GROUND SOURCE HEATING

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These systems draw heat from under the ground using either a borehole or a series of pipes laid a few metres below the surface.

The heat you get from the pipes or borehole will not in itself be warm enough. It must be 'boosted' to the level needed for heating a home using an electrical device known as a 'heat pump'. In a well-installed system, every unit of electrical energy put in will yield three or more units of heat energy.

Electricity is not particularly cheap, and is mostly generated by fossil fuel or nuclear power stations. A ground source heat pump must be carefully specified if it is to have a lower environmental impact, and lower cost, than other heating options.

Is this geothermal energy?

In the UK, most ground source heat pumps will not be making use of true geothermal energy. To do that you would need to drill much deeper, or have hot springs that can be tapped, such as in Iceland.

Solar energy is absorbed by the ground and stored a few metres below the surface. Protected from extremes of heat or cold, the ground here will remain at about 10°C all year round. Aborehole will be affected slightly by geothermal heat, but the temperature available will still only be about 10°C.

What is a heat pump?

You will almost certainly have a heat pump in your home already, as they are used to keep fridges cool - basically by 'pumping' heat out. Most air conditioning units are also heat pumps. Both of these are generally air-source systems.

A ground source heat pump will usually be the most appropriate system for home heating. Air source systems are not very good at providing heating, as their efficiency is very poor in the winter (when you need heat most) when the air is very cold. Also, heat transfer from air is more difficult than from other sources. Water-source systems are usually very efficient, but you will need a water source such as a spring that will not freeze.

Are they environmentally friendly?

In order to be environmentally beneficial, the whole heating system must be properly specified and the house must be very well insulated (certainly more than is specified by current UK Building Regs). You can vastly improve the efficiency of your existing property by taking simple energy conservation measures - see our *'Energy Efficiency in the Home'* information sheet or the CAT book *'The Energy Saving House'* for advice.

The efficiency of a heat pump is given by its coefficient of performance, or COP. A system operating at COP3 will be giving 3 units of heat energy for every unit of electricity used.

However, you need to bear in mind that most grid electricity is generated from fossil fuels or nuclear power at conversion efficiencies of only 30 to 40%, so you'll need a decent COP to outweigh this. If a system has a poor COP you'd be better off with a gas boiler - this would give off less carbon dioxide and make a smaller contribution to climate change. Electricity generation also causes other forms of pollution: sulphur & nitrogen oxides (that cause acid rain); particulates; and nuclear waste.

You can sign up for a 'green tariff', and have your electricity use allocated to renewable sources such as wind or hydro power. This is an excellent way to help promote the growth of the renewable energy industry, but it is not a green light to use loads of electricity. Doing so will increase overall electricity demand, and until more renewable energy technologies are ready, fossil fuels and nuclear power will be used to meet this increase.

If you have a stream that would be suitable for a micro-hydro system, then a renewably-powered heat pump could be feasible and beneficial. See CAT's *Micro-Hydro Factsheet* for information on installing small-scale hydro-electric systems.

A heat pump contains about 2 kilos of refrigerant, usually an HFC (Hydrofluorocarbon). However, these are potent greenhouse gases (about 1600 times more powerful than carbon dioxide) and any leak either during or after the system's lifetime will have a damaging impact. See overleaf for suppliers that use natural hydrocarbon refrigerants such as R290 or R600a (propane and isobutane), that have a much lower impact if leaked.

What about wood?

You could also consider a wood-fired heating system. This should have a much lower impact and be cheaper to run. For the same price as a heat pump you could get a modern, highly automated log or wood pellet boiler. Wood from a sustainable source is a carbon neutral fuel. Contact us at CAT for further details.

Specifying a heat pump

A heat pump operates most efficiently when the temperature gap between the heat source and the heat demand is minimised. To reach COP4 you must have a very well insulated house (so usually a new-build or an extensive renovation) and a low temperature system such as underfloor heating, which uses water heated to only 35°C.

