Information Guide:

Ground source heat pumps

Issue 29

CPD CERTIFIED
Construction CPD Certification Service

MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS

Information Guide:

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. The guide accompanies a series of seminars, all of which are CPD accredited.

The changing face of construction in the 21st Century demands that designers, specifiers and suppliers work as teams to create better buildings - or occupants and the environment.

Mitsubishi Electric aims to be a part of this by encouraging employees and customers to work together to increase their knowledge of the latest technology, legislation and markets.

Contents

Page 2 **Doing the groundwork** - understanding ground source heat pumps

Page 4 **Ground source in action**

Page 6 **Getting to grips with ground source**

Page 8 **Further information**

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.

MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS

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.

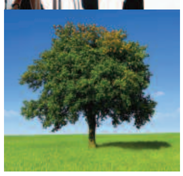
However, according to the UK's Ground Source Heat Pump Association, for every unit of electricity used to power the heat pump approximately three to four units of heat can be distributed. These efficiency levels mean that a ground source heat pump system has much lower levels of carbon dioxide emissions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

Heat pumps have been accepted as a highly energy efficient technology, and grants for ground source heat pumps have been available for some time through the Low Carbon Buildings Programme. However because they do require a power input to operate, there has been some question over whether heat pumps should be considered 'renewables'.

Lobbying by groups such as the Heat Pump Association to have all types of heat pump accepted as 'renewable', appears to be paying off, as two new European Directives will shortly recognise heat pumps using any heat source as 'renewable'. This new status is likely to encourage even more use of heat pumps across a wider range of new and existing buildings. It will also help to ensure that grants continue to be available for heat pumps through new Government programmes to support the renewable energy and heating sector.

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.

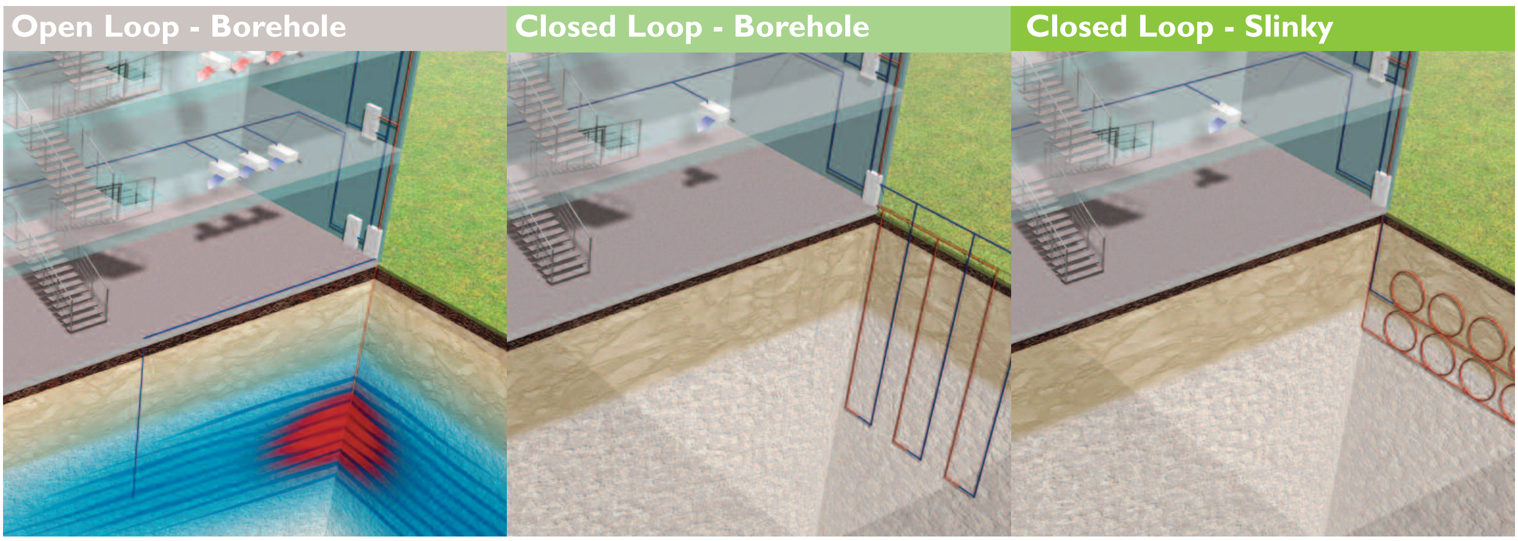


Ground source in action

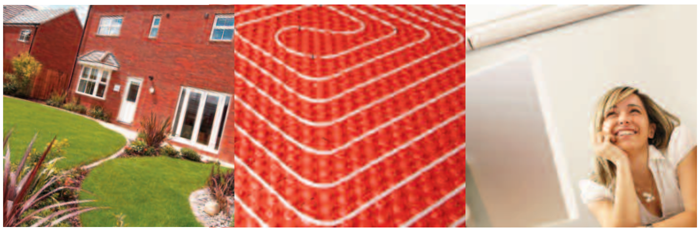
Ground source heat pump systems consist of three elements: a ground loop, a heat pump and a heating/cooling distribution system. This distribution system can be on any scale, for example in a house this could be to underfloor heating, or in a commercial building to a VRF system.

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 dumped 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.



MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS



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.

