# Mitsubishi Electric Guide to Ground Source Heat Pumps

**Information** Guide 68

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# Mitsubishi Electric Guide to Ground Source Heat Pumps

This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today.

This guide accompanies a series of seminars, all of which are CPD certified.

## Contents

# Doing the groundwork - understanding ground source heat pump systems

There is a strong drive to find methods for heating and cooling buildings which can reduce carbon emissions, as well as cutting energy costs.

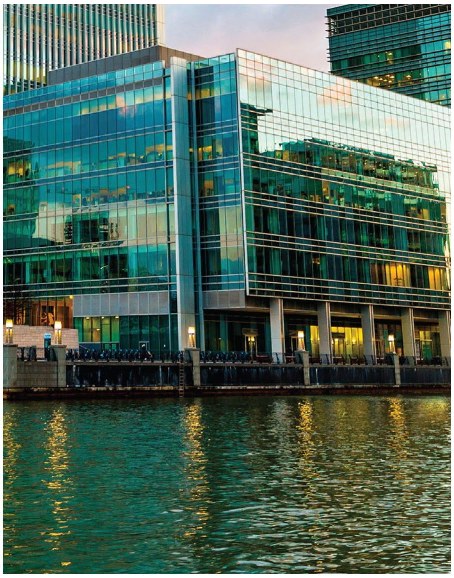
Identifying technologies which offer sustainable credentials as well as a predictable and reliable performance can be something of a challenge for specifiers and installers.

Ground source heat pumps are proving an increasingly popular sustainable choice for commercial buildings to deal with both heating and cooling requirements. One of the advantages of ground source heat pumps is that they are based on well-known and straightforward technologies.

The principle behind a ground source system is that radiation from the sun hits the earth, which then stores the heat and maintains a steady temperature of between 8°C and 12°C at a depth of around 1m. This temperature is maintained across the whole year, even in winter.

By linking a heat pump to pipes placed underground (or in a body of water), the energy stored underground can be harnessed to heat or cool a building. A heat pump is a device which moves heat from one area to another. This means that it is possible to move heat energy from a lower temperature environment, such as the ground, to a higher temperature environment (for example, inside a building).

In practice, this means that heat can be extracted from the ground and moved into a building, for example by attaching the heat pump to an underfloor heating system or fan coils.



Heat pumps work by circulating a refrigerant fluid around a compression/expansion cycle. The technology inside a heat pump is therefore similar to that found in any domestic refrigerator using the vapour compression cycle.

The key question of course is how energy efficient are ground source heat pump systems compared to alternatives such as a gas boiler system, for example? It is important to note that ground source heat pump systems do require electricity to operate, so unlike building integrated wind turbines, for example, they require a power source.

**However, according to the UK's Ground Source Heat Pump Association, for every unit of electricity used to power the heat pump, approximately three to four units of heat can be distributed. These efficiency levels mean that a ground source heat pump system has much lower levels of carbon dioxide emissions than a gas boiler heating system.**

The installation process for a ground source heat pump system depends on exactly what kind of technology has been selected (see our next feature for more details). However, once a ground source heat pump is installed, there are no external fans, and no visible external equipment. The system is also quiet in operation, safe and requires little maintenance.

**The next feature examines the range of ground source options available to designers and specifiers.**

# Ground source in action

Ground source heat pump systems consist of three elements: a ground loop, a heat pump and a heating/cooling distribution system. This distribution system can be on any scale, for example in a house this could be to underfloor heating, or in a commercial building to a VRF system.

There are two basic types of ground source system: open loop and closed loop. Open loop systems make use of the fact that water as well as earth is a good store of heat energy. Open loop systems physically extract water from a source such as a river, lake or the sea. They are therefore best applied when the building is close to one of these sources, or where it is situated over a source of underground water known as an aquifer.

Heat is extracted from the pumped water, or in cooling mode the heat from the building is transferred into the water. This is known as free or passive cooling. But often a heat pump is added to the system to provide space heating, or active cooling where loads require it.

Since water is being both extracted and then returned to the source, the Environment Agency requires two sets of permits for this type of open loop system: abstract licences and discharge consents. They are needed for any process, including the use of groundwater stored in aquifers.

