



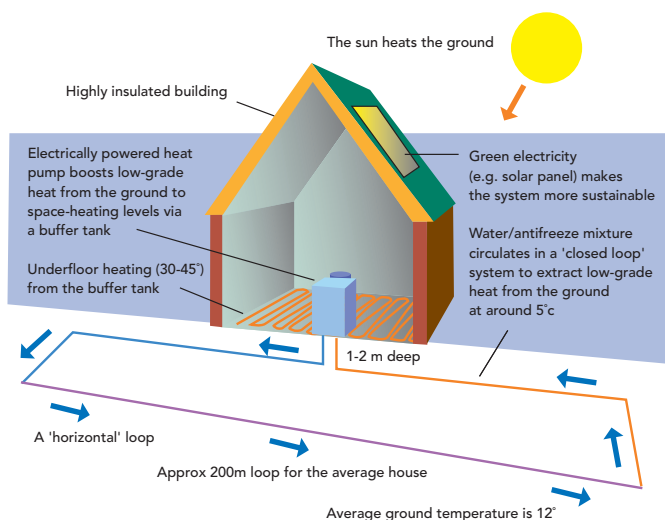
Heat Pumps



What is it?

The Earth acts as a huge thermal store absorbing the sun's energy and maintaining a constant temperature of 7 to 13°C below ground throughout the year. Heat pumps extract solar energy stored in the ground, water courses and in the air. The systems use electricity to drive a pump which extracts the solar energy and upgrades it into useful heat. Fridges are heat pumps and work by the same principal but in reverse, moving heat from inside the fridge to outside, thus cooling the inside.

There are currently approximately 600 heat pump systems installed in the UK but as many as 500,000 in North America and Scandinavia.



A **ground source heat pump (GSHP)** extracts heat from the ground by circulating a fluid (water/antifreeze mix or brine) through a closed loop of underground pipe. This fluid absorbs the heat stored in the earth and carries it to the heat pump in the building. The heat pump extracts the heat from the water via the refrigerant flowing through a heat exchanger and then distributes this heat to underfloor heating or radiators. GSHPs are

an energy efficient technology, with every unit of electricity used to drive the pump producing between 3 and 4 units of heat. However carbon dioxide (CO₂) savings will depend on the CO₂ emissions from the grid electricity supply.

GSHPs work most efficiently in combination with low temperature heat distribution systems, such as under floor heating. For a 4-person household the annual electricity use might be reduced by 75% compared to an all electric heating system. In addition, a heat pump can reduce CO₂ emissions by 20-25% compared with an efficient gas or oil boiler system.



Air source heat pump
(Powertech Solar)

With **air source heat pumps (ASHP)** a fan draws air in to the unit and this flows over the coils which extract the heat. They can also be used for cooling, removing the heat from the area to be cooled and converting it into useful heat in the form of hot water. They work all the year round even

in temperatures as low as minus 15°C but their efficiency depends on the external air temperature. A lower external air temperature gives lower efficiency.

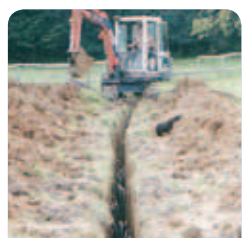
Water source heat pumps (WSHP) extract heat from a local water source and usually operate exactly like GSHP's with a fluid pumped around a cyclical "closed" system. However, some systems are "open" and involve water being pumped out of the ground from a borehole and discharged via a heat exchanger to a river or sewer. Water source heat pumps can be very efficient because of constant water temperatures and rapid replacement of the heat extracted.



Can I produce all my space heating with this technology?

Heat pumps can supply space heating and domestic hot water (DHW) but the efficiency falls at hot water delivery temperatures above 45°C to 50°C. Therefore an alternative form of heating may be needed to 'top up' the hot water cylinder.

The efficiency of a heat pump is measured in terms of its coefficient of performance (CoP). This is the ratio of their heat output compared to their electricity input. Heat pumps are best suited to low temperature underfloor heating systems in highly insulated buildings (typically new build) where



Ground loop in trench

they only have to raise the water temperature to perhaps 30 to 35°C. In such a situation a GSHP might achieve a CoP of 4 to 1. The seasonal CoP of an ASHP located on an external wall is likely to be approximately 2.5 or 3 to 1 in the UK.

Heat pumps are less well suited to traditional heating systems in which hotwater is pumped around radiators as these require hotter water (up to 80°C) which cannot be achieved efficiently. Similarly, poorly insulated buildings will also require a larger pump which significantly increases the capital cost.

How much space is required?

There are two main types of ground loop that can be used to extract heat using GSHPs. The loop can



Heat pump in Sturminster Newton

either be laid in horizontal trenches, or installed in a vertical borehole. A well insulated domestic house would require a horizontal ground loop buried between 1.5m-2m deep in a 40-100m long trench. Vertical pipe installations are more suitable for sites with limited land requiring a bore hole of

50-100m but require a specialist boring rig which makes these installations more expensive.