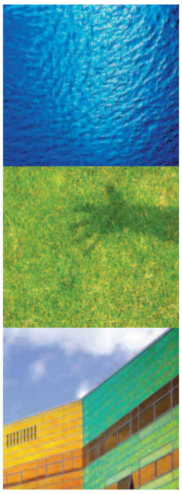
The main benefits of an open loop system are that a natural medium (water) is being used, and it occurs at a constant temperature, leading to predictable performance. Also, studies have shown that it is possible to extract more heat per borehole on an open loop system than with closed loops.

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. 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.



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 configuration

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

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.

There are now several examples of ground source heat pumps in operation around the UK. They are not restricted to rural or lakeside areas. The Zetter Hotel is in London's Clerkenwell area, on a busy street. The hotel is situated above an underground lake or aquifer, which lies around 130m below the hotel building. The aquifer provides water at a constant 13°C to 14°C. The water is pumped up a borehole, and passed through a plate heat exchanger. The system is linked to a water-cooled VRF system which provides both heating and cooling.

British company Olympus KeyMed has also used ground source technology at its 3,400m^2 logistics centre in Southend. The company opted for ground source technology at the building in order to meet local authority requirements to introduce more on-site renewables for new projects. The system consists of 50 boreholes sinking 98m into the ground strata.

MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS

Mitsubishi Electric has installed a ground source heat pump system at its own offices in Hatfield, Hertfordshire. The company has used a 'slinky' system, with the piping buried horizontally in a 1.8m trench. The ground source element is linked to a City Multi Series WY Series, which also makes use of inverter technology to ensure the condenser consumes the minimum energy needed to match the building's requirements for heating and cooling.

This system has been closely monitored for results and even in its early stages proved to be 300% more efficient than a chiller/boiler combination. (Full details can be downloaded from www.mitsubishielectric.com/aircon)

One of the most significant aspects of using ground source heat pump technology is that pre-planning and design are vitally important. The choice of system type (open or closed loop, for example) depends on geological conditions near the building. Specialist consultants must be used to carry out surveys and make recommendations - otherwise neither system performance nor energy savings can be guaranteed.

Although ground source systems have been around for some time, it is also important to note that the highest levels of efficiency are best achieved in combination with other technologies. Most crucial of these are: inverter-driven compressors (to ensure efficient operation at all operating levels), heat recovery and a good building controls strategy. These technologies in combination ensure that we can enjoy the full benefits of 'free' heating and cooling from the earth.

The Hatfield ground source heat pump

The performance of the ground source heat pump system at Mitsubishi Electric's headquarters in Hatfield was carefully monitored for the first two years of its operation.

The results of the study were produced as a report and the main findings were that the ground source system was:

£15.59 **cheaper per m² per year** than a typical chiller/boiler combination

2,964kg **less CO_2 emissions** than a typical chiller/boiler combination

1,083kg **less CO_2 emissions** than a similar air sourced VRF equivalent air conditioning unit

515% **more efficient** at heating than a boiler

338% **more efficient** at heating and cooling than a typical chiller/boiler combination

Further **information**

You can find more information on the topic of **ground source heat pumps** and related issues at the following websites:

Ground Source Heat Pump Association (GSHPA): has lots of information on the benefits of heat pumps and contacts for its members. **www.gshp.org.uk**

Energy Saving Trust: **www.energysavingtrust.org.uk**

Renewable Energy Association: **www.r-e-a.net**

For more in-depth research, the book **'An introduction to thermogeology'** by David Banks offers both theoretical insight and practical advice. (Blackwell Publishing, ISBN 978-1-4051-7061-1)

If you missed the 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.

Please call one of the numbers below:

London North East & East Anglia	**01707 282480**
London North West	**01707 282480**
London South West	**01689 881030**
London South East	**01689 881030**
London Central	**0207 9286810**
Birmingham	**0121 7412800**
Bristol	**01454 202050**
Manchester	**0161 8666060**
Leeds	**0870 330 0347**
Scotland	**01506 444960**

MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS

Regional Sales Offices

Birmingham
Tel: 0121 7412800
Fax: 0121 7412801

Bristol
Tel: 01454 202050
Fax: 01454 202900

Leeds
Tel: 0870 3300347
Fax: 0870 3300348

Scotland
Tel: 01506 444960
Fax: 01506 444961

Manchester
Tel: 0161 8666060
Fax: 0161 8666081

London South Region
Tel: 01689 881030
Fax: 01689 881031

London North Region
Tel: 01707 282480
Fax: 01707 282481

London Central Region
Tel: 0207 9286810
Fax: 0207 9286569

MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS

Telephone: **01707 282880**
email: air.conditioning@meuk.mee.com web: www.mitsubishielectric.co.uk/aircon

UNITED KINGDOM Mitsubishi Electric Europe Air Conditioning Systems Division
Travellers Lane, Hatfield, Hertfordshire, AL10 8XB, England.
General enquiries Telephone: 01707 282880 Fax: 01707 278674

IRELAND Mitsubishi Electric Europe Westgate Business Park, Ballymount, Dublin 24, Ireland.
Telephone: Dublin (01) 419 8800 Fax: Dublin (01) 419 8890 International code: (003531)

Issue 29 Version 1 (February 2010)

Mitsubishi Electric Quality ISO 9001 Registered UKAS CE

GREEN GATEWAY INITIATIVE®
Mitsubishi Electric's commitment to the environment
www.greengatewayinitiative.co.uk