Ground source heat pumps

Heat energy stored in the earth can provide homes and buildings with a low carbon source of heating and cooling

Ground source heat pumps take advantage of stable year-round ground temperatures to provide low carbon heat and cooling. Although they are sometimes marketed as geothermal energy technologies, they are technically not tapping into the deep heat from the earth. Instead, they use the solar heat that builds up in the top layer of the earth in the summer (from about one metre down to about 100 metres). This remains at a stable temperature all year – around 10°C in the UK. Heat pumps are zero emission at point of use, however they require electricity to operate and so carbon emissions generated will be dependent on how the electricity is generated. When coupled with renewable electricity, ground source heat pumps can be considered truly zero carbon heating systems.

Ground source heat pumps can be used to heat or cool standalone buildings, or multiple buildings in a district heat network. They have no adverse impacts on air quality, don't produce much noise and are practically invisible - much of the equipment is buried underground. This makes them ideal for urban areas. However certain restrictions may apply due to the space required for the ground loops and the disruption caused during their installation. They're also relatively low maintenance and reasonably long lasting. The typical life of a heat pump is around 25 years.

Heat pumps produce heat at a lower temperature than traditional heating systems. They are more effective when teamed with bigger radiators or underfloor heating and longer, or constant heating regimes. Heat pump efficiency is measured by the coefficient of performance (CoP), which is a ratio of electrical energy in versus heat energy out. A higher CoP means greater efficiency. Ground source heat pumps sit somewhere between water and air source heat pumps in terms of efficiency, where for every unit of electricity inputted the average output is 3-4 units of heat. Ultimately the efficiency will depend on the input heat from the ground and the output heat required. The more heat needed, the lower the CoP will be.

Integrated heating and cooling systems are the most efficient. Excess building heat pumped into the ground over the summer adds even more heat to the ground than normal. That means there's more heat available for winter. The system then draws more heat from the ground in the winter, leaving the ground cooler than normal in the summer. This enables it to cool buildings more effectively than air source heat pumps or air conditioning.

How they work

The principles of how ground source heat pumps work are the same for both individual building scale systems and large scale district. Using electrical energy, the heat pump circulates a solution of water and anti-freeze through a series of pipes laid in the ground called ground loops. These can be arranged horizontally in trenches or vertically in boreholes. The solution absorbs heat from the ground and delivers it to the heat pump where a heat exchanger raises the temperature of the solution. This is then used to heat water for space or hot water systems. It can also be used in an air-based system for space heating or cooling.

The solution then returns to the pipes in the ground at a cooler temperature where it re-absorbs heat and the process continues. Operating in reverse, the heat pump will absorb heat from the building and pass this to the ground.

The downside to systems that use horizontal ground loops is the outside space required for laying pipes. The length and depth will depend on the heat requirements of the building or heat network. More heat means more pipes and therefore a larger area of ground loop.

Heat pump systems that draw heat from vertical borehole ground loops can be more costly. They require suitable geology to enable the drilling of deep vertical boreholes anywhere from 15m to 100m deep. Multiple boreholes can be used so long as they're around 15m apart.

Again, the depth and number of boreholes needed will depend on the heat requirements of the building or heat network. Integrated heat and cooling systems work better with borehole systems because they go deeper into the earth where the temperature is more consistent.

Another configuration option is a shared borehole system, where multiple heat pumps can draw from one or more shared borehole ground loops. The individual, controllable heat pumps then upgrade the heat from the ground and transfer it into the space heating and hot water system of individual or shared occupancy buildings in a communal heat network.

Ground source heat pumps are eligible for Renewable Heat Incentive (RHI) payments.

AT A GLANCE

- **Uses stable heat available in top layer of earth**
- **Good for heating, cooling or integrated heating and cooling**
- **Needs space outside to lay pipes or suitable geology to drill boreholes**
- **Can be combined in shared borehole arrays for communal or district heat networks**
- **Quiet, low maintenance and zero emissions when coupled with renewable electricity.**