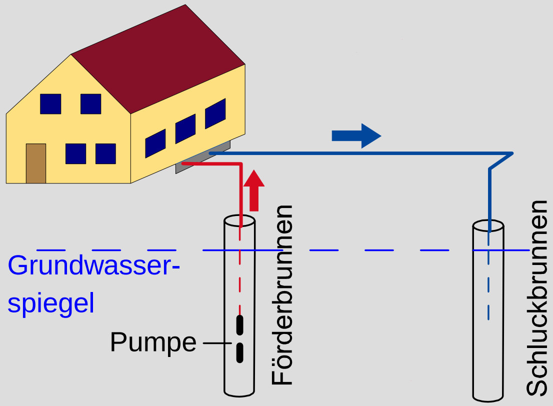
- maintenance of well(s)
- requires aquifer with sufficient yield
- water chemistry needs to be investigated

Ground Coupling

Groundwater wells

Example: The Equitable Building, Portland OR, USA; constructed 1948 (a.k.a „Commonwealth Building“)

2 production wells each 50 m deep
1 injection well 170 m deep
Maximum producttion 130 m³/h
Groundwater temperature 18 °C



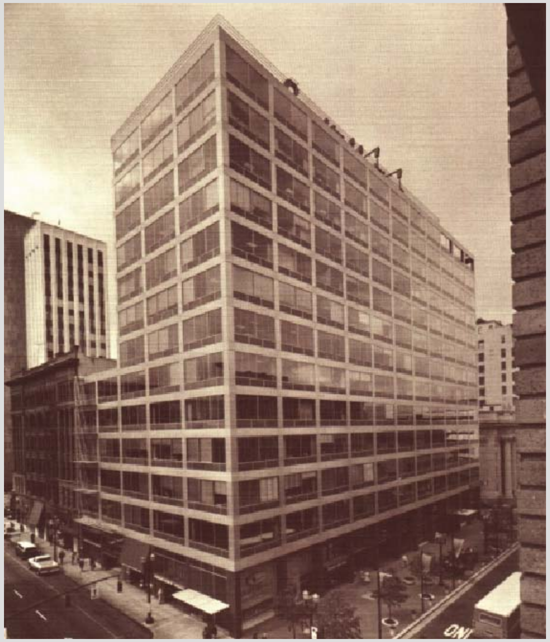


Photo: ASME

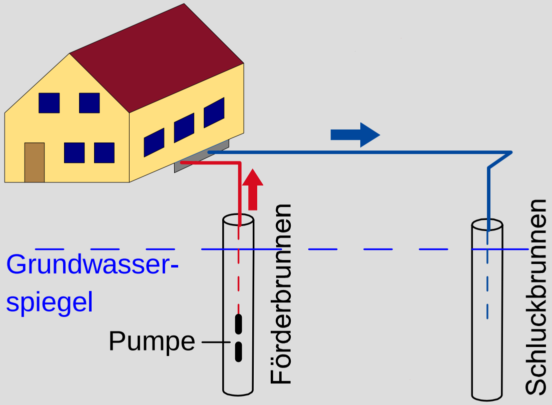
Ground Coupling

Groundwater wells

Example: The Equitable Building, Portland OR, USA; constructed 1948 (a.k.a „Commonwealth Building“)

2 heat pumps 2.4 MW heating and cooling capacity combined

No problems with wells, heat pumps replaced ca. 1980



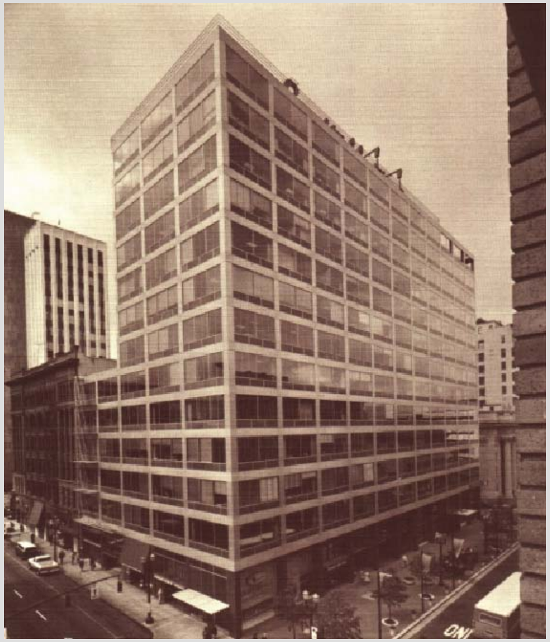
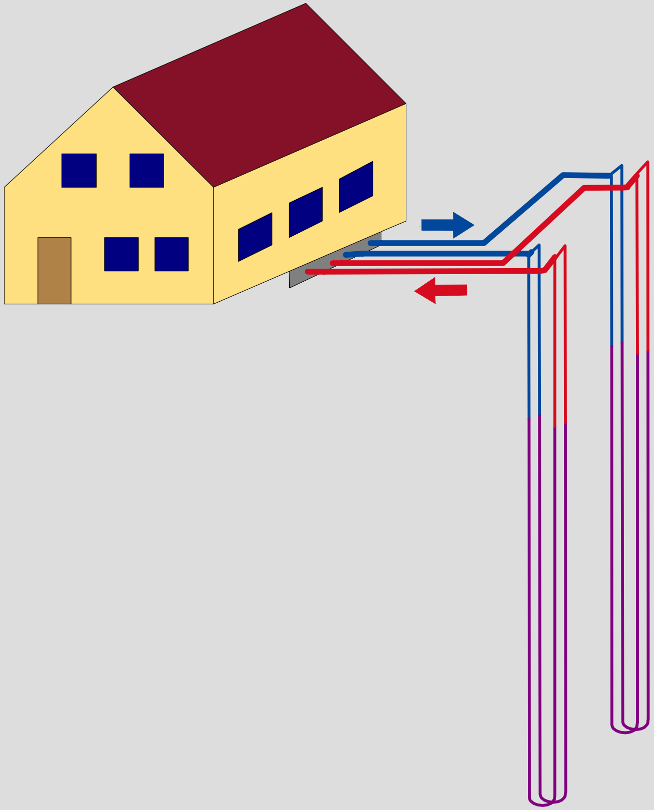


