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Ground source heat pumps; Too good to be true or buried renewable treasure?

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Abstract

How viable is installing a Ground Source Heat Pump (GSHP) in a domestic building and specifically installing one in an existing house. At first sight it can look like a GSHP can achieve incredible efficiencies of several hundred percent. With every kilowatt of electricity used to power the heat pump, several kilowatts of heating energy is given out. Can the Ground Source Heat Pump be one of the methods used to heat our homes and water while reducing our CO2 emissions and our dependency on fossil fuels?

Domestic installation of a ground source heat pump.

Unlike most forms of heating, Heat Pumps are not based on the combustion of a fuel. By moving heat, rather than creating it through burning, is one of the key reasons HP are so efficient. An additional bonus to this is, that they are very safe with no combustible gases or liquids being used. GSHP generally have a long, low maintenance working life. Up to 25 years for the pump itself and 50 for the ground pipes. The heat from which the heat pump attains its primary energy, stored heat in the ground, warmed by the sun, is renewable. However, the energy used by the electric compressor to pump the fluids around the system can come from any one of a number of sources not necessarily renewable, sustainable ones. But because of the inherent efficiency of the GSHP, even when fossil fuel derived electricity is used, less is required to heat the premises than would other wise be needed.

The main components to a GSHP system are;

1. Pipe work in the ground absorbing the heat

2. The Heat Exchanger Pump

3. A way of delivering the heat into the building (either for space or water heating or both)

By looking at installing a heat pump in a typical Victorian home, conclusions can be drawn as to the practicalities of installing and using a GSHP and if they can be one of the solutions used in reducing our reliance on fossil fuels and CO2 emissions. The property is a mid terrace, 2 bedroom house of approximately 100 years old. It has loft insulation and double glazing and currently uses a valiant combination boiler for water and central heating. A domestic HP is of a similar size to the existing “combi” boiler and there is a downstairs storage area (formally a WC) where the HP could be installed. For this quote, the size of the HP was 1200mm high, 600mm wide by 840mm deep. The annual heating demand (space and water) for the property is approximately 90kWh/m² which is representative of the many Victorian properties in the UK. But inefficient when compared to a newer, lower energy

house where the annual heating demand is closer to 60kWh/m². The house has a floor area of approximately 58m² with a rear garden of 75m².

Several companies that produce off the shelf domestic heat pumps were looked at. With Valiant being chosen because a boiler by this manufacturer is used at the premises already as well as the companies long record of supplying conventional domestic boilers in the UK. Their web site offers an interactive method of calculating the type and size of Heat Pump installation required.

The following is based on Valiant's interactive web site for determining the suitability of installing a GSHP. A number of basic factors are inputted to help to determine the type and suitability.The approximate age of the property is asked for (pre 1970) but there is no taking account of the insulation of the property or the soil conditions. The area of any attached garden is required to determine whether an horizontal or vertical installation is best suited. From these factors, an approximation of the energy requirements and the type of system needed, are made.

In this case, the garden is of insufficient size for a horizontal ground array to be used and a 100m deep borehole is recommended. It was determined that the size of the garden required to heat the house is approximately 4 times bigger than what exists if a horizontal ground array was to be used. However there would be difficulty in getting excavating equipment to the rear of the property.

It is recommended that the Valiant GeoTHERM Exclusive 6kw would be suitable for the property to supply all the domestic hot water and central heating through radiators. The quote was for £7045 but does not include the heat delivery system in the property, the cost of drilling the bore hole or the ground pipes.

The existing radiators would probably not be suitable for a GSHP and would likely need to be either replaced with specialist radiators or have an under floor heating system installed. The floors are of timber construction and although not impossible, it would be a considerable undertaking to install under floor heating. The expense of which could negate the benefits of the lower running costs. Specialist radiators would most likely be the most practical method of providing heating taking into account cost and ease of installation. This installation though would not be eligible for financial assistance through the RHI scheme when it comes into effect, as the property is connected to mains gas supply.

The cost of installing a vertical bore hole GSHP system:

