RENEWABLES FACT SHEET
GROUND SOURCE HEAT PUMPS

JHWalter
SUSTAINABLE RESOURCE MANAGEMENT

What are Ground Source Heat Pumps?

Ground Source Heat Pumps take energy from the ground and raise it to a higher temperature, using a process which is similar to a reverse refrigeration process.

How does it work?

A GSHP system consists of a ground heat exchanger, a water-to-water or water-to-air heat pump, and a heat distribution system. Generally closed-loop or ground coupled systems are used, where the ground heat exchanger consists of a sealed loop of pipe buried either horizontally or vertically in the ground. Most commonly GSHPs are indirect systems, where a water/antifreeze solution circulates through the ground loop and energy is transferred to or from the heat pump refrigerant circuit via a heat exchanger.

To maximise the efficiency of a heat pump when providing heating it is important, not only to have a low heating distribution temperature but also to have as high a source temperature as possible. Overall efficiencies for GSHPs have generally been higher than for air source heat pumps because ground temperatures are higher than the mean air temperature in winter and lower than the mean air temperature in summer. The ground temperature also remains relatively stable allowing the heat pump to operate close to its optimal design point whereas air temperatures vary both throughout the day and seasonally and are lowest at times of peak heating demand. However both technologies are improving swiftly at the moment.

Electricity is required to power the pump that circulates the air/water. The more efficient a system the more heat will be obtained from same amount of electricity. The efficiency of a ground source heat pump is measured using a factor known as the coefficient of performance (COP). Commonly ground source heat pumps achieve a 1:4 coefficient although technological improvements are now achieving better results with some pumps quoted at 1:5. What this means is that for each kW of electrical pump energy used 4 or 5 kWs of heat are produced i.e. the system is 400 to 500% efficient. This can be compared with a gas or oil boiler's efficiency of only 90%.

Where will it work?

GSHPs can be used to provide space and domestic water heating and, if required, space cooling to a wide range of building types and sizes. The provision of cooling (by reversing the system and storing the heat underground) is possible but will result in increased energy consumption however efficiently it is supplied. GSHPs are particularly suitable for new build as the technology is most efficient when used to supply low temperature distribution systems such as underfloor heating. They can also be used for retrofit especially in conjunction with measures to reduce heat demand. They can be particularly cost effective in areas where mains gas is not available or for developments where there is an advantage in simplifying the infrastructure provided. A GSHP system can be designed to provide all the required heat. However, because of the relatively high capital cost, it may be economic to consider a system where the heat pump is designed to cover the base heating load, while an auxiliary system covers the additional peak demand.

The ground heat exchanger is buried either horizontally in a shallow trench (at a depth of about 1m) or vertically in a borehole.. The collector coil can also be laid under water, for instance in a pond, but system efficiencies are likely to be lower because of seasonal variations in the water temperature. Horizontal collectors require relatively large areas free from hard rock or large boulders and a minimum soil depth of 1.5m. They are particularly suitable in rural areas where properties are larger and for new construction. In urban areas the installation size may be limited by the land area available. Multiple pipes can be laid in a single trench. The amount of trench required can also be reduced if the pipe is laid as a series of overlapping coils (like a Slinky) placed vertically in a narrow trench or horizontally at the

bottom of a wider trench. The trench lengths are likely to be 20% to 30% of those for a single pipe configuration but pipe lengths may be double for the same thermal performance.

The pumps work best with under-floor or warm air heating systems, and in houses which have good insulation. Consequently before installing such systems in existing structures, upgrading of insulation and draught proofing must be considered. GSHP systems may not be suitable for direct replacement of conventional water-based central heating systems because of the high distribution temperatures unless extensive measures are taken to improve the thermal insulation of the building.

Radiators with Heat Pumps

Whilst radiators can be used with heat pumps, efficiency is lost since the operating temperatures are lower than that generated by oil or gas boilers. Low temperature radiators are available which would be better suited to GSHP systems.

Regulations

The installation of Ground Source Heat Pumps will have to comply with Building Regulations, and be installed by an approved installer. Planning permission is not normally required for domestic installations, although Listed Building Consent and or Conservation Area Consent will be required if applicable. Closed-loop ground source heat pump systems will not normally require permissions/ authorisations from the environment agency

Income/Savings

Savings against existing systems depend on fuel systems being replaced. However compared to oil savings can be in the order of £750 per annum compared to oil (*Energy Savings Trust)*. Clearly the size and construction of the building will also have a major effect on savings.

Renewable Heat Incentive

The scheme, to be introduced on 1st April 2011 provides for payments not dissimilar to FITs (Feed-in Tariffs) for electricity. The scheme will create a significant shift in the cost/benefit of smaller scale schemes with additional income now being generated from green power generation. Examples of proposed tariffs are shown below. For the smaller and medium installations (up to 350kW) the tariff will be paid on the deemed amount of heat that is used rather than using metering. For more information see the RHI Fact Sheet.

Table of RHI tariff Technology	Scale	Proposed tariff (p/kWh)	Years
Ground source	≤45kW	7	23
Ground source	45- 350kW	5.5	20
Ground source	>500kW	1.5	20

Capital Costs

The cost of installing a ground source heat system for a domestic dwelling can be in the order of £6,000 to £12,000. For all types of ground collector, setting up costs are a significant part of the total cost therefore the unit capital cost will fall as the collector size increases.

Grants

Grants for domestic installations are available through the Low Carbons Building Programme. In some situations grant may be available through the Rural Development Programme for England (RDPE)

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Scoping Feasibility Project Management Planning
Environmental Compliance Design Funding Delivery

David Wright
01522 504321
07919 694228
davidwright@jhwalter.co.uk

Henry Leivers
01522 504315
07738 421391
henryleivers@jhwalter.co.uk

Steve Catney
01522 504330
07919 694229
stevecatney@jhwalter.co.uk