The main benefits of an open loop system are that a natural medium (water) is being used, and it occurs at a constant temperature, leading to predictable performance. Also, studies have shown that it is possible to extract more heat per borehole on an open loop system than with closed loops.

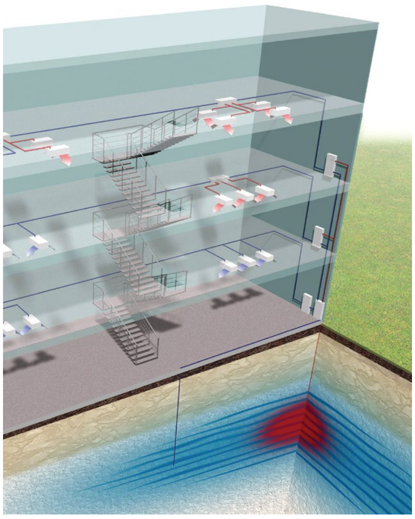
However, the open loop system must be close to open water or on water-bearing ground, which does not occur everywhere in the UK. The involvement of the Environment Agency and permits are also points to note about open loop systems.

Closed loop systems do not circulate water from the ground or other source, instead the system uses a mixture of water and antifreeze which is pumped through a sealed pipe where it absorbs heat from the ground. A heat exchanger then extracts this heat and transfers it to the heat pump. In cooling mode, heat from the building is transferred back into the ground.

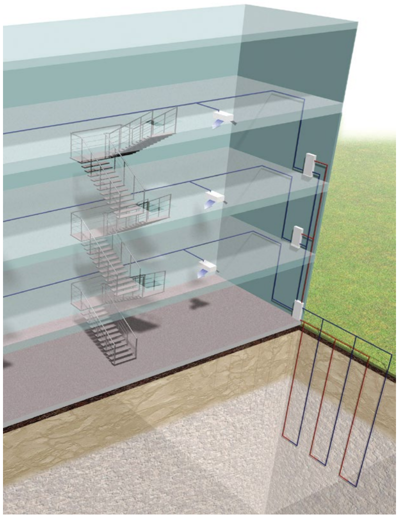
Closed loops can be placed vertically into the ground, through drilled boreholes. These are usually between 15m to 150m, and must be drilled by specialist contractors. It is also possible to save space by using the building piles to house the closed loop. Alternatively, the loops can be placed horizontally in trenches, using a coiled pipe known as a ‘slinky’. These horizontal systems are very flexible, and can even be placed under car parks in order to maximise the use of the land around a building.

It should be noted that closed loops can also be used when the building is near a pond or lake. A water depth of 6m gives a constant temperature of around 10°C to 11.5°C, as with the ground. The tube is made into coils, floated on rafts with ballast weights to sink them to the correct depth once in position.