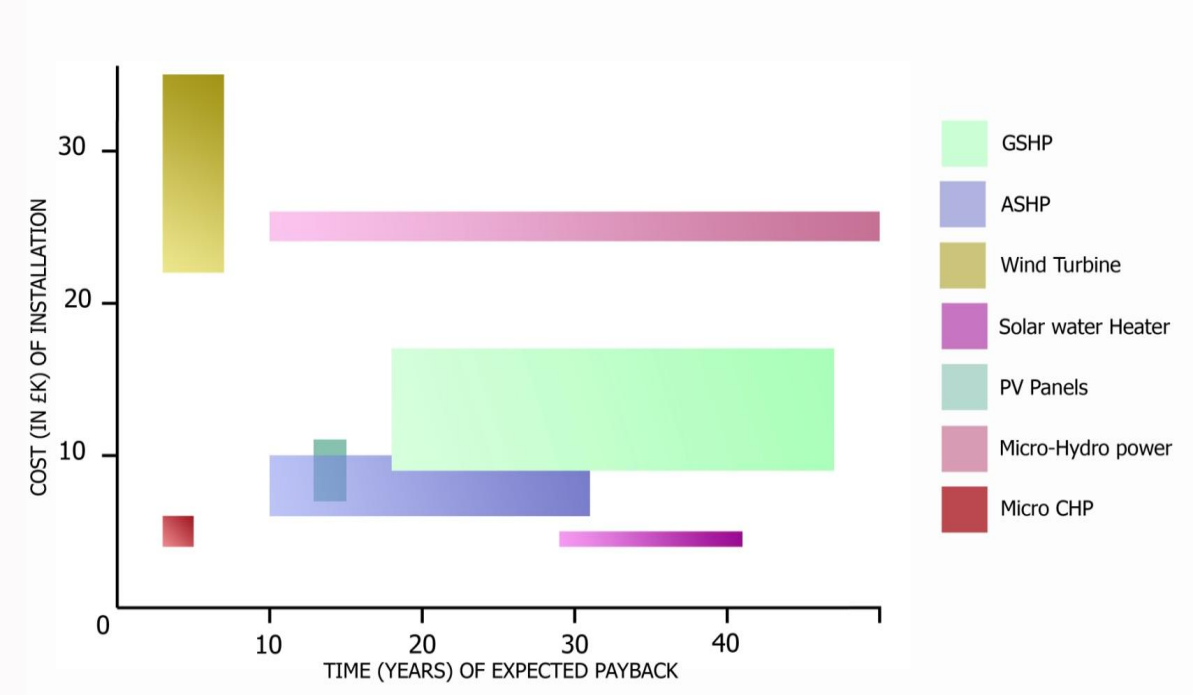
Heat Pump		£6050
Glycol Antifreeze solution		£465
Buffer storage tank		£530
Specialist Radiators	(5@£200)	£1000
Plumbing, Commissioning and labour		£4000
Drilling, pipe work and grout (@£35-£65 per metre for drilling) for 100m =		£5000
Total		£17,045

These prices are exclusive of VAT (at 17.5%)

The cost and difficulty of installing a GSHP to a typical Victorian house emphasised the problems involved with trying to reduce the energy requirements of the UK housing stock. As well as the difficulties facing the GSHP industry in becoming a more mainstream form of heating in the domestic market.

With the potentially large investment in a GSHP system, it is worth considering if this really is the best way to heat the home renewably. With so many factors involved with choosing a sustainable energy source, there is no clear answer for the consumer. The option whether to go for a GSHP, Air Source Heat Pump, Wind Turbine, Solar Thermal Water Heater, PV Panels, Micro Hydro or Micro CHP is dependant on many factors and must be considered on a case by case basis. Before going to the expense of installing any heating or energy producing system, the best way of reducing costs and CO2 emissions, is to reduce the amount of energy used in the first place. This should be done by the less visible means of ensuring there is very good insulation of walls, floors and ceilings. Very efficient glazing and draught proofing. As well as ensuring that there is considered use of energy efficient appliances and lighting.

It is worth looking at "ball-park" comparisons between GSHP and other renewable ways of heating the home and water. Based on a well insulated, three bedroom, semi detached house, with ideal orientation and sufficient space, the following Graph shows how various renewable energy sources compare cost of installation with likely pay back period.



Graph showing installation costs and pay back comparisons of domestic, renewable energy sources.

In the UK, the use of GSHP's is little known among the general public. With so little public perception, it is a difficult task for manufactures and installers to bring to the publics attention this source of heating. With such a long, embedded history of conventional gas boilers in the UK, "alternative" energy suppliers have a major undertaking to get a larger market share. There appears also, a general lack of knowledge about financial help that may be available when installing renewable technology. The Government needs to be more proactive in

making the public aware of what help is available and not changing policies which could adversely affect the renewable energy industry. Because of the high, up-front costs associated with GSHP, those less able to afford it might not be able to benefit from the lower running costs, unless help is available.

Grants for renewable technologies are not in themselves sustainable. The alternative to conventional fossil fuel heating and cooling needs to be financially viable on their own merit and be seen as a realistic, cost effective option.

For the domestic user, if installing a GSHP, or any other form of renewable technology, it is important to know about the installer and their abilities. Ensure that they are a member of the Government approved Microgeneration Certificate Scheme (MCS) or part of the Renewable Energy Association Ltd (REAL). The MCS certifies all renewable technology. It is advisable to get at least 3 quotes from different GSHP installers, find out exactly what it includes and to see their previous installations. The installer of the GSHP system should be able to calculate the likely efficiencies, amount of heat produced, how to control the system and explain warranties and guaranties as well as arranging to undertake periodic servicing.

The GSHP can be seen as one of the environmentally benign systems which could help reduce Britain's, and the western Worlds dependence on fossil fuels and CO2 emissions. However they need to work in collaboration with better insulated and draught proofed buildings. As well as better understanding by the users of their actions and the effect they have. With the ever increasing cost of fuel which looks set to continue rising, GSHP can have real economical benefits if the planning and installation is executed properly. GSHP can be part of more intelligently designed buildings of all scales, from single dwellings to large blocks of flats or hospitals and schools, that help reduce the amount of energy we use.

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