Underfloor heating can be fitted under solid or suspended timber floors, but thick carpets should not be used, as they will stop heat coming through. To combat this, some underfloor heating systems run at 50°C or more, which leads to COP3 or lower from a heat pump. Feeding standard radiators at 75°C could result in COP2.5 or below.

To enable a heat pump to work at maximum efficiency all year round it is usually sized to meet most, but not all, heating requirements. Because of this, some form of backup heating is necessary during very cold spells.

Providing domestic hot water with a heat pump is not ideal, as the associated efficiency loss is too great. So you may need an alternative water heating system if you don't already have one – a solar water heating panel to ease the burden would be ideal. Contact us if you would like more advice on solar water heating.

High quality heating controls are very important - to run the system as efficiently as possible. Weather compensation controls regulate internal heating according to outside temperatures. For example, in cool weather underfloor heating may need water at only 25°C to provide suitable comfort.

Guidelines for Installation

There are no installation standards for heat pumps at present, so installers trying to reduce costs can skimp on the length or bore of pipe, or the depth of the trenches dug to lay it.

Trenches should be at least two metres deep to harness a reasonably consistent year-round heat source. A typical installation is 7- 8 kilowatts (kW); for trenches you'll need 50 to 80 metres of pipe per kW, or 10 metres of 'slinky' (coiled pipe) per kW.

Boreholes will need 20 to 50 metres of pipe per kW, and will usually be 100-150 metres deep – which means you may need 2-4 pipes per borehole, or maybe more than one borehole.

Pipe diameter should be 20-40mm for best performance - large enough to reduce pumping power but small enough to increase flow velocity and cause 'turbulent flow' (which gives better heat transfer).

How much will it cost?

At current prices, a ground source heat pump could be a cheaper option than oil, LPG (propane & butane), or electric storage heaters. It will only be more cost effective than a modern gas boiler if the system can achieve COP4 or higher.

A rule of thumb is that the whole system is likely to cost about £1000 per installed kilowatt. The heat pump itself will be £400 to £600 per kW, with trenches £300 per kW or boreholes £500 per kW. A 8kW system could cost from £7,000 to £8,000. A £1,200 grant could be available – see below.

A water source system (only feasible if you have access to a spring or similar) is usually cheaper, as a ground loop or borehole is not needed. Putting in underfloor heating will come to about £2000, and most existing homes will need to have insulation levels improved. Without efficiency measures, the cost of a heat pump will be much higher.

Air conditioning

Using a heat pump for air conditioning should never be necessary in the UK, as passive (not powered) ventilation and cooling can be used instead. For new buildings, use can be made of passive solar design principles, to take advantage of natural solar heating and cooling and provide higher levels of comfort than air conditioning.

Further Information

For more detail on heat pumps, see our tipsheet on the subject, available through CAT Mail Order or from *www.cat.org.uk/catpubs/ppv.tmpl*
Details of a CAT course on heat pumps are in the CAT courses leaflet or at *www.cat.org.uk/courses*

See *www.cat.org.uk/information* for more advice on domestic renewable energy and energy efficiency.

Low Carbon Buildings: *Tel: 0800 915 0990; Web: www.lowcarbonbuildings.org.uk*
Grants for householders, small businesses, community schemes, and larger projects.
If you live in Scotland, contact the
Scottish Community Renewables Initiative
Tel: 0800 138 8858; Web: www.est.org.uk/schri
The Energy Saving Trust can give details of local grants to help with energy conservation measures
Tel: 0800 512 012; Web: www.est.org.uk

Suppliers of hydrocarbon-based systems:

Earthcare Products Ltd *Tel: 01920 444082; Web: www.earthcareproducts.co.uk*
John Cantor Heat Pumps
Web: www.heatpumps.co.uk
For more on hydrocarbon refrigerants see *www.care-refrigerants.co.uk* & *www.mipiggs.org*