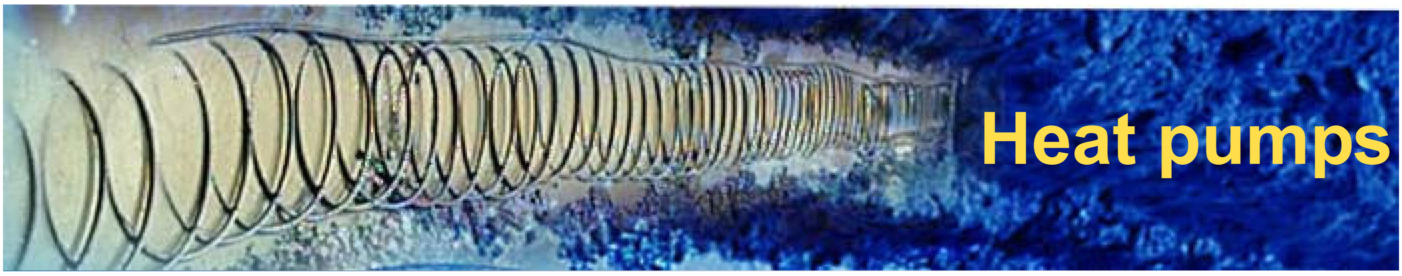


Heat pumps

Summary:

- Ground, water and air source heat can be used
- Works best in homes with a low heat demand
- Need ground space for trench or borehole
- Soil type determines heat transfer
- Low temperature radiators, under floor or air heating
- Coefficient of Performance (CoP) of 3–4
- Not 100% renewable
- Can be reversed for cooling
- Low maintenance
- 40-year lifetime
- System needs to be carefully sized by an experienced engineer

Heat pumps

Heat flows naturally from a higher to a lower temperature. Heat pumps reverse this natural flow, extracting heat energy from a cool source, such as the ground, and delivering it to a hot system, such as a building's heating system.

In the same way that a fridge uses refrigerant to extract heat from the inside, keeping your food cool, a heat pump extracts heat from a range for sources, and uses it to heat your home and hot water.

An ideal heat source for a heat pump has a high stable temperature during the heating season. Ground source, water source and air source are common in the domestic setting.

Ground source heat pumps

Ground source heat pumps do not tap into geothermal heat. Instead they use solar heat that has been stored in the earth.

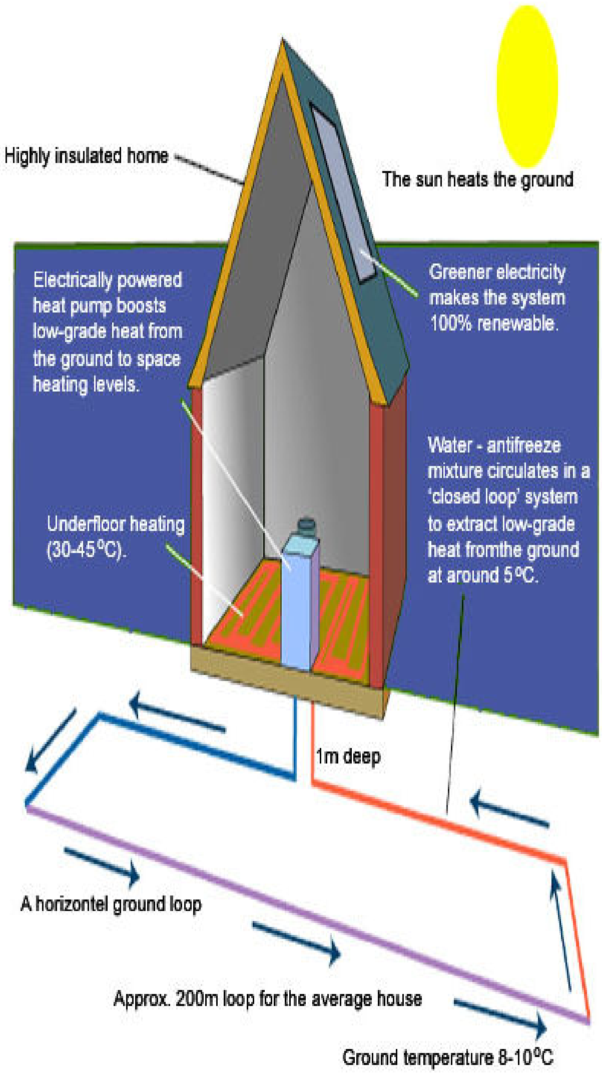
The earth acts as a huge solar collector. **Solar energy** is absorbed at the earth's surface. From there it can warm the air. It is also transported downwards into the earth by conduction and washed downwards by rainfall.

