enviko
renewable energy solutions

Ground Source Heat Pump Information Booklet

Zero Carbon Living

Introduction

A Ground Source Heat Pump (GSHP) takes heat from the ground and converts it into energy, which can be used to heat buildings. In the UK the earth, a few metres below our feet, keeps a constant temperature of about 11-12C throughout the year. Because of the ground's high thermal mass, it stores heat from the sun during the summer.

Ground source heat pumps use a buried ground loop which transfers heat from the ground, into a building. This can be to provide space heating, and is some cases, to pre heat domestic hot water. For every unit of electricity used to pump the heat, 3-4 units of heat are produced making them highly efficient. Thus the GSHP has an efficiency of 380% compared to 85% for the most efficient gas boilers.

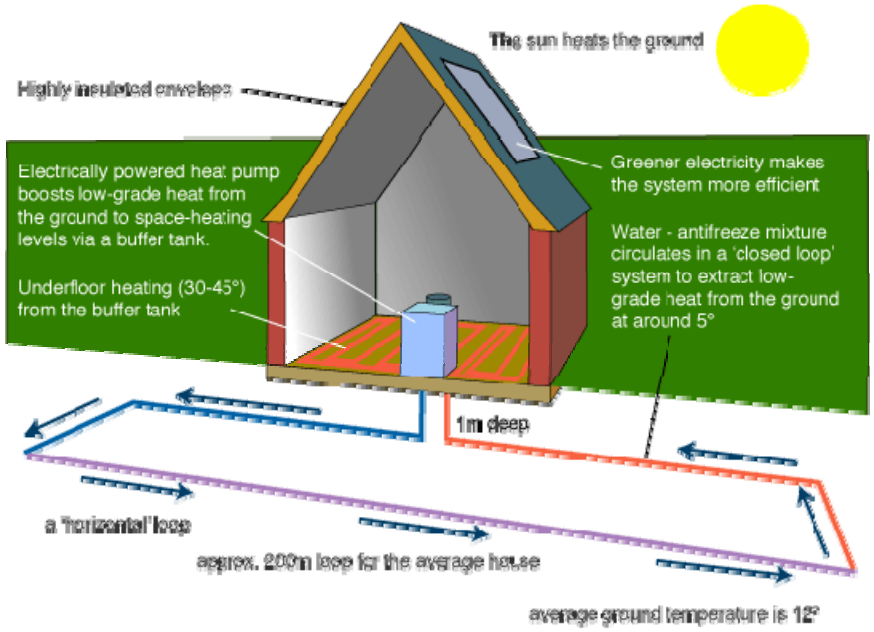
The technology used in this process is very simple and familiar to all of us in the form of a refrigerator, which uses heat exchangers to cool down the inside of the fridge and emits heat on the outside. The GSHP cools down the ground outside and emits heat inside.

Our favoured ground source pump manufacturer is NIBE, a Swedish company and one of Europe's leading manufacturers in the domestic heating sector. They hold the title of most efficient heat pump in the world - 5.03kw output for every 1kw unit used.

How does it Work?

The Illustration below shows the main elements of a typical system. Three basic principles are followed throughout the entire process:

1. Heat flows from warmer to cooler
2. Compression of gas to liquid releases heat
3. Expansion of liquid to gas causes cooling



Basic Layout of Ground Source Heat Pump System

There are three important elements to a GSHP:

• **Ground loop** - comprises lengths of polyethylene 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** - A heat pump is a powerful refrigerator, the main elements of which are:

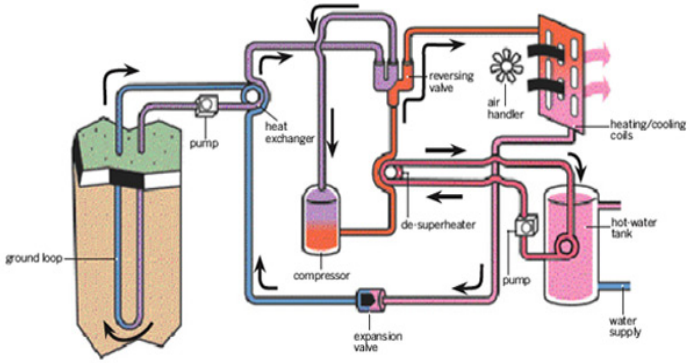
Evaporator - (e.g. the squiggly thing in the cold part of your fridge) takes the heat from the water in the ground loop

Compressor - (this is what makes the noise in a fridge) moves the refrigerant round the heat pump and compresses the gaseous refrigerant to the temperature needed for the heat distribution circuit.

