ground source heat pumps

the ground loop collector pipe is laid in a trench

what are they?

A heat pump is simply a device for absorbing heat from one place and transporting it to another. They can be used to remove unwanted heat (e.g. a fridge or air conditioning unit) or to transport heat to where it is wanted.

The fridge is a good demonstration of how surplus heat (from cooling food) can be extracted and redistributed. In fact in a super-insulated home the heat from the back of a fridge or freezer can contribute significantly to space heating. Heat pumps, fridges and air conditioners work on the same principle (see http://home.howstuffworks.com/ac1.htm for a bit of science). An air conditioner takes heat from inside (even if it's already cold) and dumps it outside. A heat pump does the opposite. In fact if a heat pump is run in reverse it becomes an air conditioner!

Heat pumps for space and/or water heating can get 'free' heat from air, water or the ground outside the building. In each case the system has 3 components: a collector, the heat pump, and a distribution system. Ground source heat pumps (GSHPs) rely on heat from the sun warming the surrounding land. In the UK, soil maintains a relatively stable temperature of between 8-12°C at a depth of over a metre, even in winter. The collector or ground loop is simply a closed circuit of pipe, containing a water/antifreeze mix, buried either in a horizontal trench at least 1.2m but preferably 1.5-2m deep, or in a vertical bore-hole 15-150m deep. The liquid is pumped through the pipes, collecting heat from the surrounding soil, and into the heat pump, usually sited inside the building.

The heat pump itself has 3 parts:

- the evaporator absorbs the heat from the liquid in the ground loop into a refrigerant, which:
- the compressor compresses to the required distribution temperature, then:
- the condenser releases that heat into a tank of water feeding the distribution system.

Since the heat pump will produce circulating temperatures of only 30-45°C, highly efficient low temperature radiators or preferably underfloor heating are required, with back-up heating if the system is used for domestic hot water.

Although relatively new to the UK, heat pumps were invented over 50 years ago. There are over 440,000 domestic units installed worldwide, increasing by 66,000pa.

what are the benefits?

Since the heat comes from a renewable source (the sun), heat pumps can help reduce fossil fuel consumption and CO2 and other emissions. It must be remembered though, that heat pumps require a reliable electricity supply which may come from a non-renewable source. Efficient heat pumps can produce about 3-4 kW of heat using 1kW of electricity for the pump and compressor. This is sometimes expressed as being 300-400% efficient, or having a coefficient of performance (CoP) of 3-4. Running costs are therefore much lower than by direct electric heating. The Energy Saving Trust (2009) suggest savings of £1000 and 7 Tonnes CO2 for 100% of space heating and 50% of hot water in a detached property using a 8-12 kW heat pump costing £6000-£12000 (excluding the distribution system).

Suggested savings over other fuels are £750 and 1.8T for oil, £350 and 6.5T for solid fuel, £410 and 1.2T for gas. This shows a relatively small financial benefit over gas, so that if a gas supply is available, the cost of installing a GSHP is much less attractive than an efficient gas-fired condensing boiler (at current gas prices). The GSHP running costs are also subject to fluctuations in electricity prices. Using onsite PV or wind generation to pump the system would remove this risk and create a 'greener' system.

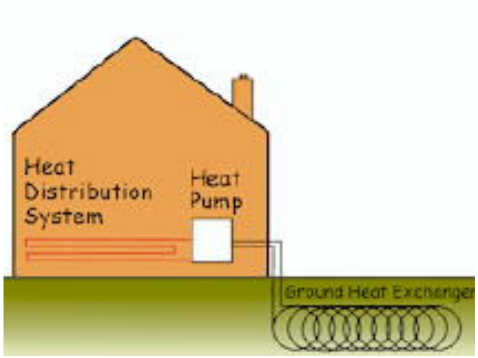
Other benefits claimed are high reliability with low maintenance costs and long life expectancy (20-25 years for the pump and up to 50 for the ground loop). There is no local combustion or storage of fuel, and the pump unit only occupies the space of a large domestic fridge. It is quiet and requires no ventilation or flue because it produces no local pollution. Improvements in coolant and refrigerant technology have also reduced the wider impact of these components.

what can I do?

Look hard at your circumstances. A GSHP could be for you, particularly if:

- you are planning a new build or major refurbishment (underfloor pipes or high spec radiators essential)
- your property has a very high level of insulation throughout – remember, the heat is distributed at only 30-45°C - some older buildings may never be energy efficient enough
- there is no mains gas supply (financial benefits are much less compared to gas)
- you have enough land for a horizontal collector trench - probably at least 2 trenches 300mm wide, 40-50m long and 1.8m deep (or shallower and wider) to take a coiled pipe. Vertical boring is much more expensive
- you are on a green electricity tariff (this enhances the environmental benefits)
- you can include onsite electricity generation (e.g. pv or wind) to power the pump

the pump unit sits in a corner of your house, impersonating a fridge



simplified diagram showing a basic ground source heat pump system

Get professional advice. System design is crucial for GSHPs. This is very project-specific as required output is calculated from the property's demand (heat loss, water use etc), and collector length matched to output. An oversized heat pump will cost more for no additional benefit, and possibly suffer reduced equipment life and operating efficiency due to frequent cycling. Under-capacity may require more top-up heating.

resources

- heatpumpnet.org.uk – list of UK heat pump installers, suppliers and other services
- Ground Source Heat Pump Association - 01908 665555, gshp.org.uk
- South Yorkshire Energy Centre in Sheffield has a ground source heat pump and is open to the public. syec.co.uk, 0114 258 4574