A geological survey may be advisable to investigate both the hardness of the sub soil/rock and also the heat conductivity from the ground to the heat extraction loop. Horizontal ground loops should not

be installed under tarmacadam surfaces such as car parks as ground source heat pumps rely on rainwater seeping into the ground to replenish the heat extracted. The pump itself is a square box similar in size to a fridge freezer.

ASHP's and WSHP's are less needy of space. The pipe work of a WSHP can simply be sunk to the bottom of a nearby watercourse whilst the coils of an ASHP are self contained inside a compact unit resembling an air conditioning system.

How much maintenance is required?

Heat pumps are highly reliable with virtually no maintenance required following installation. As they don't have many moving parts they do not require annual inspections or servicing. The underground piping typically carries a 50-year warranty. ASHPs and WSHPs that are sited externally will have a shorter life expectancy (~15 years).

What does it cost?

A typical 8 kW GSHP system costs between £6,400 -£9,600 excluding the cost of the internal heat distribution system. An under floor heating system is the best solution although it is also possible to use specially designed low temperature radiators. An average house would be looking at a total outlay of £10,000-13,000. Running costs are competitive compared to modern gas condensing boilers. ASHPs and WSHPs can often be installed in a day with little disruption to existing systems. As a result they are much cheaper. A 7 kW ASHP system might cost around £3000 plus installation costs and should be able to supply 70% of space and water heating for a modern well insulated home.

Can I get a grant?

The Low Carbon Buildings Programme (LCBP) offers a maximum of £1200 for GSHPs regardless of size, subject to an overall limit of 30%. A condition of the grant is that you must already have installed a basic level of energy efficiency measures including wall and loft insulation, adequate heating controls and low energy light bulbs. Air Source Heat Pumps are eligible for £900 LCBP grants, subject to an overall limit of 30% of eligible costs. These grants will be available until March 2011 (subject to demand) and will be superseded by a Renewable Heat Incentive



Ground source heat pump installation



Installed heat pump

thereafter. Grants of 50% are available for heat pumps installed in public and community buildings (see links in 'More Information' below).

What is the pay back?

Savings are best in off-gas areas. If you replace an electric night storage system you would expect to save up to a third on your bills enabling the system to pay for itself 16-21 years. Because of the lower installation costs of ASHPs and WSHPs it might be possible to achieve a quicker payback but this depends on the location of the heat pump and CoP of the system.

Are there any planning issues?

Always check with a local authority before installing a system. In most cases few planning restrictions apply to Ground Source Heat Pumps as the technology is hidden from view.

Open WSHP systems which take water from a local water course will require an abstraction license from the Environment Agency. ASHPs are not permitted development and require planning permission. Some models have given rise to concerns about noise nuisance from the air intake fan.

What is the potential for this technology in Dorset?

GSHPs have good potential for the new build sector which is expected to require 21,000 new homes in Dorset by 2016. WSHPs could be integrated with micro hydro schemes to provide 100% renewable energy to former mills and their surrounding buildings.



Pros and cons of heat pumps

	Pros	Cons
GSHP	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Space and water heating <input checked="" type="checkbox"/> Generally don't require planning permission <input checked="" type="checkbox"/> High CoP in well insulated dwellings <input checked="" type="checkbox"/> Low maintenance 	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Best for new build <input checked="" type="checkbox"/> Specialist installation requiring excavation for burial of ground loop <input checked="" type="checkbox"/> Expensive
ASHP & WSHP	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Space and water heating <input checked="" type="checkbox"/> Suitable for existing dwellings <input checked="" type="checkbox"/> Fairly simple installation with few planning constraints <input checked="" type="checkbox"/> Much cheaper than GSHP 	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Lower CoP than GSHP <input checked="" type="checkbox"/> No grants for water source heat pumps <input checked="" type="checkbox"/> WSHP needs local water source and requires an abstraction license

Heat pump installers based in the South West

In order to access a grant from the Low Carbon Buildings Programme (and the new Renewable Heat Incentive) accredited installers and accredited products must be used. These are listed on the Microgeneration Certification Scheme (MCS) website: www.microgenerationcertification.org
 Telephone: **020 7090 1082** The Dorset Energy Group suggest getting a minimum of 2 quotations and to use local accredited installers whenever possible.

More information

Ground Source Heat Pump Association: 01908 665555 www.gshp.org.uk

Grants

Low Carbon Buildings Programme	0800 915 0990	www.lowcarbonbuildings.org.uk
Community Sustainable Energy Programme	0845 367 1671	www.communitysustainable.org.uk
	0800 915 0990	www.lowcarbonbuildings.org.uk/info/permited/

Renewable energy advice for householders:

SW Energy Saving Trust Advice Centre 0800 512012 www.energysavingtrust.org.uk

Renewable energy advice for businesses in Dorset:

Business Link 0845 600 9966 www.businesslink.gov.uk/southwest

Renewable energy in Dorset and advice for community groups:

Renewable Energy Development Officer, Dorset County Council 01305 228530 p.west@dorsetcc.gov.uk
www.dorsetforyou.com/climatechange

This publication can be made available in audio tape, large print and Braille, or alternative languages on request.

Design & Print Service, Dorset County Council, October 2009, 4063 108440