FACTSHEET 6: Introduction to Ground Source Heat Pumps

Introduction

The ground is a very good store of heat energy, and this heat can be harnessed and used to heat buildings and in some cases help provide hot water. The ground has a high thermal mass, and because of this the earth in the UK the ground stays at a constant 11-12°C at a depth of 1-2m. Ground Source Heat Pumps pump this heat from the ground so it can be used in the home and workplace.

1. How does it work?

A ground source heat pump has three key elements:

a) **The ground loop** – this comprises of lengths of plastic pipe buried in the ground, either in a borehole or a horizontal trench. The pipe will be filled with a mixture of water and anti-freeze, which is then pumped around the pipe and absorbs the heat from the ground.

b) **The heat pump** – a heat pump works by using the evaporation and condensing of a refrigerant to move heat from one place to another. Heat pumps are a very familiar and widely used technology, with fridges, freezers and air conditioning units. For GSHPs the pipe running through the ground is the evaporator, and this takes the heat from the earth. This heat is then transported through a compressor, which increases the temperature and heats the water in the tank from which the heat distribution system is fed. The system is driven by a compressor, which pumps the fluid around the system.

c) **The heat distribution system** – due to the temperatures involved, GSHPs work best with underfloor heating systems that provide good space heating with water of 35-50°C. If traditional wall mounted radiators are to be used they must be larger than ones used for conventional heating systems. The hot water produced can also be stored in conventional hot water cylinders to reduce additional energy input for hot water supply.

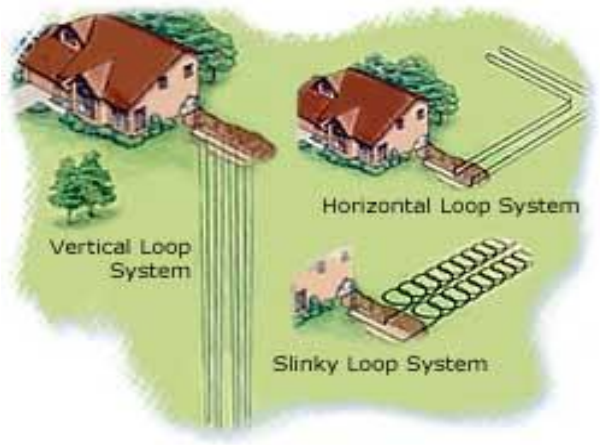

FIGURE 1: GSHP SYSTEMS

2. The trench

The ground loop can be put in the ground in one of three ways. It can be coiled into a 'slinky' and put in a trench, and for this type of system a trench of around 10m will provide about 1kW of heating. Pipe can also be laid straight in horizontal trenches, though this will require a much greater length of trench. If trenches are unsuitable then ground loops can be put in a vertical borehole that goes to much greater depths – these boreholes can be more expensive to install but require much less land.

3. Costs

GSHP systems generally require professional installation in order to ensure that the job is well done and that the correct type and size of heat pump is installed. Heat pumps can be designed to produce 100% of the heat for space heating requirements. These systems will cost around £800-1200 per installed kW, excluding the cost of the heat distribution system. The cost of distribution systems will vary, but where no central heating system is installed underfloor heating can be fitted at rates often competitive with normal central heating systems.

These systems also come with an attached running cost, because an electric pump must be run in order to pump the fluid around the ground loop. The level of efficiency of a GSHP system is measured as by the Coefficient of Performance (CoP), and it is this figure that is used to work out running costs. The CoP is the ratio of the number of units of heat given out by a system against the number of units of electricity used to drive the system. A heat pump CoP's generally ranges from between 2.5-4, with the higher end of this range being for systems with underfloor heating systems, as they work at lower temperatures.

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With a CoP of 3-4 GSHP will be a cheaper form of space heating to run than oil, LPG or electric systems, though not normally mains gas systems.

The economics of a system will be made much more favourable by three key factors.

1. If a property is off mains gas then this will make a GSHP much more economically attractive.

2. If a system is for a new building or a renovation project then there is considerable potential to reduce costs by combining ground loop installation costs with the foundations or other pipe work.

3. A building will need to be extremely well insulated in order for the systems to function as efficiently as possible. This makes GSHP a real economic possibility for new build projects and renovations where strict new insulation guidelines ensure that these buildings will have high levels of insulation, and there will also be ample opportunity to install underfloor heating.

4. There are now government incentives to support renewable heat production and use.
   The RHI was launched in November 2011, and is the first financial support scheme for renewable heat of its kind in the world.
   In the first phase, long term tariff support has been made available to non-domestic, industrial, business and public sectors . The second phase of the RHI scheme will see it expanded to include support for household installations. The timing of this introduction is expected to be in the Spring of 2014.
   For more information please visit:
   https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi

4. Environmental impacts

Because GSHP systems require electricity to run the pumps, they are not without environmental impact and can be said to generate pollution if they use mains electricity. Measures can be taken to reduce this impact though, most notably purchasing mains electricity from a 'green tariff' scheme. They can also be coupled with other renewable energy production systems such as solar PV, small-scale wind or micro-hydro if these are applicable. Even if mains electricity powers these systems, it will work at a good CoP level and so produce less CO_2 emissions than the most efficient condensing gas or oil boilers with the same output, and so have a positive environmental impact.

The refrigerant fluids in the ground loop can also pose an environmental threat by being toxic and flammable, and can cause ecological damage if they are allowed to leak out. Because of this correct fitting of a system is crucial, which is why these systems are best fitted by one of the professional installation companies. Modern refrigerants are also being developed with greatly reduced levels of toxicity.

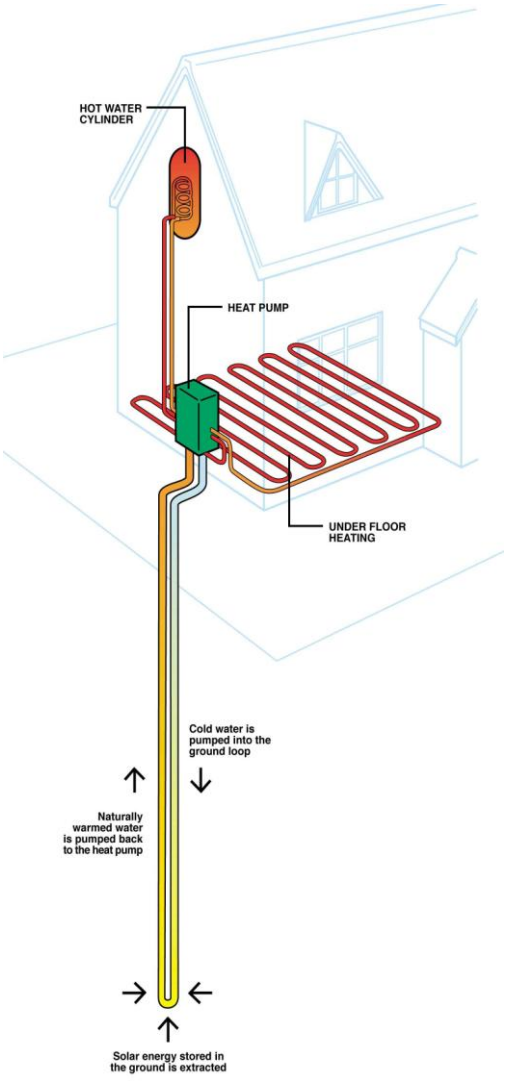

Figure 2
GSHP system with underfloor heating