As you dig deeper into the earth the temperature becomes more and more stable until it approaches the temperature of well water, about **8–10ºC** year round.

The temperature of the ground is too low for direct use to heat our homes so it is necessary to refine or to upgrade the temperature of the heat. Electricity is used to upgrade it in the heat pump.

There are three key parts of the system:

- Heat collector
- Heat pump
- Heat distribution



NOTES

Heat collector

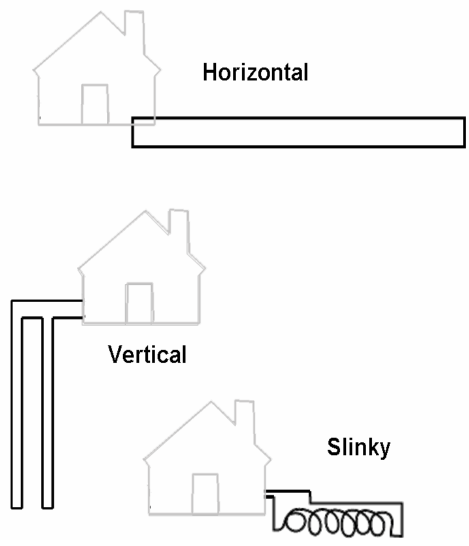
The heat collector consists of a carefully calculated amount of plastic piping buried a number of feet below the surface of the ground and plumbed in a closed loop.

There are three main types of ground loop:

Horizontal – used when there is plenty of ground available. Requires 50–80m of pipe per kW of installed capacity.

Vertical – used when the ground available is very small or rocky. A drilling rig is used to drill one or two, 75 to 100 m deep holes.

Slinky – used when the space is a bit limited as the spirals provide a greater surface area for heat absorption. From one third to two thirds shorter than traditional horizontal loop trenches.



Sizing the ground loop

The sizing of the ground loop is critical to the economics and operation of the system. It must be done by a **specialist**.

The more pipe used in the ground, the greater the output of the system but as the costs associated with the ground loop typically form 30–50% of the total cost, **over sizing** will be uneconomic.

Under sizing would lead to the ground loop running colder and not heating your home sufficiently. At worst, this could result in ground temperatures not being able to recover and heat extraction from the ground being unsustainable.

The length of pipe required and thus the area of ground needed for the collector depends upon the building **heating demand**, the **soil conditions** at the site and the **type of ground loop**.

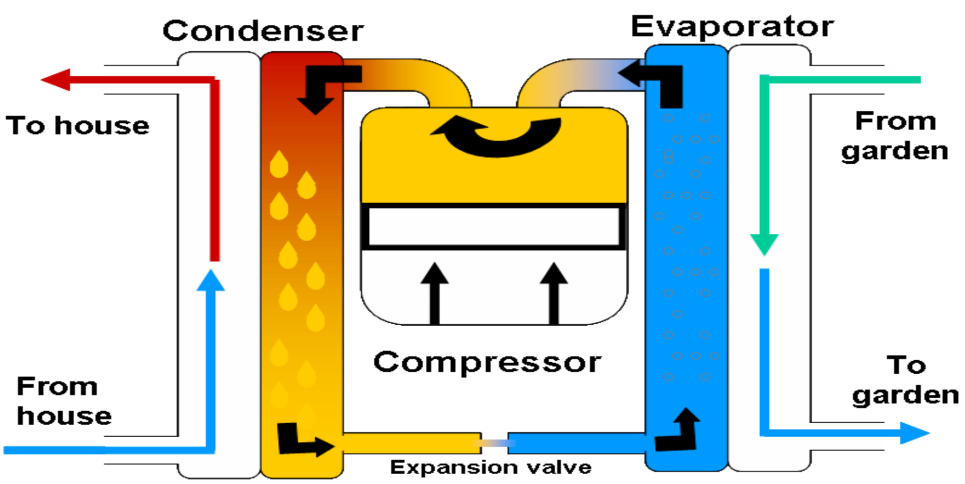
A heat pump works best in a home that has a low heat demand.

The thermal properties of soil are related to particle size and moisture.