Photo: ASME

Ground Coupling

Borehole Heat Exchangers (BHE)



Advantage:

- no regular maintenance
- safe
- possible virtually every-where

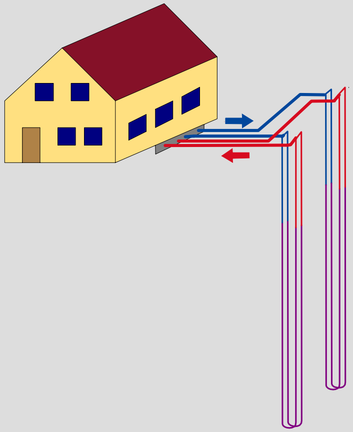
Disadvantage:

- limited capacity per bore-hole
- relatively low temperature level of heat source

Ground Coupling

Borehole Heat Exchangers (BHE)

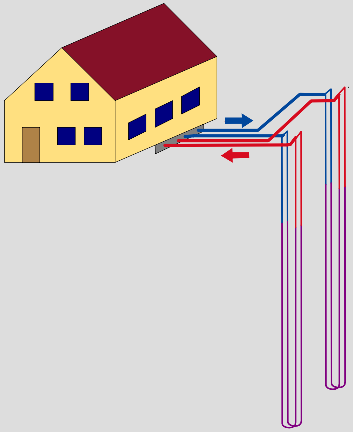
Drilling of borehole and installation of heat exchange pipes



Ground Coupling

Borehole Heat Exchangers (BHE)

Pipe connections to building



Ground Coupling

Borehole Heat Exchangers (BHE)

