



Ground Source Heat Pumps Basics

Using the ground as a solar heat battery

Key Points

- Provides space heating and hot water for all household needs throughout the year
- Captures low-grade heat from below the ground and upgrades it to useful temperatures
- Best performance in well-insulated buildings connected to a low-temperature underfloor heating system
- Used with vertical boreholes or horizontal trench heat collectors

How does it work?

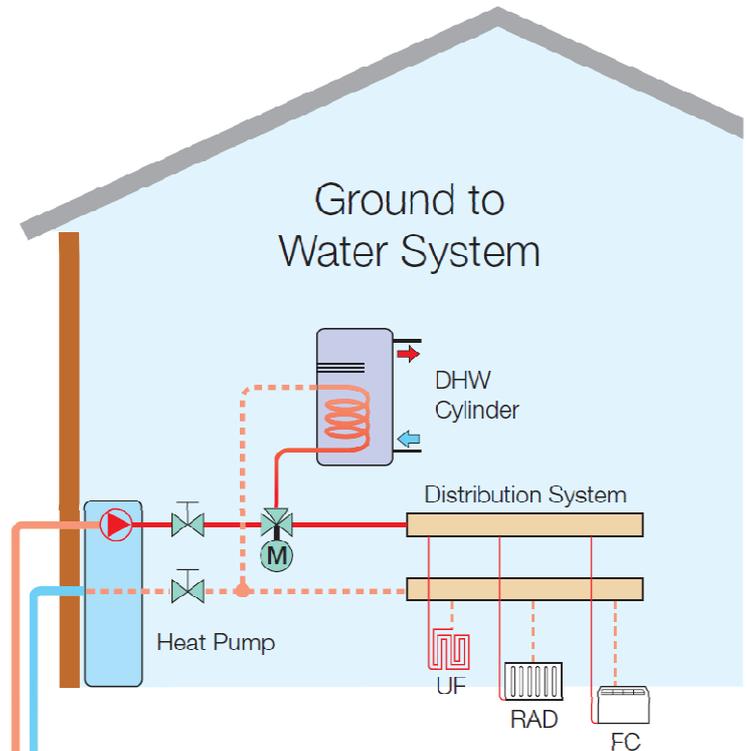
A heat pump extracts low-grade heat from the environment, upgrades it, and delivers it to a conditioned space. It works on the same principle as most domestic fridges.

In a fridge, heat is removed from the internal refrigerated volume and 'dumped' into the kitchen. A ground source heat pump collects heat from the soil or rock and delivers upgraded heat to a heating network or hot water cylinder.

The heat pump enclosure contains an electrically-driven refrigeration unit and two heat exchangers, one for the 'cold' side (the ground collector) and one for the 'hot' side (the heating network). The ground (or a body of water) acts as a 'solar energy sponge' and remains at a fairly steady temperature all year round, just a few metres below the surface. It is important to remember that this is principally



**A small ground source heat pump in a community building—
the main unit is the size of a washing machine**



Schematic of a ground to water heat pump, supplying either underfloor heating (UF), low-temperatures radiators (RAD) or fan coils (FC). Image courtesy of FETA / Heat Pump Association, used with permission

solar—not geothermal—energy. The ground collector contains a circulating fluid such as water (with antifreeze) or brine, and comprises one of following:

- Horizontal shallow ground loop
- Vertical deep borehole(s)
- Lake-bed collector (water source system)

As the cold liquid is pumped around the collector, which is fully sealed and designed for a 100 year life, it picks up heat from the surroundings. The temperature lift may be as little as 4°C, but this is enough to capture a useful quantity of 'free heat'.

What are the advantages?

By harnessing an inexhaustible resource, a heat pump uses much less energy than a typical heating system to provide the same benefit: up to four units of heat are delivered for each unit of electricity consumed.

Because of this, it also has lower CO₂ emissions: a typical heat pump system (running on mains electricity) causes 45% fewer CO₂ emissions than an equivalent oil boiler.

A heat pump running on 'green' electricity qualifies as 100% renewable and zero-carbon heat source.

Ground source heat pumps are also low-maintenance, low-noise solutions with a 20-year life expectancy, cause zero local pollution, and are free from the safety and regulatory obligations of gas appliances. Once installed, they are invisible from the exterior of a property, and hence domestic GSHPs are usually exempt from planning permission.



Collector 'slinkies' (inset) have just been installed under this field - works will be invisible once the grass is restored

How much energy can it supply?

Ground source heat pumps are available in a wide range of output capacities. Units delivering up to 14 kW of heat (sufficient for a very large new-build home) can run on a normal domestic single-phase supply; larger heat pumps usually require three-phase electricity.

Most GSHPs can provide hot water at up to 55°C, with an immersion boost used to raise the water temperature to 60°C occasionally, to prevent Legionella growth; some can reach 65°C directly, and heat pumps can also be partnered with solar thermal systems.

At large commercial sites, heat pumps rated at hundreds of kilowatts exist, providing both heating and cooling.

Suitability for heat pumps

Although GSHPs are an ideal option for new, well-insulated buildings, they can also be used successfully in a retrofit scenario. In these cases, the requirements to consider are:

- Upgraded building insulation and air-tightness, to allow the low-temperature heat delivery to be effective
- Geology—wet soils and areas with good groundwater movement are best; dry gravel is not suitable. For boreholes, a geological survey is recommended
- For horizontal collectors, adequate land area is needed—a rule of thumb is at least 10m for each kW of capacity
- Heat delivery—underfloor heating can rarely be retrofitted, so replacement low-temperature radiators or fan coils may be used instead, adding to costs
- An adequate electricity supply is required to drive the heat pump compressor (i.e. three phase for larger units)
- Space for the heat pump unit and an adjoining thermal buffer tank (which may or may not be integrated)

Costs

A typical domestic GSHP costs in the range of **£6,000 to £8,000**, which includes the heat pump itself, hot water buffer tank, computer controller and all of the required plumbing works to link these to a heat distribution network. If new heat emitters are required (e.g. low-temperature oversized radiators), costs will obviously rise.

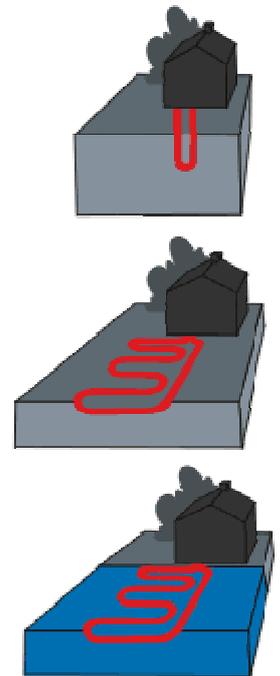
Groundwork costs are also additional, and will vary depending on the terrain, but a figure of around £40 per linear metre is typical for vertical boreholes. Horizontal trench systems are considerably cheaper, but are more disruptive and occupy more space, so land must be available. Trenching can cost another £2,000—£3,000.

Grants

All grants for domestic renewable energy systems ended in early 2010. However, heat pumps will be supported under the Government's *Renewable Heat Incentive (RHI)*, which arrives in April 2011.

This will pay a beneficial rate for each unit of 'green heat' heat generated, and is similar to the Feed-In Tariffs (FITs) already in place for renewable electricity generators.

Metering and payment mechanisms, as well as the actual RHI tariff rates, are currently under consultation, with further details expected to be announced later in 2010.



Heat pump collector options: vertical borehole (top), horizontal loops (middle) and water source (bottom)

Further Information

Microgeneration Certification Scheme

Find approved GSHP products and installers
www.microgenerationcertification.org

Heat Pump Association

www.heatpumps.org.uk

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