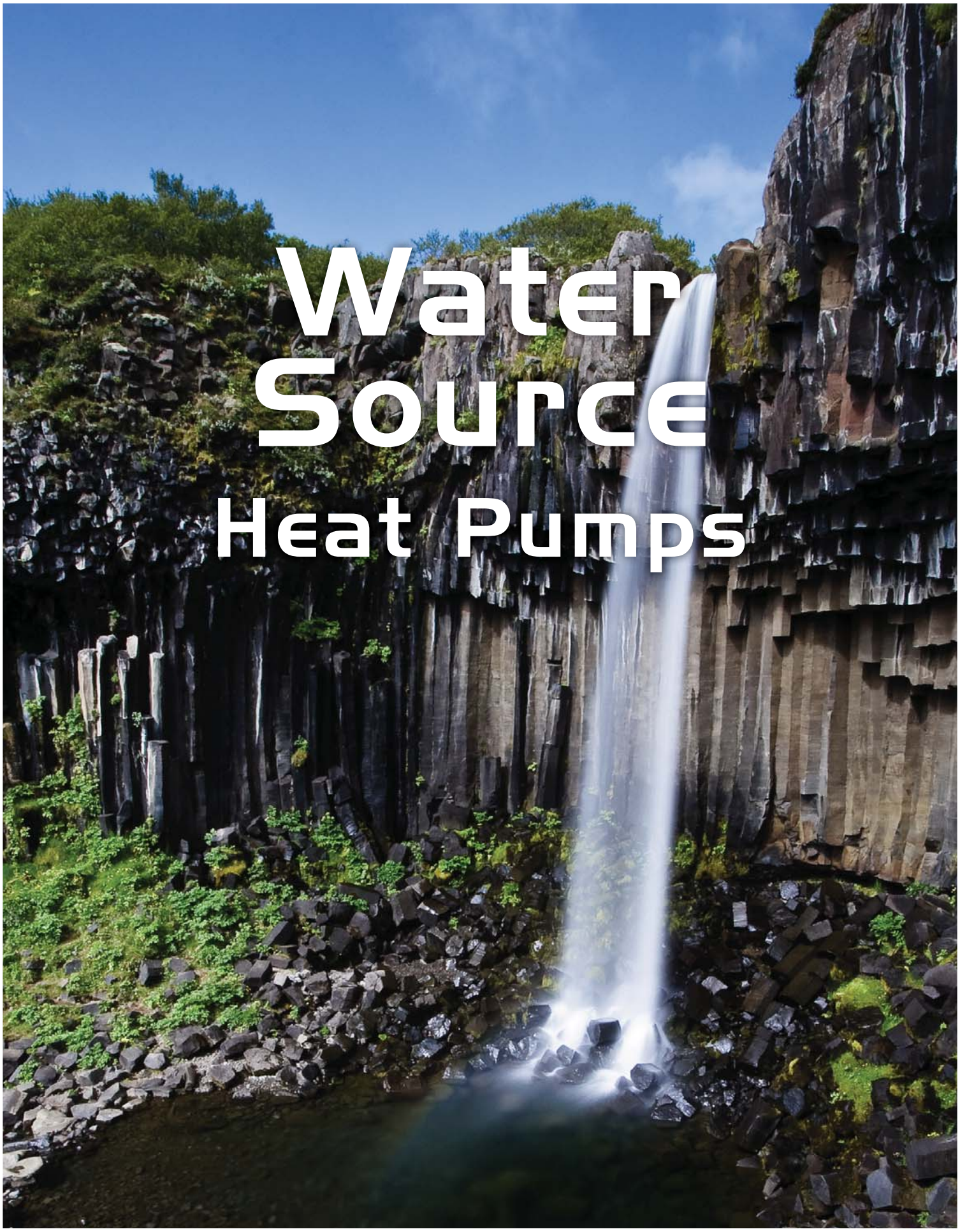
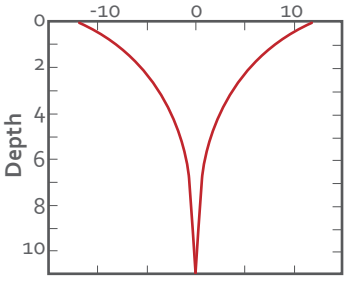


Water Source Heat Pumps

MANNVIT

Principals of
Ground Source Heat Pumps *(GSHP)*

About half of the suns incident energy is absorbed by the earth. The earth has a low thermal conductivity making it warmer than air in the winter and cooler in the summer. At 15m depth below the ground surface, seasonal temperature variations are negligible.