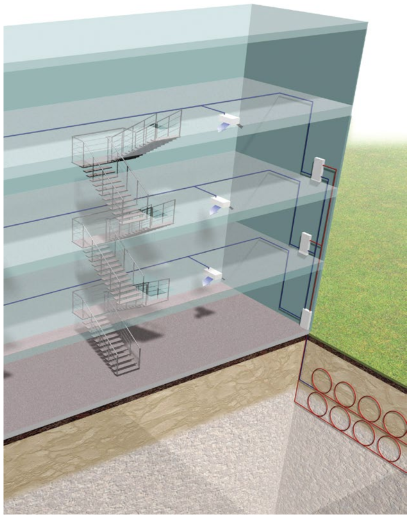
**Open Loop - Borehole**



**Closed Loop - Borehole**



**Closed Loop - Slinky**

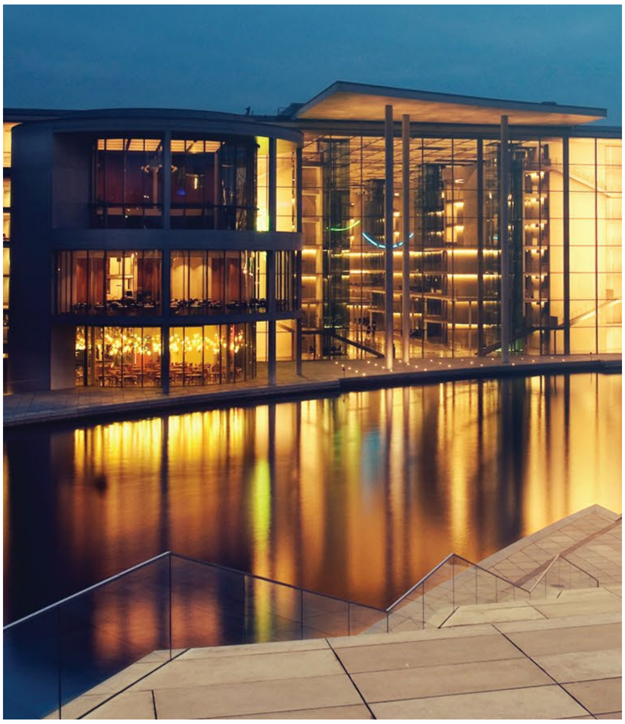


# Ground source in action

Modern ground and water source heat pumps offer a range of features which benefit installers and end users. Inverter-driven ground/water source heat pumps create a modulating system for optimum efficiency. For example, the Ecodan CRHV Monobloc ground/water source heat pump systems can be used singularly or banked together to modulate and cascade available units on and off to meet the load from a building.

## Benefits of ground source heat pumps

- High COP in both heating and cooling modes. They are classed as sustainable technologies
- The water loop means that heat can be recovered and transferred
- Low $CO_2$ emissions to meet increasing legislation
- No plant outside the building - less intrusive than other technologies such as wind turbines
- No external noise issues
- Low maintenance
- Design flexibility due to the number of system configurations



Ecodan CRHV Heat Pump

## Heat pumps: sources and sinks

- Heat pump technology is a method of moving heat energy (whether that is warmth or 'coolth') from one place to another. This can mean transferring heat from one side of a building to another, or moving heat out of a building into the ground.
- The terms 'source' and 'sink' refer to the different origins and ultimate destinations of heat energy. In a ground source system, the ground can be the source (when heat is being transferred into a cold building) or the sink (where heat is being removed from a building in the cooling process).
- Heat pumps can be linked to a number of sources/sinks such as air, water and a mix of these. So for example, one can find air-to-air systems, ground-to-air systems and so on. Although the sources and sinks are different, the principle of moving energy from one place to another remains the same.

# Getting to grips with ground source - Flag Station Farm

Ground source heat pumps can be applied to a variety of applications and while some preparation is required to ensure smooth and efficient operation, they can provide many years of reliable and energy efficient service.

Projects such as offices and hotels have successfully made use of GSHPs. And one example of commercial application is Flag Station Farm, in Mansel Lacy in the countryside north-west of Hereford. It is managed by farmer Thomas Powell and his family.

Flag Station Farm includes four sheds that house up 180,000 chickens from one day old to six weeks. Chicks are sensitive to their environments and require proper care in order to grow. A comfortable and controllable temperature are two important factors for success.

Mitsubishi Electric's Ecodan system has already worked effectively on other poultry farms so it was the ideal choice at Flag Station Farm, particularly given its large, rural location.

Bavenhill Mechanics of Preston Cross, Herefordshire, installed 20 Ecodan CRHV heat pumps in a cascade system, supported by 40km of ground loop pipework. Bavenhill Mechanics is an accredited Ecodan installer operating throughout the West Midlands and the Welsh border counties.

Chris Chapman, Managing Director of Bavenhill Mechanics, commented

“Our past projects involving Ecodan have shown that indirect heating is more beneficial to young chickens in helping them reach their full growth potential. This system eliminates the problem of cold spots and draughts, resulting in happier and healthier livestock.”