Brine-water heat pump with DHW storage tank

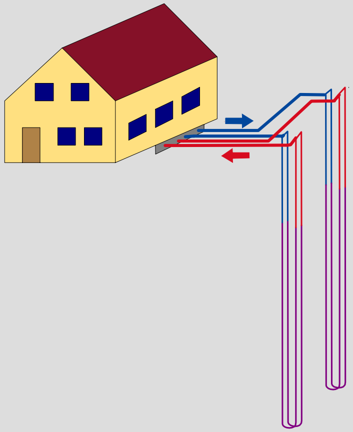


Photo: BBT

Intelligent Energy Europe

GROUND REACH

GSHP examples - BHE

Office building in Aachen, DE

BHE field

Thermal Response Test

Heating and cooling,
28 BHE each 43 m,
operational since 2003

Photos: EWS

GSHP examples - BHE

Office building in Aachen, DE

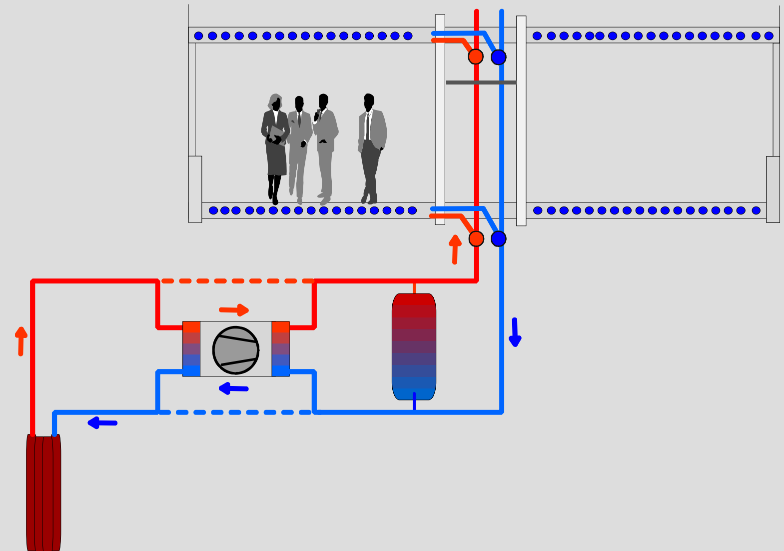


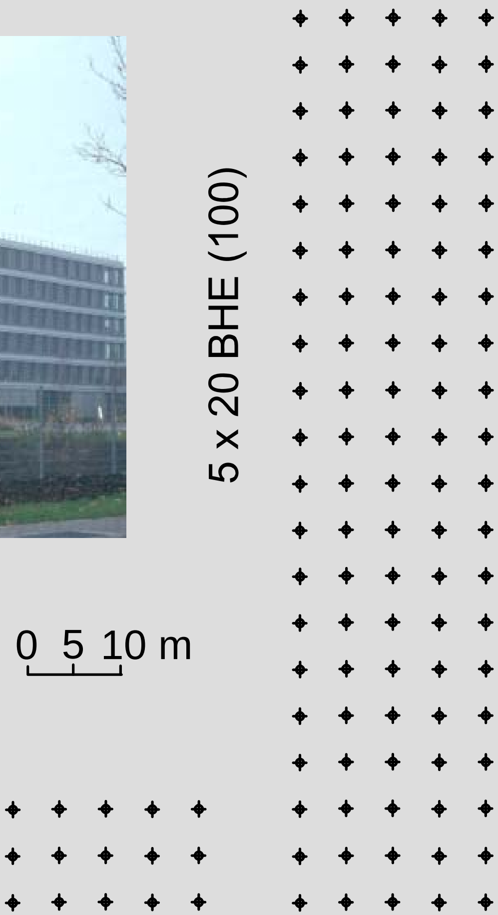
Photo und Graphik: VIKA

Heating and cooling,
28 BHE each 43 m,
operational since 2003

Heating capacity 55 kW
Cost for cooling in summer
2003 ca. 250 € (0,12 €/m²)

GSHP examples - BHE

DFS Langen, DE



Layout of BHE field

GROUND REACH

GSHP examples - BHE

DFS Langen, DE

BHE-field, manifolds and pipes in the building

GSHP examples - BHE

DFS Langen, DE

Heat pump,
ca. 350 kW heating and cooling capacity

4 compressors, refrigerant NH_3

GSHP examples - BHE

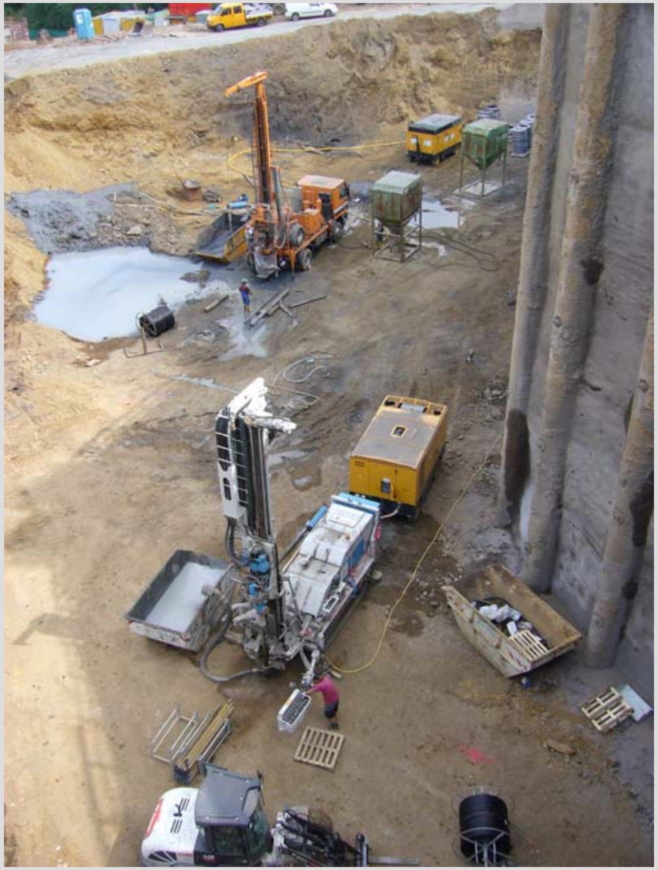
Main-Kinzig-Forum Gelnhausen, DE

County administration and conference centre

86 BHE, >400 kW

GSHP examples - BHE

Drilling for 120 BHE south of Darmstadt, DE



GSHP – very large BHE plants

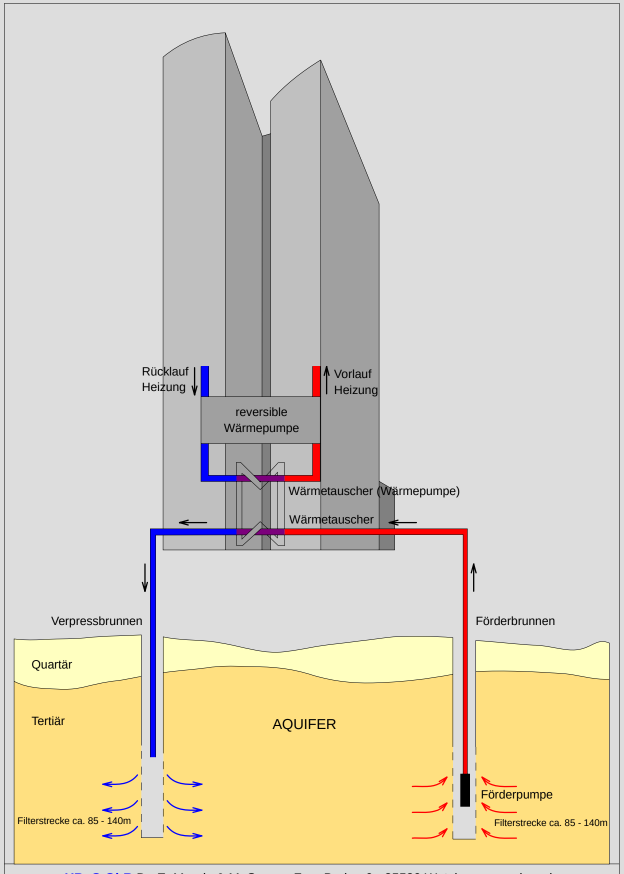
Country	City / project name	No. BHE	depth BHE	total BHE length
NO	*Loerenskog, SiA hospital **	*ca. 300*	*150 m*	*ca. 45’000 m*
NO	Oslo, Nydalen district	180	200 m	36’000 m
SE	Lund, IKDC	153	230 m	35'190 m
SE	*Stockholm, Vällingby Centr.**	*133*	*200 m*	*26’600m*
SE	*Kista, Kista Galleria **	*125*	*200 m*	*25’000 m*
TR	Istanbul, Metro market	168	107 m	18’000 m
DE	Golm near Potsdam, MPI	160	100 m	16’000 m
SE	Stockholm, Blackeberg area	90	150 m	13’500 m
SE	Örebro, Musikhögskolan	60	200 m	12’000 m
DE	Langen, DFS	154	70 m	10’780 m
CH	Zürich, Grand Hotel Dolder	70	150 m	10’500 m

