

Ground source heat pumps

Introduction

Here in the UK, the earth - a few metres below our feet - keeps a constant temperature of about 11-12°C throughout the year. Because of the ground's high thermal mass, it stores heat from the sun during the summer. Ground source heat pumps (GSHP) can transfer this heat from the ground into a building to provide space heating and heating for domestic hot water. For every unit of electricity used to pump the heat, 3-4 units of heat are produced. As well as ground source heat pumps, air source and water source heat pumps are also possible.



Fig 1: Ground loop being installed to connect to the Heat Pump.



Fig 2: 8kW Heat Pump unit connected to the ground loops via the manifolds.



Fig 3: Under floor heating loops terminated at manifolds.



Fig 4: Under floor heating pipe distribution system.

How does it work?

There are three important elements to a GSHP

- **Ground loop** - comprises lengths of pipe buried in the ground, either in a borehole or a horizontal trench. The pipe is usually a closed circuit and is filled with a mixture of water and antifreeze, which is pumped round the pipe absorbing heat from the ground.

- **Heat pump** - although we may not know it, heat pumps are very familiar to us - fridges and air conditioners are both examples. A heat pump has three main components:

Evaporator - takes the heat from the water in the ground loop.

Compressor - moves the refrigerant round the heat pump and compresses the gaseous refrigerant to the temperature needed for the heat distribution circuit.

Condenser - gives up heat to a hot water tank which feeds the distribution system.

- **Heat distribution system** - consists of under floor heating or radiators for space heating and in some cases water storage for hot water supply.

What are the options?

Three options are available for the ground loop: borehole, straight horizontal and spiral horizontal (or 'slinky'). Each has different characteristics allowing you to choose the most suitable for your property.

Horizontal trenches can cost less than boreholes, but require greater land area. For slinky coil, a trench of about 10m length will provide for about 1kW of heating load.

Sizing

Sizing of the heat pump and the ground loop is crucial to the operation of the system and will depend on your heating requirements. At the outset it is a good idea to look at energy efficiency measures such as wall and floor insulation to reduce your heat demand. When sizing a system it's important to consult a professional installer for expert advice. A heat pump can be designed to meet 100 per cent of space heating requirements but it will usually only pre-heat domestic hot water so top up heating (e.g. an immersion heater) may be required.

However recently there have been developments which allow heat pumps to produce water temperatures up to 65°C making them suitable to heat domestic hot water and provide space heating using traditional type radiators.

How much does it cost?

- **Installation costs:** The installed cost of a GSHP, for a professional installation, ranges from about £800-£1,400 per kW of peak heat output, excluding the cost of the distribution system. Trench systems are cheaper so tend to be at the lower end of this range, and the price per kW gets lower as the systems get larger. The installed cost of a typical 8kW system would vary between £8,000-£12,000 plus the cost of the distribution system. Note that costs are dependent on property and location, so the cost for a system for your home may differ.
- **Running costs:** The efficiency of a GSHP system is measured by the Coefficient of Performance (COP). This is the ratio of the number of units of heat output for each unit of electricity input used to drive the compressor and pump for the ground loop. Typical CoPs range between 2.5-4. The higher end of this range is for under floor heating, because it works at a lower temperature (30-35°C) than radiators.

Based on current fuel prices, assuming a CoP of 3-4, a GSHP can be a cheaper form of space heating than gas, oil, LPG and electric storage heaters. However, the amount saved will depend on the fuel replaced. If national grid electricity is used for the compressor and pump, then an economy 7 tariff usually gives the lowest running costs.

Are there any environmental impacts?

The main environmental impacts are:

- **Pollution from using national grid electricity generated through fossil fuel:** Measures can be taken to reduce these impacts - for example, you could purchase dual tariff green electricity from a choice of energy suppliers. However, even if national grid electricity is used to run the compressor, the system will still produce less CO₂ emissions than even the most efficient condensing gas or oil boiler with the same output.
- **Use of refrigerants in the system.** Refrigerants are present in GSHP systems and can pose a threat to the environment through being toxic, flammable or having a high global warming potential. However, new types and blends of refrigerant with minimal negative impacts are being developed. A correctly fitted system will also greatly reduce the potential for leakage, which is why using a professional installer is highly recommended.

Is my house suitable?

You should consider the following issues if you are considering a ground source heat pump. A professional installer will be able to provide more detailed advice regarding suitability.

- The type of heat distribution system. GSHPs can be combined with radiators but under floor heating is better as it works at a lower temperature.
- Is there space available for a trench or borehole to accommodate a ground loop?
- Is the ground material suitable for digging a trench or borehole?
- What fuel is being replaced? If it is electricity, oil, LPG or any other conventional fossil fuel the payback will be more favourable. This makes heat pumps a good option for off gas grid areas.
- Do you want to be 100 per cent renewable? If so, purchase green electricity, or install solar PV or some other form of renewable electricity generating system to power the compressor and pump.
- Do you require a back up heating system?
- Is there also a cooling requirement?
- Is the system for a new building development? Combining the installation with other building works can reduce costs.
- Can you incorporate insulation measures? These measures include wall, floor and loft insulation, as these will reduce your heat demand.

Useful links

- For advice and information about renewable energy technologies and other energy saving measures for your home: www.est.org.uk/myhome
- The UK Heat Pump Network: www.heatpumpnet.org.uk
- The Heat Pump Association (part of the Federation of Environmental Trade Associations): www.feta.co.uk
- The IEA Heat Pump Centre - includes case studies for ground source heat pump installations: www.heatpumpcentre.org
- The Energy Saving Trust's publications, in particular:

Domestic Ground Source Heat Pumps (CE82/GPG339): Design and installation of closed loop systems available from: www.est.org.uk/housingbuildings