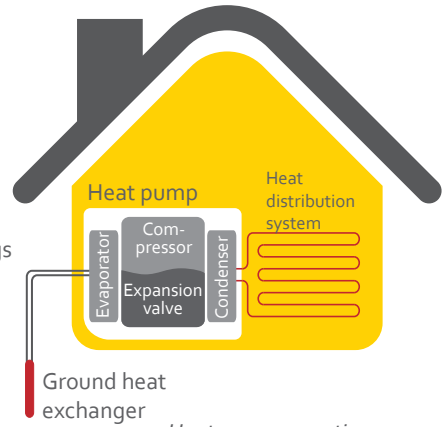
Temperature variations with depth

Heat pumps work like air conditioning units or fridges for every kW of electricity they use they draw 3kW of renewable energy from the ground. This results in saving so of 30 – 70% of energy use of conventional heating and cooling systems

How do GSHP work?

In heating mode:

- Heat from ground water arrives at the first heat exchanger called the evaporator.
- The heat caused the liquid refrigerant to evaporate.
- The low temperature and low pressure refrigerant is compressed raising its pressure and temperature.
- The refrigerant is fed into a second heat exchanger called the condenser.
- Air or water circulates around the condenser where it is heated and then circulates to the buildings heat distribution system such as radiators, fan coils, chilled beams and under-floor heating.
- The high temperature refrigerant then passes through an expansion valve and the temperature drops allowing the cycle to be repeated.
- In cooling mode this cycle is simply reversed.

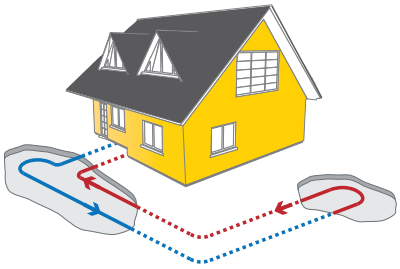


Heat pump operation

3 principal types of GSHP:

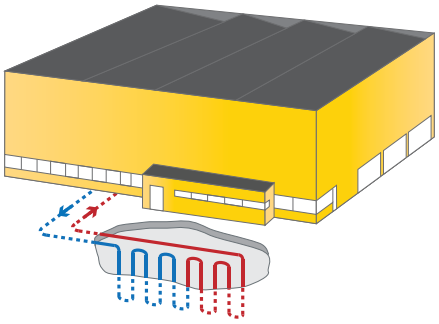
Horizontal Heat Exchanger: use closed loop heat exchangers laid horizontally within the top 2 metres of the ground using stretched coils. They are influenced by seasonal variations in temperature. The typical use is domestic and other small buildings and have area requirements of between 50 and 95m2 per kW of thermal.

Horizontal GSHP



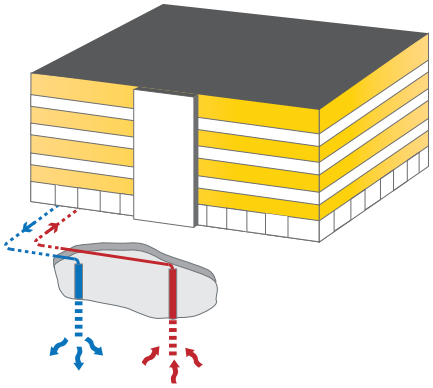
Vertical Heat Exchanges: use the same closed loop heat exchangers but installed in vertical boreholes to depths of between 50 – 100m. The area required is 1.5 and 12 m2 per kW of thermal, and they can be typically used for commercial buildings. Boreholes are centred at approximately 6 meter spacing. The vertical pipes are connected to horizontal underground supply and return header pipes.

Vertical GSHP



Water Source Heat pumps: draws water from an aquifer, in a paired well configuration. This system has the largest thermal output, with water from the well being pumped direct to the heat exchanger. There is considerable potential to exploit water source heat pumpss due to presence of ground water under large part of the UK. Typically 2 water source heat pumps boreholes will be require to provide similar heat capacity as 20 closed loop vertical boreholes. Their application is in larger commercial scale projects with limited space availability.

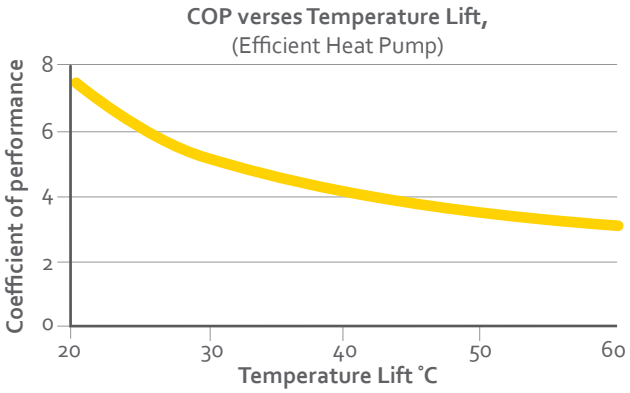
Water Source Heat pumps



Heat pump efficiency

The Coefficient of Performance (COP) is the ratio of heat provided by the source to the energy required. The maximum efficiency can be gained by minimising the temperature difference between heat sink and the heat source, for example:

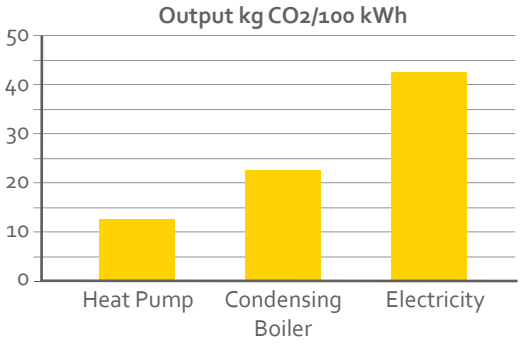
- With ground water temperature of say 10°C
- And heating Fan Coils to 60°C
- COP = 3.5



CO2 Reductions

Heat pumps emit up to 60% less CO_2 than conventional condensing boilers for a COP of 3.5.