BHE: Borehole Heat Exchanger

* under construction

GSHP examples - Groundwater

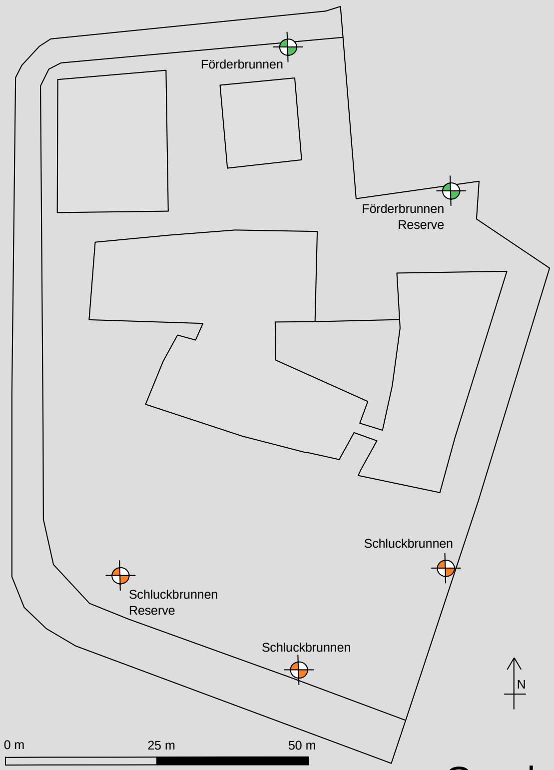
WestendDuo, Frankfurt, DE

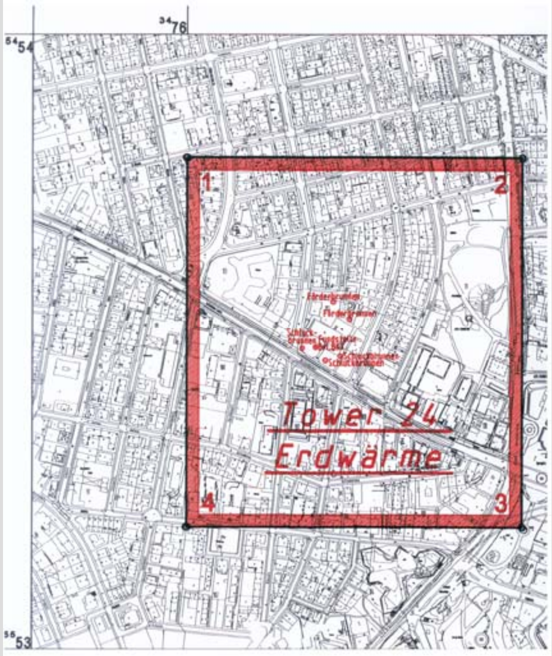


UBeG GbR Dr. E. Mands & M. Sauer - Zum Boden 6 - 35580 Wetzlar - www.ubeg.de

Schema geothermische Grundwassernutzung Tower 24

Open loop system with 2 production and 3 injection wells



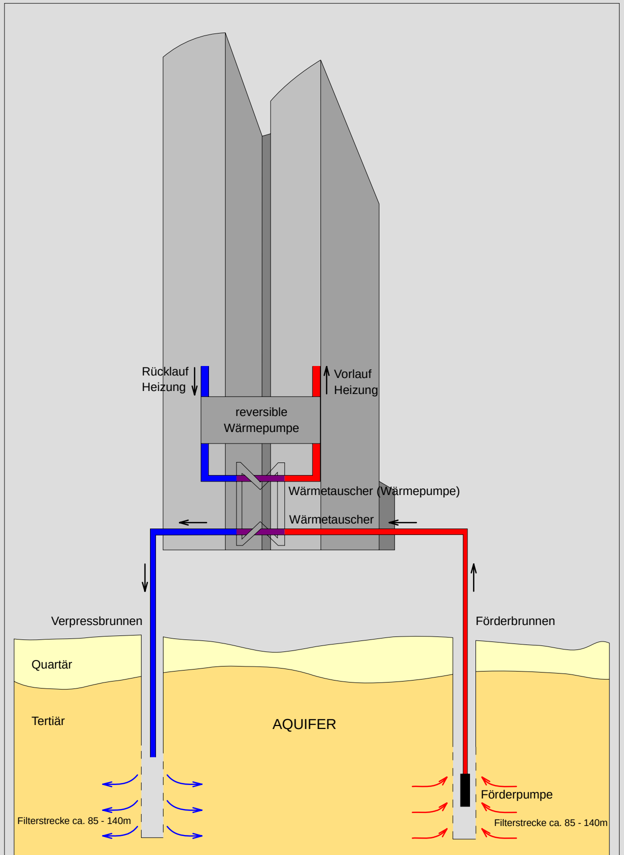


Mining field

Graphs: UBeG

GSHP examples - Groundwater

WestendDuo, Frankfurt, DE



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Schema geothermische Grundwassernutzung Tower 24

