



The Powergen HeatPlant.

A Ground Source Heat Pump for Domestic Space and Water Heating in Small Well Insulated Houses.

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The Powergen HeatPlant ground source heat pump is a simple device designed to collect the solar energy stored naturally at low temperature in the ground around a building and transfer (or 'pump') it into the building's heating system.

It is such an efficient process that it can provide full electric space and water heating at lower running costs than a condensing gas boiler.

The capture of renewable solar energy from the ground also leads to very large reductions in CO₂ emissions compared with any conventional fossil fuel.

The system, shown diagrammatically above, is extremely simple and consists of a long length of very tough plastic pipe buried in the ground (called the 'ground heat exchanger' or 'ground loop') connected through a water circulating pump (the 'source pump') to the evaporator of a vapour compression refrigeration unit (the 'heat pump').

The building's heat distribution system is connected to the condenser ('output' or 'load') side of the heat pump, in the same way as one would connect to a conventional boiler.

The highest operating efficiencies arise when low temperature systems such as underfloor heating are used, although radiators are perfectly acceptable providing they are sized appropriately.

Domestic hot water at 60°C is provided from a specially designed indirect cylinder and, such is the efficiency of the unit, there is no need for any supplementary immersion heater top-up.

The ground loop heat exchanger is made from high density fusion welded polyethylene pipe and is virtually indestructible. This pipe is buried in the ground in a configuration and size designed to suit both the site layout and the energy needs of the building.

Vertical borehole loops (as shown in the diagram) require less land but require specialist installation, horizontal layouts need a lot more space but can possibly be installed on a DIY basis.

The general physical principles of the system rely on the fact that below a depth of 5 metres or so, the huge thermal mass of the earth gives ground temperatures which are not only stable but, on average in the UK, are within the range 8°C - 14°C.

A water and antifreeze mixture, which the heat pump cools to a temperature of around 2°C, is circulated within the ground loop by the source pump whenever the building's thermostat senses a demand for heat.

The 10 degree difference between the surrounding earth and the loop causes energy to flow from the ground into the loop, warming the source water for the heat pump, typically by about 3K.

The heat pump's condenser is fitted into the heating system's primary pipework and is sized to deliver heating system water temperatures in the range 30°C to 70°C, with flow and return water temperature differences usually between 5 and 10K, depending on the design of the heat distributing pipework.

The heat pump compressor is driven by an electric motor and provides the system with an overall efficiency, known as the Seasonal Performance Factor (or SPF) of around 3.5 (i.e. The purchase and use of 1 kWh of electricity to drive the heat pump extracts 2.5 kWh of renewable energy from the ground and results in a total of 3.5 kWh of useful heat being delivered into the house).

In addition to these energy benefits the lack of a flue removes the possibility of steam plumes, unsightly corrosion and direct local pollution.

What is more, the lack of a fossil fuel combustion process removes the possibility of fuel smells and spillages from in and around the house, and relieves a landlord of the statutory requirement to perform a potentially costly annual safety inspection check.

As an example of how effective ground source heat pumps can be in delivering both the lowest annual running cost and lowest annual CO₂ emissions, the table below shows the results of an analysis based on two years of monitored fuel consumptions from two developments of small well insulated 'Housing Association' bungalows with total annual useful space and water thermal energy requirements of 8000 kWh (60m²) and 12500 kWh (100m²).

Heating and HWS System	Annual Fuel Cost		Annual CO ₂ Emissions	
	[£ p.a.] (01/01/06)		[Tonnes p.a.]	
House Floor Area:	60m ²	100m ²	60m ²	100m ²
Typical Heat Loss (kW _{th}):	2.1	3.5	2.1	3.5
Annual Useful Heat (kWh _{th}):	8000	12500	8000	12500
Ground source heat pump	£210	£305	1.1	1.6
Condensing gas boiler	£235	£350	2.0	3.0
Non-condensing gas boiler	£270	£405	2.3	3.5
LPG (bottle) (non-condensing)	£685	£1055	2.9	4.5
Oil (28sec) (non-condensing)	£430	£666	3.1	4.8
Electricity (storage + panels)	£510	£760	3.9	6.2
Smokeless coal (stove + back boiler)	£805	£1230	6.8	10.4