HIenergy
HIGHLANDS AND ISLANDS OF SCOTLAND
HARNESSING NATURE'S POWER

Factsheet

Ground Source Heat Pump

Although above ground the Scottish weather is renowned for its unpredictability, beneath our feet there is very little change all year round.

A metre or so below the earth's surface temperatures remain relatively constant in the UK at around 7-13C (in the Highlands and Islands this is likely to be at the lower end of this). A ground source heat pump (GSHP) takes advantage of these constant temperatures and transfers the heat retained in the ground to a building.

GSHP technology is over half a century old. Continuous development has greatly improved its efficiency and reliability. It is now a proven, safe, and environmentally friendly technology installed on a widespread basis across much of Europe and the USA. The technology is also highly versatile and can be used to provide cooling as well as heating.

A typical GSHP system is made up of an indoor and outdoor component. The outdoor component consists of a closed circuit of flexible piping which is buried in the ground. Depending on ground conditions and space constraints the length of pipe can either be laid horizontally in a trench or buried in a vertical borehole (see figure 1).

A fluid (typically made up of an antifreeze solution) is pumped through the pipe absorbing heat from the ground as it circulates. When the fluid reaches the indoor component of the system its heat is extracted through a heat pump which also increases the input temperature to a more useful output of 30-50C.

The heat is increased by compressing it in the pump. To do this the heat pump requires a small amount of electricity to run. This electricity is used only to run the pump and does not provide direct heating. The heat can then be supplied to the rest of the building via its normal heating distribution system.

Ground source heat pumps provide a lower grade of heat than traditional methods. As such they are particularly suited to buildings which use underfloor heating as opposed to radiators.

If you require further information, please contact the renewable energy team at Highlands and Islands Enterprise
Tel: **01463 244350** Email: **renewables@hient.co.uk**

Ground Source Heat Pump
Configurations & Associated Costs

The technical feasibility of installing a ground source heat pump will largely depend on local ground conditions and availability of space.

A geotechnical survey would normally be required before deciding on which configuration of system best suits the property. The results of the survey would provide necessary information on both sub-surface conditions and the location of any obstructions such as sewers or tunnels.

For an individual house, a horizontal loop system would require a garden area of up to 100 square metres. Vertical boreholes may require to be in excess of 60 metres deep. Ground conditions will dictate the cost of installation and performance of the system.

The sizing of the heat pump and the ground loop is vital to the operation and efficiency of the system. It is important that it matches closely the heat demand and heat loss for the building.

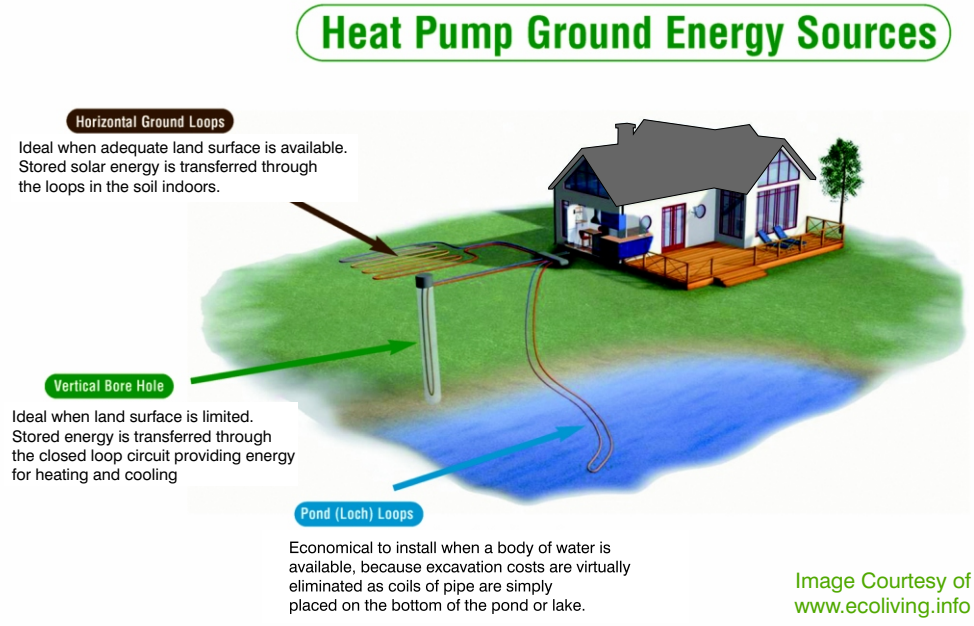

Figure 1: Different Ground Source Heat Pump Configurations

Associated Costs

The Energy Saving Trust provides indicative installed costs of £800-£1,400 per kW of peak heat output, excluding the cost of the internal distribution system. Trench systems are cheaper than boreholes so tend to be at the lower end of this range, and the price per kW reduces 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.