Dry loose soil traps air so it has a lower conductivity than **moist packed soil**. If the soil is dry and loose you may need 50% more ground loop.

There are wide variations in soil type across the UK and therefore it pays to have a site investigation.

Heat pump



NOTES

Heat pump

The gas in the refrigeration circuit inside the heat pump has an extremely low boiling temperature. So when the liquid comes in from the garden circuit, that liquid transfers its heat to the colder liquid refrigerant in the evaporator.

This causes the refrigerant to turn to vapour and passes upwards to the compressor.

Electricity is used to drive the compressor. It squashes the vapour and this increases its temperature, as increasing the pressure raises the temperature.

The vapour then moves onwards to the condenser heat exchanger.

Water coming from the building's heat distribution system passes up the other side of the heat exchanger and this water absorbs the heat from the refrigerant coming from the compressor.

The refrigerant condenses back to liquid form like steam on a window.

It passes through an extremely small opening in the throttling device and undergoes a large drop in pressure with an associated drop in temperature.

This cold liquid is let into the bottom of the evaporator heat exchanger where the whole process is repeated.

The key to any heat pump is that the energy required to concentrate (make it useful) is less than the energy required to provide the heat directly.

Coefficient of Performance (CoP)

The coefficient of performance is the key figure used with heat pump systems. It indicates the ratio of useful heat energy output to electrical energy input.

If a system has a CoP of 3, for every 1kWh of electricity input you will get 3kWh of heat output.

Well designed systems can achieve a CoP 3–4.

The real bonus of taking this route is that the energy required to concentrate heat is much less than the energy that must be liberated by burning a fuel. This is how one unit of input energy can produce four times as much heat.

The Coefficient of Performance (COP) attainable with this process is limited ultimately by the temperature rise needed to make the heat useful.

The smaller the temperature rise, the less energy needed to pump the heat.

Distribution system

A heat pump works best if it operates with a low temperature distribution system such as under-floor heating. Heating using air ducts or low temperature radiators is also possible.

Heat pump systems may not be suitable for direct replacement of conventional water-based heating systems because of the high temperatures normally used for radiators. These usually require water at between 60ºC to 80ºC.

Under-floor heating	**30–45ºC**
Low temperature radiators	**45–55ºC**
Conventional radiators	**60–80ºC**
Air ducts	**30–50ºC**

Water and air source heat pumps

If at least a ½ acre by 8 ft deep pond or lake is available on your property, a **water source system** can be installed by laying coils of pipe in the bottom of the body of water.

This system tends to be less efficient than ground source due to greater seasonal variations in water temperature.

Air source heat pumps absorb heat from the outside air to heat buildings.

Air source heat pumps present an advantage over ground source heat pumps because they require less space to install.

They are also cheaper to install because they do not need the ground loop and associated works.

When the outdoor temperature drops the efficiency of an air source heat pump drops much more quickly than the ground source option. The best Coefficient of Performance that can be achieved with an air source heat pump is CoP 3. However systems are improving.

NOTES

Permissions

Building control approval will be required.

Planning permission is not usually required as there is visual impact.

When a heat pump is installed in a house, there is a risk that the current surge on starting will cause a dip in supply voltage affecting lighting and other appliances.

It is important to check at an early stage with your local **electricity distribution company** that the electricity connection is sufficiently strong.

Costs

Vertical borehole
£1,400 - £1,700 per kW installed

Horizontal slinky
£700 - £1,250 per kW installed

Typical 8kW horizontal system
£6,000 - £10,000

Air source
£4000, - £7,000

Information in grants is constantly changing but a good starting point is the Energy Saving Trust. Tel: 0800 512 012 www.energysavingtrust.org.uk

Some argue that because heat pumps uses electricity to operate then they are not really a renewable technology. However, as long as the CoP is greater than 2 then a heat pump will produce less CO_2 than a condensing boiler. The system can be made greener if you use electricity from a renewable energy source.

More information

Energy Saving Trust advice centre
Tel: 0800 512 012
www.energysavingtrust.org.uk

The Low Carbon Buildings Programme
www.lowcarbonbuildings.org.uk

Action Renewables
www.actionrenewables.org

Scottish Community and Household Renewables Initiative
www.energysavingtrust.org.uk/schri/

UK Heat pump network
www.heatpumpnet.org.uk

Heat Pump Association
www.feta.co.uk

Online newsletter
www.earthenergy.co.uk/eegrswel.html

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