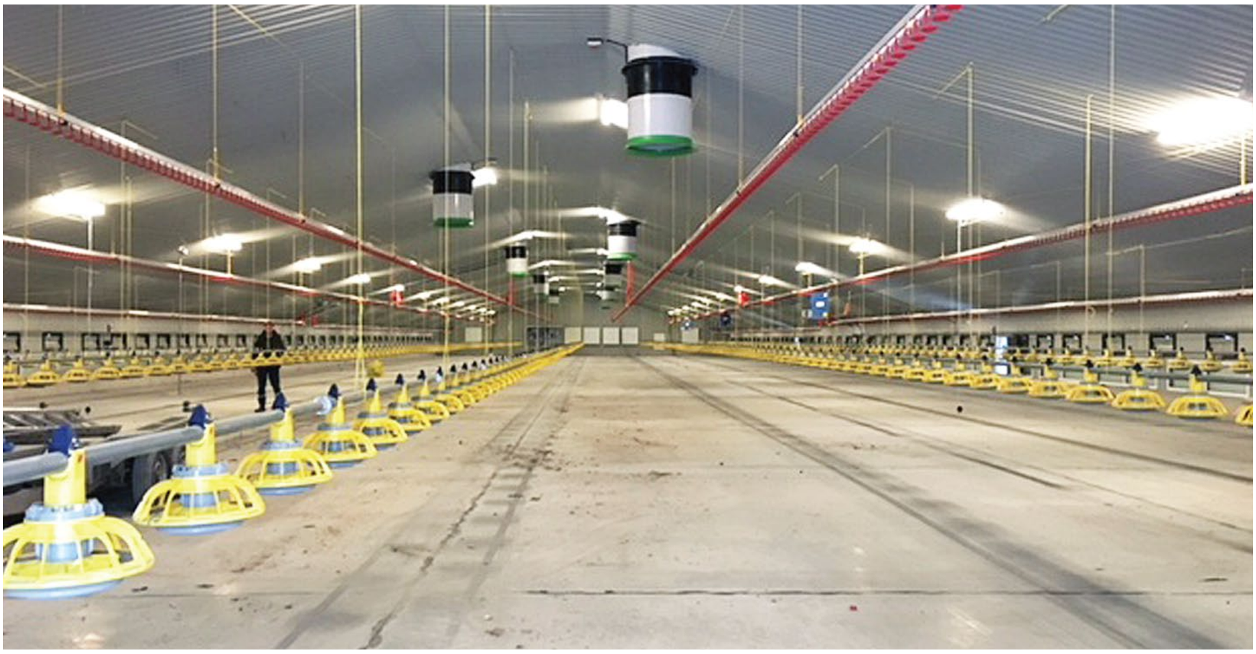
The Ecodan system is also an energy efficient form of heating that qualifies for the Renewable Heat Incentive (RHI), a government financial incentive to promote the use of renewable heat, meaning the farm will also benefit financially in the long-term.

The heat pumps for all four sheds are controlled centrally by a building management system so that temperature and ventilation can be adjusted in accordance with weather conditions and design broiler cycle curves. The heat is emitted throughout the sheds via underfloor heaters.

For the first week of their lives, chicks need temperatures of about 30ºC to 35ºC, and the temperature should be reduced by five degrees each week thereafter until they are acclimatised to the surrounding environment.

With the chicken sheds now in full operation, farmer Thomas Powell said:

“We knew the Mitsubishi Electric system would work well for us as we had already used it on other smaller sites, and it made sense financially as it qualifies for the Renewable Heat Incentive. Having plenty of land to work with meant a GSHP system was the right choice for the new development and we are delighted with the results.”



To receive a CPD seminar on 'Ground Source Heat Pumps', you can call your Mitsubishi Electric Regional Sales Office to arrange an in-house presentation of this information.

If you would like to receive invitations to future CPD events, please email **livingenvironmentalsystems@meuk.mee.com**

## Further information

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**Note:** The fuse rating is for guidance only. Please refer to the relevant databook for detailed specification. It is the responsibility of a qualified electrician/electrical engineer to select the correct cable size and fuse rating based on current regulation and site specific conditions. Mitsubishi Electric's air conditioning equipment and heat pump systems contain a fluorinated greenhouse gas, R410A (GWP:2088), R32 (GWP:675), R407C (GWP:1774), R134a (GWP:1430), R513A (GWP:631), R454B (GWP:466), R1234ze (GWP:7) or R1234yf (GWP:4). *These GWP values are based on Regulation (EU) No 517/2014 from IPCC 4th edition. In case of Regulation (EU) No.626/2011 from IPCC 3rd edition, these are as follows. R410A (GWP:1975), R32 (GWP:550), R407C (GWP:1650) or R134a (GWP:1300).


**Effective as of January 2021**


Green Gateway greengateway.mitsubishielectric.co.uk