Open loop system with 2 production and 3 injection wells

Heat pump and groundwater heat exchanger

Graph and photos: UBeG

GSHP – new developments

Deployment in new regions:

Villa in Zekeriyaköy, Istanbul

- Floor area 300 m^2
- Total 11 fan coil units supplied by a 17 kW HP, basement and living area are supplied by 2 ducted HP units of 8 kW each
- 10 kW heating only unit for DHW
- 4 BHE each ca. 100 m

(Photos: Form Group)

GSHP – new developments

New applications:

Snow melting on private driveways in combination with GSHP – increasingly popular in USA

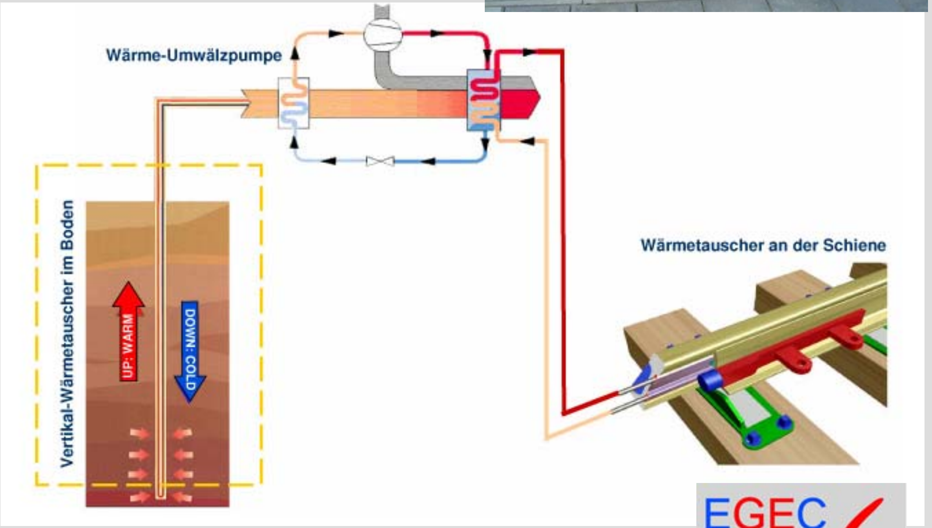
Photos: GeoSourceOne, Ohio

GSHP – new developments

New applications:

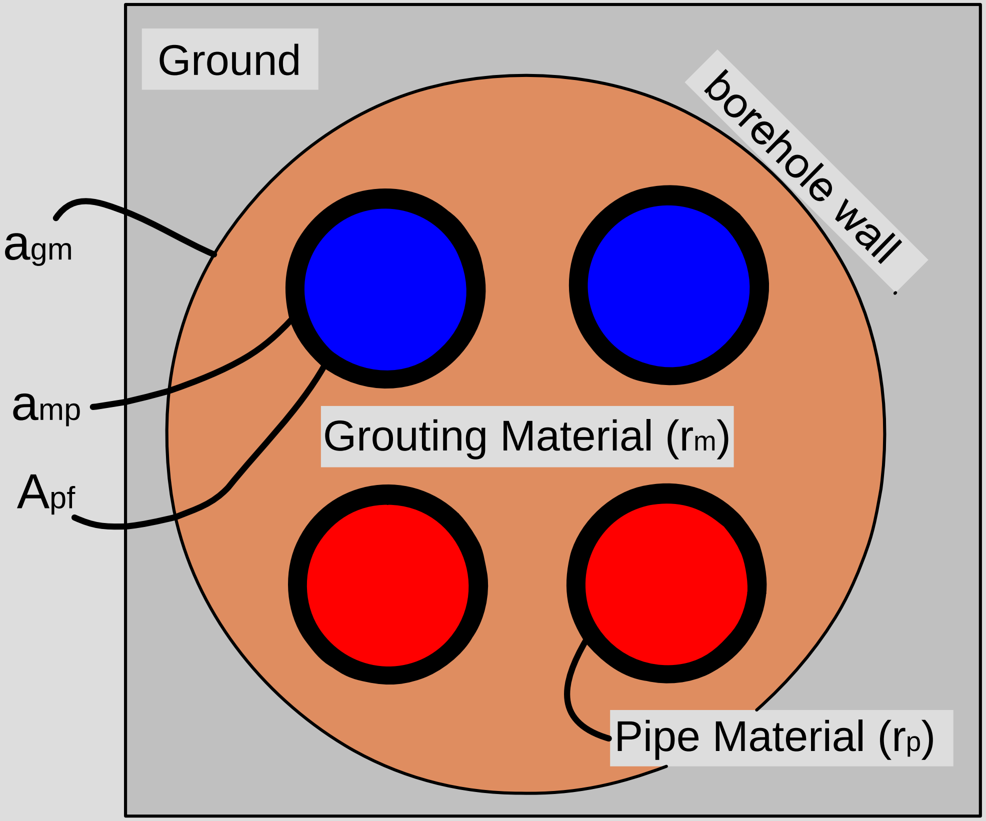
- Heating of railway points (switches)
- Pilot application in Holzminden, DE
  Classical GSHP system with 1 BHE
  100 m deep