Condenser - (the hot thing at the back of your fridge) 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.

Key components to a GSHP system



Rapid Expansion of liquid into gas at the expansion valve in the refrigerant circuit causes cooling in the evaporator heat exchanger. Thermal transfer within the evaporator heat exchanger causes warming of the cooled refrigerant gas and an equivalent cooling of the ground loop solution.

The “warmed” refrigerant gas now passes through the compressor and is turned back into liquid. The compression of the gas into a liquid causes heating within the condenser heat exchanger. Thermal transfer within the condenser heat exchanger supplies heat to the domestic heating and hot water system and an equivalent cooling of the refrigerant liquid.

The domestic heating and hot water system should be a “wet” system consisting of radiators, underfloor heating and/or hot water tank. This part of the system is essentially the same as for alternative “wet” systems such as gas or oil fired boilers with the heat pump taking the place of the boiler.

The important difference is that the system will be designed for an output temperature of 50^0C rather than 80^0C typical for systems fuelled by oil or gas.

What options are available?

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.

Diagram Illustrating horizontal trenching

Vertical collectors are used where land area is limited and for larger installations. They are inserted as U-Tubes into pre-drilled boreholes. Vertical collectors are more expensive than horizontal ones but have thermal efficiency and require less pipe and pumping energy.

Sizing

The length of pipe required depends upon the building heating load, soil conditions, loop configuration, local climate and landscaping. Sizing of the heat pump and the ground loop is crucial to the operation of the system. 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% of space heating requirements but it will usually only pre-heat domestic hot water so top up heating (e.g. an immersion heater, or solar thermal equipment) will be required.

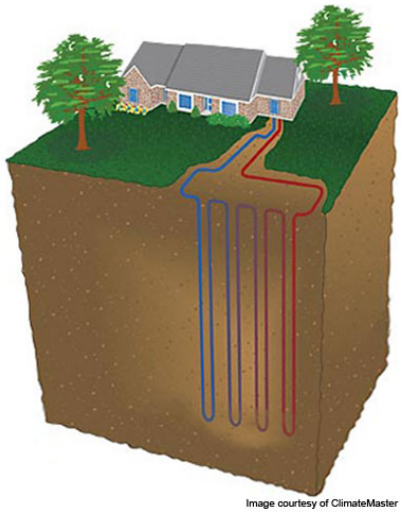


Image courtesy of ClimateMaster

Is my house suitable?

You should consider the following issues if you are considering a ground source heat pump. An accredited 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% 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? Including wall, floor and loft insulation will reduce your heat demand.

How much does it cost?

- **Complete System Prices**

As a general guide, the cost of installing a GSHP system for a well insulated, domestic property is likely to be between £6,000 and £9,000. This approximate price includes the supply and installation of a horizontal ground loop, heat pump and buffer cylinder.

Quotes are prepared individually for each system, without charge and without obligation. This can be done upon receipt of building plans, showing room layout and dimensions, and a site plan. For existing buildings we also require a calculation of heat loss.

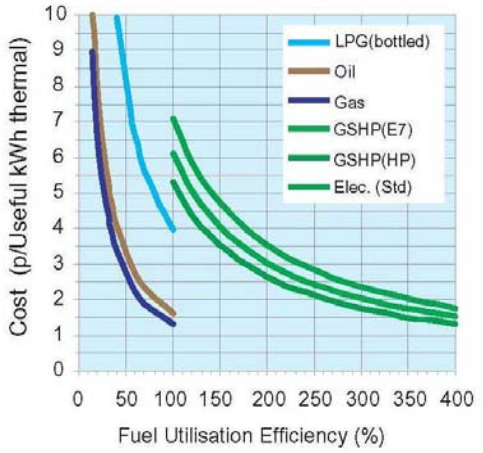
Orders are to be confirmed in writing and customers will then be invoiced for 30% of the total order cost. The remaining costs will be settled 2 weeks prior to the commencements of works and upon the successful commissioning of the system.