Functionality

In order to function GSHPs require an energy input to power the heat pump and circulate the fluid in the pipes. This input can be via mains electricity or, more desirably from an environmental standpoint, generated by another renewable energy technology (such as grid connected wind or solar PV).

Modern heat pump systems have a coefficient of performance (COP) of between 3 and 4. This means they can supply 3-4kW of heat output for every 1kW of electricity input.

A range of NIBE heat pumps
www.ecoliving.info

Heat Distribution System

The efficiency of a heat pump is a function of the difference between the temperature of the source and the output temperature of the heat pump (ie the temperature of the distribution system).The smaller this temperature difference the higher the COP of the heat pump will be. For example if the distribution temperature required falls from 60°C to 40°C the COP can increase by more than 40%. It is therefore important to use the lowest possible temperature distribution system.

Typical delivery temperatures for various heating distribution systems are shown opposite.

The most efficient type of space heating to use with a GSHP system is underfloor heating. Ideally the system should be designed to give floor surface temperatures no higher than 26°C and should be sized using a water temperature difference of about 5°C.

Distribution system	Delivery temperature °C
Underfloor heating	30 - 45
Low temperature radiators	45 - 55
Conventional radiators	60 - 90
Air	30 - 50

Source: Energy Saving Trust (2004)

Ground Source Heat Pump
Considerations

The impact of GSHPs can be much more favourable in the following circumstances:

Financial - Where associated fuel costs are minimised. The fuel used to power the heat pump is electricity and usual tariff rates for this will apply. Maximum advantage should be taken of any preferential tariffs (off-peak, Economy 7 etc.) in order to to keep annual costs as low as possible.

Carbon Reduction - Where the electricity required to power the pump is renewable (either generated onsite or via a 'green tariff')

Efficiency - Where underfloor heating is used as the distribution system (as it operates at a lower temperature than radiators).

The system will also perform better in buildings with a high thermal efficiency. Good levels of insulation are therefore a necessity to ensure the system performs well over its lifetime.

New Build - If a GSHP is being considered for a new property the overall cost of the project could be reduced significantly if the installation is combined with the other scheduled building works.

Other Considerations

Relevant Permissions
Neither the internal or external component of the ground source heat pump system can be seen from the outside of a property. Visual impact will therefore not be an issue for planners.

Advice should still be sought prior to any development regarding the digging of trenches and boreholes. Both the local planning department and the Scottish Environmental Protection Agency (SEPA) should be consulted.

A horizontal 'slinky' GSHP
the coil should be buried at a depth of 1 - 1.5m deep

Installation
The installation of a heat pump system should only be undertaken by accredited professionals. Reputable installers should be willing to warranty the performance figures offered.

It is advisable to have a separate kWh meter fitted to the heat pump to allow for easy monitoring of the energy input. Arrange permission for an off peak tariff before installation and consider installing a timer so the heat pump operates on off-peak electricity only.

The digging of trenches or boreholes should also only be carried out by an experienced, well trained team.

Maintenance
Ground source heat pump systems require little or no maintenance. The outdoor component, the buried piping, should remain intact and functioning well for in excess of 50 years. The other half of the system the compressor and heat pump is housed indoors and protected from the elements. It may have a lifetime of 20-25 years. Usually, periodic checks and filter changes are the only required maintenance.

Drilling a borehole

Useful Links

UK Ground Source Heat Pump Association
www.nef.org.uk/gshp/

The Energy Saving Trust - Ground Source Heat Pump
www.est.org.uk/myhome/generating/types/groundsource/

UK Heat Pump Network
www.heatpumpnet.org.uk

Domestic Ground Source Heat Pumps: Design and installation of closed-loop systems - Excellent guide written by the Building Research Establishment aimed at potential users of GSHP technology
www.nef.org.uk/gshp/documents/CE82-DomesticGroundSourceHeatPumps.pdf

A comprehensive list of accredited manufacturers and installers of ground source heat pump equipment can be found here
www.lowcarbonbuildings.org.uk/info/installers