Heat pump installation (right)



Photos and graph: Railutions

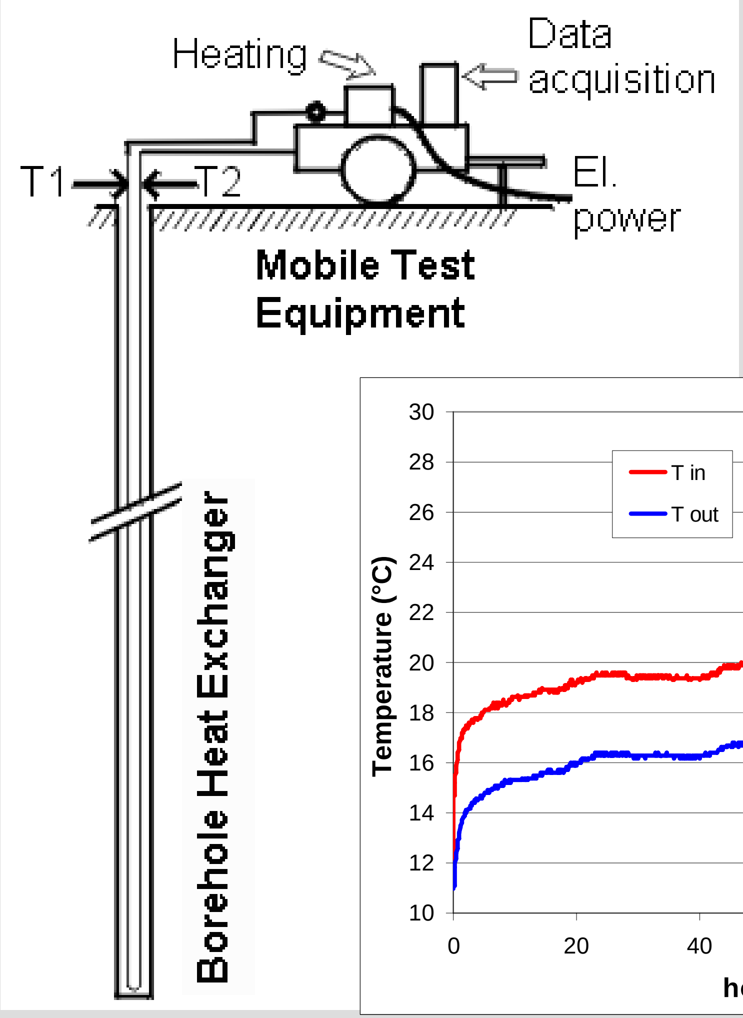
GSHP – new developments

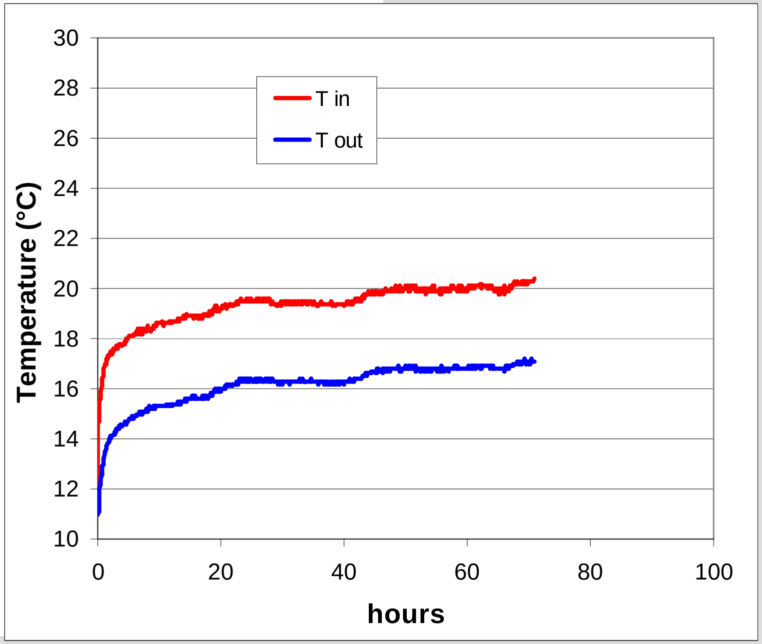


Components of borehole thermal resistance r_b

Solution: Thermally Enhanced Grout (e.g. Stüwatherm)

GSHP – new developments





For planning accuracy: Determination of underground thermal parameters for BHE: Thermal Response Test