Please remember that VAT incurred for the purchase of most structural and integral materials used in building a new home or converting a non-residential building into a residential building (e.g. a steading) can be reclaimed. Ground Source Heat Pumps are included in this, and VAT on these is charged at 5%.

- **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 underfloor heating, because it works at a lower temperature (30-35oC) than radiators.

The best gas condensing boiler has a seasonal efficiency of approximately 85% compared with an efficiency of about 73% for a conventional boiler. Heat pump systems however can operate at seasonal efficiencies greater than 100% and an efficient GSHP will operate with a seasonal efficiency of at least 300%. The graph below illustrates the domestic fuel cost per useful kWh of heat provided versus fuel utilisation.



Graph Illustrating Domestic fuel costs versus fuel utilization efficiency

Grants available

The Government is supporting the introduction of Ground Source Heat Pumps into the UK through grants under its Low Carbon Buildings Programme, which has replaced the former Clear Skies grant scheme.

- **Low Carbon Buildings Programme**

Phase 1 - Householder Stream.
At present, grants are available for non-reversible closed loop systems, utilising a borehole or trenches. A grant of up to £1,200 is available for domestic systems. For details of how to apply for grants, and of energy efficiency measures that must be in place before the grant can be accessed, please visit www.lowcarbonbuildings.org.uk.

Phase 2 - *Community Stream.*
Phase 2 of the LCBP is for the installation of microgeneration technologies in public sector buildings (including schools, hospitals, housing associations and local authorities) and charitable bodies. Grants are available for up to 50% for installations with a maximum of £30,000. Phase 2 is administered by the BRE, for further information please visit www.lowcarbonbuildings.org.uk.

- **Scotland**

In Scotland, grants are available under the Scottish Community and Household Renewables Initiative. The SCHRI scheme awards grants of 30% of the capital cost to owners of homes in Scotland. The maximum grant is £4,000.

Ground Source Heat Pump Installation

What happens now?

In order accurately to price a system for a customer we need to gather specific information about the property, or planned property. In a new build situation, this information can be gathered from building and site plans. With an existing building heat loss calculations should be carried to determine the exact heating requirements. Enviko provides this service as part of our service. When retrofitting a system without heat loss calculations, Enviko will not be liable for any dissatisfaction regarding heat provision. If you require a geological survey, we can arrange for that to be carried out however it is unlikely that this will be required.

When an accurate price has been quoted and accepted and a deposit received, the installation of the ground loop is arranged and the heat pump will be ordered. You will be sent our Customer Requirements pack, specifying the exact building access and ground requirements.

We normally carry out the installation of the ground loop and the installation and commissioning of the heat pump ourselves, in accordance with the “Good Practice” guidelines stipulated by the Energy Saving Trust.

Ground Loop Installation

Ideally the ground loop installation takes place during the major ground works of a new build. This reduces future ground disturbance, may utilize favourable rates from the builder for digging trenches and allows time for the thermal gradient to be restored. Additionally, you may of course want the land to be landscaped to form a garden.

The installation of a horizontal ground loop is a simple process. The correct length depth, width and spacing are calculated. These specifications will be passed on to the ground work contractor. The trenches are dug and our engineers lay the piping the following day. The pipe is terminated at the manifold (on the external side of the wall, usually at the point at which the heat pump is to be installed internally). The trenches are then back filled, leaving no trace of your heating fuel supply.

Heat Pump Installation

The heat pump needs to be ordered about 6 weeks before heating is required. The unit is delivered directly to the customer and our engineers will carry out the fitting and commissioning and testing. Electrics and plumbing will have been specified in advance and provided as part of the build. Commissioning takes less than one day and involves filling, purging and priming the ground loop and the heat pump unit.

It should be noted that heat pump systems are sized to provide efficient heating and should not be used to “dry out” a newly built property. Industrial heaters can be hired for this purpose.

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