- CO_2 emissions for Electricity= 0.43 $kgCO_2/kWh$
- CO_2 emissions for Gas = 0.194 $kgCO_2/kWh$
- CO_2 emissions for heat pump = 0.123 $kgCO_2/kWh$



Licences and Planning

EA Licences Required for water source heat pumps include:

- Licence to Investigate Groundwater
- An Abstraction Licence
- A Discharge Consent

The Permitted development rights introduced in 2008 allow the installation of water source heat pumps without the need for planning permission.

Renewable Heat Incentive (RHI)

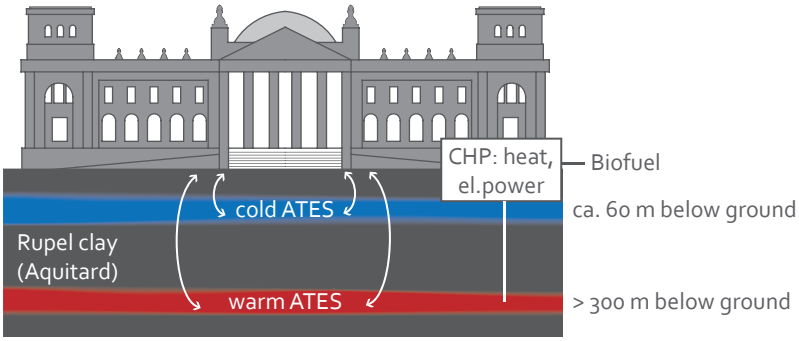
Due to be introduced in April 2011, the RHI will provide payments for every kWh of renewable heat generated payable over 20 years. The draft tariffs have been set at between 1.5 – 7.0 p/kWh. These payments are in addition to savings which can be made in fuel costs.

GSHP	Scale	Draft Tariff (p/kWh)
Small	<45kW	7.0
Medium	45-350kW	5.5
Large	>350kW	1.5

RHI Draft Tariff

Case Study: The Reichstag Building in Berlin

Water source heat pumps were retrofit into the Reichstag Building, the home of the German Parliament in Berlin. Two aquifers were used, the first at 60m depth which acted as the cold storage via 2 sets of 5 wells and the second at 320m, used for heat storage via 2 wells. 850kW heat pumps were used. The concept was so successful it was extended to several surrounding buildings



(courtesy of GTN)

Additional information:
Alison Longstaff: a.longstaff@mannvit.com

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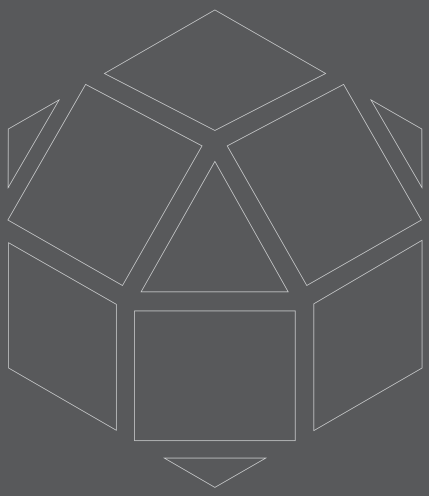

Mannvit Engineering

Mannvit UK are an independent renewable energy consultant, dedicated to the development of renewable energy, energy efficiency and other efforts to reduce the effect of climate change. We design and manage the development of renewable energy solutions for our clients to capitalise on financial incentives, reduce carbon emissions and fuel costs. We are proud of our heritage and draw on 40 years of renewable energy experience from our operation in Iceland where 72% of electricity and almost 100% of heat is generated from renewable sources. Since the 1970's Mannvit has been actively designing and project managing Hydroelectric Power plants, Geothermal Power Plants and Bio Energy projects. We offer a broad range of services in renewable and alternative energy consulting from our UK offices and offer a multi-disciplinary approach to ensure the success of every project we run for our clients.

The Mannvit website

Mannvit's corporate web site, www.mannvit.com contains further information and project examples for hydroelectric and geothermal power plants as well as contact information.

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DEDICATED TO THE DEVELOPMENT OF GREEN ENERGY

Mannvit UK Ltd.

Rotterdam House
116 Quayside
Newcastle upon Tyne NE13DY
United Kingdom
mobile: 07771862879

1 Lode Road
Lode
Cambridge CB25 9ER
Tel: 01223812197
Fax: 01223 812265

@: mannvit@mannvit.com
w: www.mannvit.com