GSHP – new developments

Use of heat pipes with CO_2 as BHE

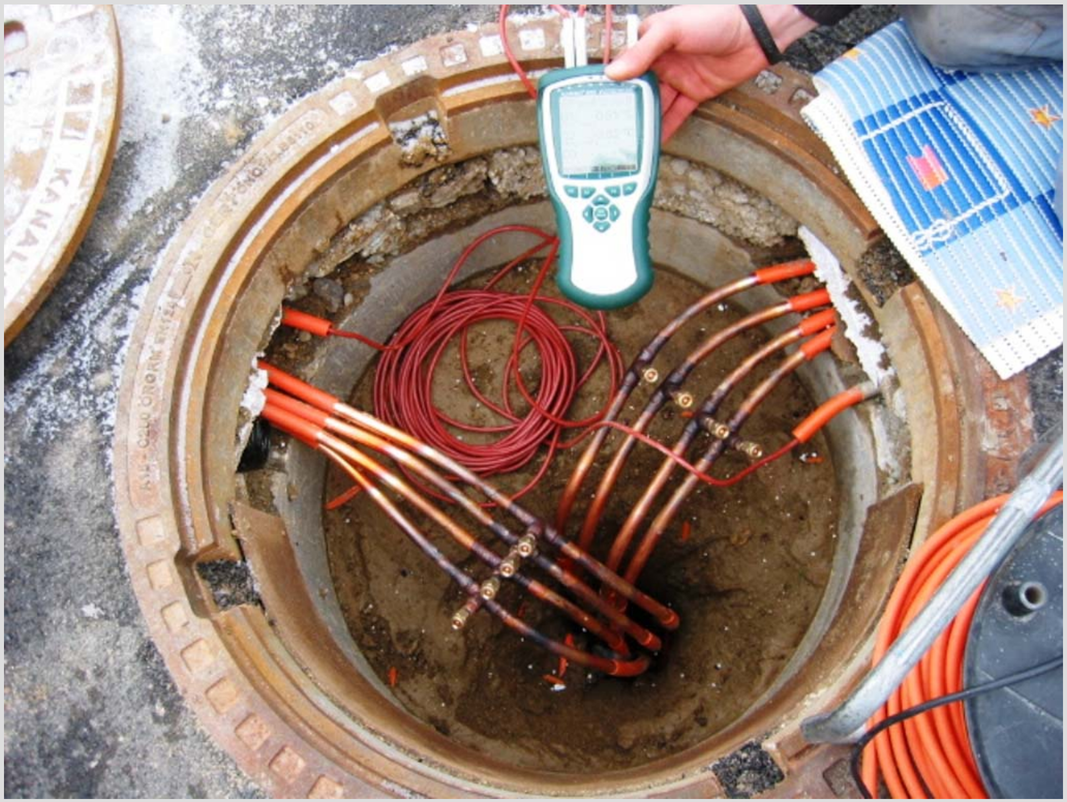
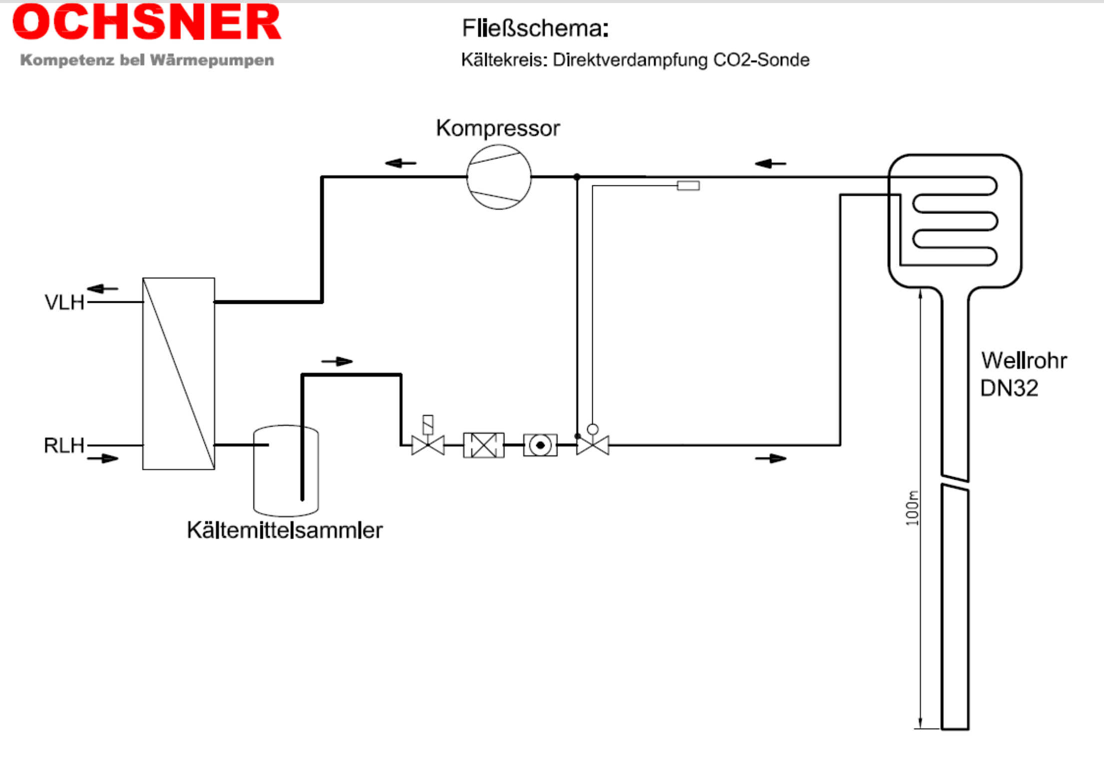
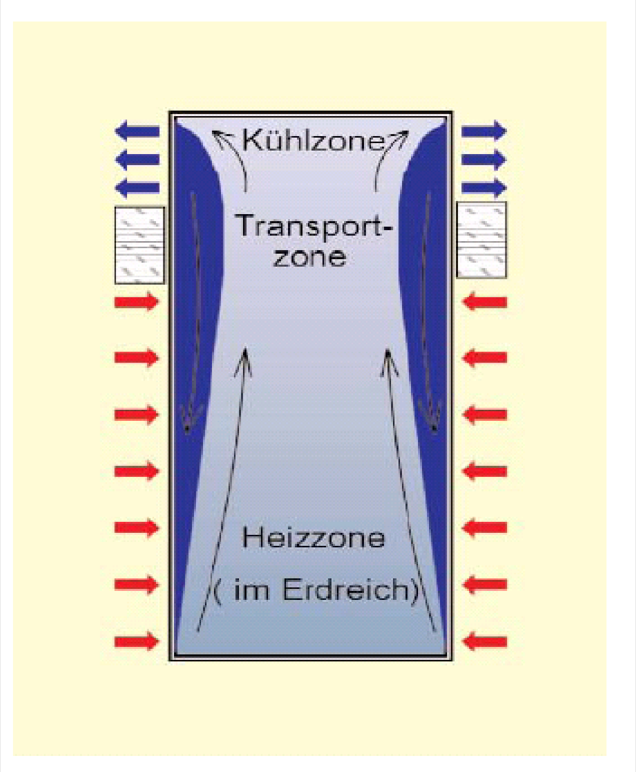


