Morri Consult Ltd

Ground Source Heat Pump Technology


Ground Source Heat Pump


Under-floor Heating


Borehole Drilling Rig


Ground Pipe Manifold

Ground Source Heat Pumps

Morri Consult has been established to respond to the growing need for energy from renewable sources. We are acutely aware of the increasing fuel costs that have resulted in higher gas, electricity and oil bills for consumers and businesses alike, and the increasing damage to the environment caused by the burning of fossil fuels.

We have considerable expertise in designing and installing both large systems in the commercial and public sectors and also in providing cost-effective solutions for domestic users and integrating these systems with existing home energy systems.

Ground source heat pumps are very much in vogue at the moment. They can provide domestic energy at very low cost. But they are not the universal panacea that they first appear. There are many factors to be taken into account and unless the right system is installed for the right application, your energy bills may actually increase!

What is a Ground Source Heat Pump?

It is most simply explained as a refrigerator in reverse. A refrigerator extracts the heat out of its interior (and by so doing lowers the temperature of the interior) and then dumps this heat through a radiator on the back (and so raises the temperature of the radiator).

You may have noticed that the radiator on the back of your refrigerator is always warm. If this explanation is a little confusing, just be aware that 'heat' and 'temperature' are two different things. A body can have a lot of heat stored in it but be a relatively low temperature - the sea for example. Alternatively things can have a high temperature but not much heat, such as a match.

So a heat pump extracts the energy from a large body of low-grade heat and converts this into a smaller amount of high temperature heat.

The heat pump creates the energy for your domestic heating from 'waste' energy that permanently resides in the ground outside your home. Energy for nothing then? Well, not quite. Read on.

Energy Extraction

The energy that can be extracted from the ground depends on a number of factors. The greater the area you extract the energy from, the more energy you can extract at any given instant. Why? Well, when we extract the energy we lower the temperature around the extraction pipe. This energy has to be replaced by the surrounding ground before we can extract any more (i.e. raise the temperature again) so that we can extract a constant small amount of energy from every metre of extraction pipe. The more pipes we have the more energy we can extract in total.

The type of ground also plays a big part. If the ground is dry and sandy, the heat transfer is not as efficient as wet heavy ground and so the energy does not get replaced as quickly. So if your ground is of the sandy type, you will need a much bigger area to extract the same amount of energy as wet heavy ground

The extraction rate in terms of power varies from about 20 Watts/square metre for dry ground to about 35 Watts/square metre for wet heavy ground. The extraction pipes are buried at a depth of around 1.5 metres and can be laid as a grid or alternatively as 'slinkies' i.e. loops of pipe. This maximises the available trench width and therefore requires less excavation. As an average, 40-50 metres of pipe are required to deliver 1 kilowatt when laid in this configuration. Other configurations are possible to optimise the extraction.

Where it is simply not possible to excavate sufficient area to lay the ground array, the pipes may be sunk in one or more boreholes up to 100 metres in depth. This can be an effective solution but obviously there are much increased cost implications. The borehole needs to be around 15cms in diameter and will cost in the region of £35 to £45 per linear metre to excavate. The depth and the number of boreholes depends on the power required and the ground type.

The Heat Pump

The heat pump itself consists of a compressor and associated components. It recompresses the heat exchange vapour that has evaporated from a liquid within the ground array (and so absorbed the heat from the ground).

The technical name for this heat is called 'the latent heat of evaporation'. To understand this, imagine you have been swimming and are standing on a windy beach, you will soon begin to feel very cold as the water evaporates from your body. This is because the water, in order to evaporate, has to extract the heat from your skin.

In compressing the vapour and condensing it, the heat is released. This heat is transferred (via a heat exchanger) to a hot water circulation system. The more compression, the higher the temperature becomes. So the final temperature of the output is, to a limit, up to us. Unfortunately, the higher we raise the temperature the less efficient the process becomes.

Why? Well, we have to put more effort into the compression, so the compressor has to work harder and consume more energy itself. This leads to the concept of 'Coefficient of Performance' or CoP. This is really a technical way of defining the amount of energy we have to put in compared to what we get back.

If a single kWh of electricity costs around 12p and a CoP of over 4, for every 12p we spend we get more than 4 kWhs of energy, so our energy is actually costing around 3p per kWh. However, if our electricity costs more than this - say 16p per kWh then our GSHP energy is costing us about 4p per KWh since the ratio is still 4 to 1.

If we restrict our output temperature to (say) 35°C we can get a CoP of around 4. That is to say that for every kWh of energy we put into the system we get 4 kWhs back. In fact some of the power we put into the compressor goes directly into heat energy as well so the ratio becomes even better.

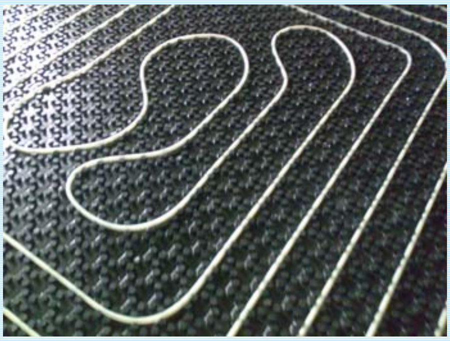
So far so good. However, if we wish to raise our output temperature higher than 35°C to something approaching 50°C - a temperature at which we might conceivably run a traditional radiator central heating system, then our CoP drops to less than 3 (probably about 2.75).