Photo: M-Tec

GSHP – new developments

Use of heat pipes with CO_2 as BHE





Graphs: Ochsner

GSHP – new developments

Use of heat pipes with CO_2 as BHE

House in Freistadt, Austria
160 m², floor- and wall-heating
heat pump 6,4 kW

Photos: Ochsner

EU RES Directive proposal

The new proposal of the European Commission for the promotion of Renewable Energy Sources list in paragraph 16 of the preamble:

Heat pumps using geothermal resources from the ground or water, and heat pumps using ambient heat from the air to transfer the thermal energy to a useful temperature level, need electricity to function. ... Therefore, only useful thermal energy coming from heat pumps using ambient heat from the air that meet the minimum requirements of the coefficient of performance established in Commission Decision 2007/742/EC … should be taken into account for the purpose of measuring compliance with the targets established by this Directive.

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EU RES Directive proposal

The new proposal of the European Commission for the
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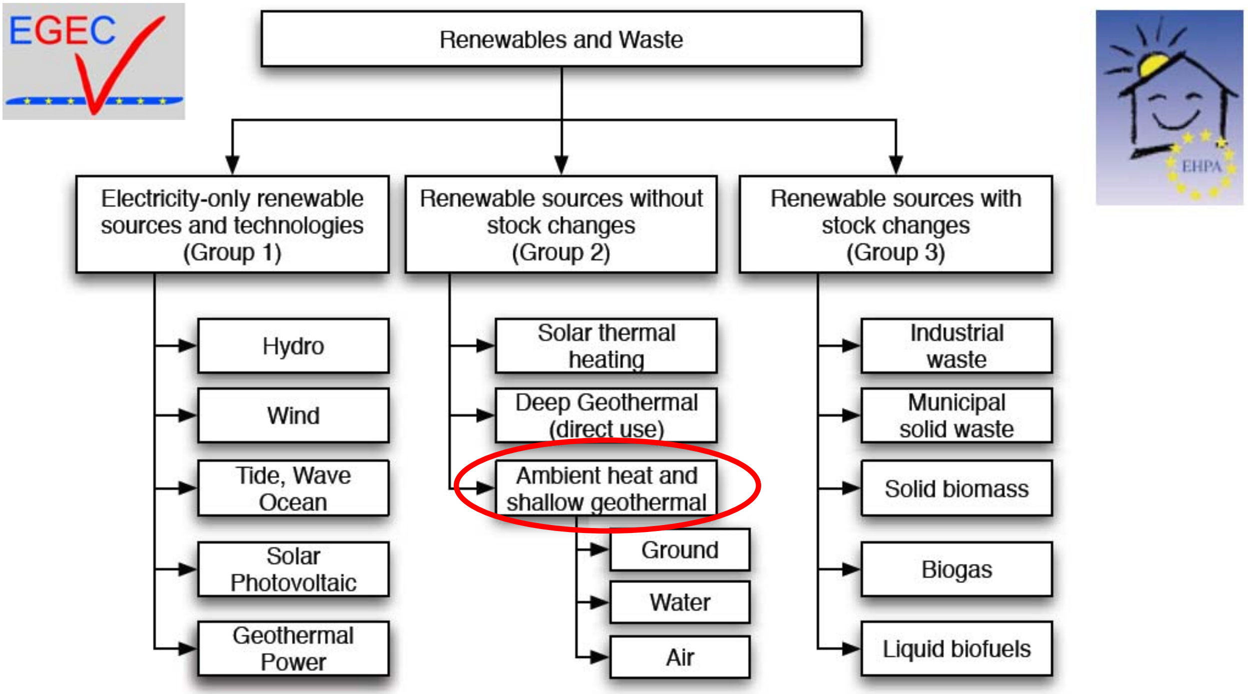
Classification agreement EHPA-EGEC, July 2007



Thank you for your attention!

For more information:

www.groundreach.eu

www.egec.org

www.ehpa.org