Now for every 12p spent, we are only getting 3 kWh back. So each kWh now costs 4.4p. Even at today's prices, gas costs around 4p per kWh. Modern condensing boilers are relatively cheap and operate at over 90% efficiency so given the heavy investment required; a GSHP scheme simply doesn't make economic sense.

Additionally, if our electricity costs 16p per kWh and our CoP is less than 3, then each kWh of GSHP energy costs us nearly 6p per kWh and it is now not just a question of economic sense; it actually becomes an expensive means of heating your home. So it is not as straightforward as it first appears but don't discard the idea yet, read on.

Applications

As we have seen above, the energy saving capability of a GSHP system is dependent on what use we make of the output. Lower temperature applications yield the greatest benefits. That is why GSHP installations are ideal for underfloor heating schemes (or for heating swimming pools). Underfloor heating temperatures are much lower than traditional radiator schemes and provide the same (or better) level of comfort. So to heat your home through underfloor heating via a ground source heat pump is probably the cheapest means currently available. As energy prices continue to rise then the savings increase.



If you have a conventional radiator system then the benefits are likely to be marginal when compared to natural gas heating. For oil fired or total electric systems then the benefits are greater and can be easily calculated.

The importance of home insulation cannot be overstressed. Your domestic heating requirements are basically based on how much heat your home loses through the roof, walls, windows and floor. If your home is well insulated then the amount of energy you need to input to maintain a comfortable temperature is drastically reduced. If your home is not well insulated then you will need a heavily overrated fossil fuel boiler to keep your house warm. This will mean that your radiators have to be maintained at a temperature that is beyond the capability of a GSHP system - certainly beyond economic viability.

If your home is well insulated and there is a conventional radiator system then a GSHP scheme is still a possibility. However, the radiators may need to operate at a lower temperature and may need to be sized much larger than if operated at (say) 65°C. If you are well insulated and so currently operate your radiators at a more modest temperature whilst maintaining good comfort levels then a GSHP system may fit the bill. It all depends on what your energy is currently costing.

From the above, it should be clear that to consider a GSHP system a considerable amount of investigative work is required. Firstly, the heat losses of your property/building need to be calculated very accurately. This will then allow the correct size of system to be calculated. This correct sizing can be vitally important as it may mean the difference between drilling one or two boreholes or excavating large areas of ground. The type of ground will also need to be investigated to ensure that the optimum amount of pipe is laid.

If the scheme is to be used to power an underfloor heating system, then the operating temperature can be defined and the CoP of 4 established. If an electricity tariff can be selected, which may provide energy at a reduced cost (say 8p per kWh) the central heating cost can be reduced to very low levels.

Note that mixed schemes (radiators and underfloor) may be possible but the GSHP will deliver heat at the required radiator temperature and the underfloor part will require 'zoning' and temperature attenuation (as with a conventional mixed heating system).

Since the temperatures available from a GSHP are less than with a conventional boiler (and it makes sense to use lower temperatures) it can be seen that the provision of hot water presents some difficulty. A GSHP system will not alone provide water that is 'piping hot'. So what's the solution? The GSHP can be used to pre-heat your hot water, remember it takes as much energy to heat cold water to lukewarm as it does to turn lukewarm water into hot water. So a GSHP can be used to significantly reduce your hot water bills. If this is combined with a thermal solar panel scheme then, most of your hot water requirements can be met throughout the year. A small immersion system can be installed to ensure that hot water is available when solar heating is not. Note that a solar hot water system on its own can generate up to 70% of your annual domestic hot water requirements.

Incentives

The Renewable Heat Incentive (RHI) is designed to revolutionise the way heat is generated and used in buildings and homes by providing an financial incentive. Covering Solar Thermal systems, GSHP and Biomass Heating the RHI extends across both the domestic and non-domestic markets. Currently as part of the RHI there is a Renewable Heat Premium Payment for the domestic sector specifically designed to assist with the purchase of green heating systems. Domestic systems qualifying for these premiums will also be eligible for the RHI tariff from Summer 2013.

The RHI for non domestic systems is tariff based and installations completed on or after 15th July 2009 are eligible. Non domestic includes business, public sector, charities and not for profit organisations, local authorities and social landlords. The heat output is metered and payment is based on the amount of eligible heat multiplied by the tariff level. Payments will be made quarterly over a 20 year period.

Our Policy

At Morri Consult we are happy to discuss all forms of alternative energy sources with you, to allow you to make the right decision. We won't try to sell you anything that is not economically right for you. We believe in giving it straight, in terms of the facts and figures, and what you can expect from an alternative energy source.

We do not supply equipment from a single supplier; we will advise and help you select the product that best meets your needs. Above all we are always around to answer your questions and deal with any issues that may arise. We are professionally qualified engineers and technicians with teams of trained staff.

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