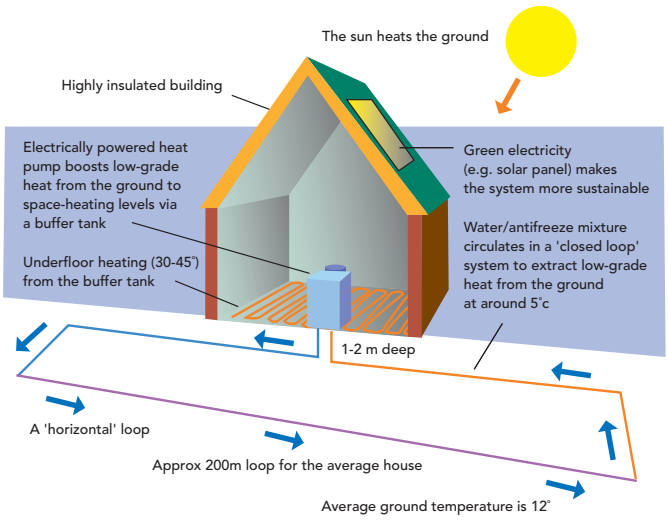
Heat Pumps

What is it?
The Earth acts as a huge thermal store absorbing 50% of the sun's energy and maintaining a constant temperature of 11 to 13°C throughout the year. Heat pumps extract solar energy stored in the ground, water courses and in the air. The systems require electricity to drive the pump so could be integrated with other technologies to make it completely renewable. Fridges are heat pumps and work by the same principal moving heat from where it's cold to where it's warm.

There are currently 550 systems 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 a refrigerant) through a closed loop of underground pipe (see above). 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, compresses the refrigerant to a higher temperature and then distributes this heat via a second heat exchanger to a conventional heat distribution system. GSHPs are an extremely energy efficient technology, with every unit of electricity used to drive the compressor producing between 3 and 4 units of heat.

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 a conventional electric immersion system. In addition a heat pump will reduce CO2 emissions by 30-50% compared with efficient gas or oil boiler systems.


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 their location as the air temperature tends to be more variable fluctuating on a daily and seasonal basis .

Water source heat pumps (WSHP) extract heat from a local water source and usually operate exactly like GSHPs 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. Consideration needs to be taken with regards to corrosion issues, filtration and extraction rates. It is also important to consider the electrical energy required to pump the water from the ground.

Can I produce all my space heating with this technology?
Yes. For domestic hot water (DHW) heat pumps can be used but it's more cost effective to use solar thermal and have an off-peak fossil fuel driven immersion system to back this up. This technology is most suitable for new build or complete renovation where a trench can be excavated during the building works and under floor heating incorporated in the design. Heat pumps can raise the output temperature to about 50°C but the higher the temperature required the more electricity is required to drive the pump and hence it's less efficient.

The efficiency of a heat pump is measured in terms of its coefficient of performance (CoP). This is the ratio of its heat output compared to its electricity input. Heat pumps are best suited to low temperature distribution systems in

This fact sheet was produced by the Dorset Energy Group, the body responsible for implementing the Bournemouth, Dorset and Poole Renewable Energy Strategy and Action Plan. The group involves an executive and four working groups with representatives from each of the nine local authorities in Dorset, Dorset Energy Advice Centre, Dorset Agenda 21, and a wide range of other stakeholders.
For general queries regarding this sheet contact Kevin Lindegaard at Dorset County Council on 01305 228530.

highly insulated buildings where they only have to raise the temperature to perhaps 30 to 35°C. In such a situation a GSHP might achieve a CoP of 3-4:1. The CoP of ASHPs depends on where the system is located. For instance a system placed in a kitchen will generally have a higher CoP (4:1) than one in a loft (3:1) or one located on an external wall (2.5:1).

Heat pumps are less well suited to traditional systems in which hot water 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 the pump to work harder consuming valuable electricity and therefore reduce the CoP of the system.

Ground loop in trench

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 either be laid in horizontal trenches, or installed in a vertical borehole. A domestic household would require a horizontal ground loop buried between 1.5-2m 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. The pump itself is a square box similar in size to a fridge freezer.

ASHP and WSHP 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.

Heat pump in plantroom (Kensa engineering)

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 but doesn't include the cost of your distribution system. An under floor heating system is best although it is also possible to use 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.

Capital cost reductions are expected to occur in both ground loop installation and heat pump manufacture as the technology matures in the UK. As the UK industry is very small, installation costs can also depend on the distance installers have to travel to the site, so it is best to choose one based locally.

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 system might cost around £2,500 plus installation costs which should be able to supply 70% of a normal homes space and water heating depending on the ambient air temperature.

Can I get a grant?
The Low Carbon Buildings Programme offers a maximum of £1200 for GSHPs regardless of size subject to an overall limit of 30%. The installer and the product must be approved and 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. The grant scheme unfortunately does not cover ASHP and WSHPs.

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 2/3 on your bills enabling the system to pay for itself in 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 your local authority, before installing a system. In most cases few planning restrictions apply as the technology is hidden from view. However, as GSHPs involve engineering operations they will probably require planning permission.

Open WSHP systems which take water from a local water course will require an abstraction license from the Environment Agency. ASHPs are sometimes installed on an outside wall and any change to the buildings appearance may require planning consent.

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 2010. ASHPs could prove ideal for dwellings off the gas grid such as the 6000 located in North and West Dorset. WSHPs could be integrated with micro hydro schemes in order to provide 100% renewable energy to former mills and their surrounding buildings.

The information on this leaflet was correct as of January 2007.

Pros and cons of heat pumps

	Pros	Cons
GSHP	✓ Space and water heating ✓ Generally don't require planning ✓ High CoP in well insulated dwellings	✗ Best for new build ✗ Specialist installation requiring excavation for burial of ground loop ✗ Expensive
ASHP & WSHP	✓ Space and water heating ✓ Suitable for existing dwellings ✓ Fairly simple installation with few planning constraints ✓ Much cheaper than GSHP	✗ Lower CoP than GSHP ✗ No grants for these technologies ✗ WSHP needs local water source and requires an abstraction license

Heat pump installers based in the South West
It is best to check that a product and installer are approved by the Low Carbon Buildings Programme. Always get several quotes before committing to an installer.

Company	Technology	Telephone	Web address
Earth Energy Ltd	GSHP & WSHP	01326 211070	www.earthenergy.co.uk
Greener Energy Systems Ltd	GSHP & WSHP	01983 812600	www.greenerenergysystems.co.uk
Kensa Engineering Ltd	GSHP	01326 377627	www.kensaengineering.com
M S Frise	GSHP, ASHP & WSHP	01373 826333	www.frise.co.uk
Parker Heating Ltd	GSHP	01425 402498	parkerheating@btconnect.com
Westward Energy	GSHP	01837 880159	www.westwardenergy.co.uk
Powertech Solar	ASHP	08707 300111	www.solar.org.uk

More information

Ground Source Heat Pump Association	01908 665555	www.nef.org.uk/gshp
Energy Saving Trust case studies	0845 1207799	www.est.org.uk/myhome
Low Carbon Buildings Programme	0800 9150990	www.lowcarbonbuildings.org.uk
Renewable Energy Officer	01305 228530	k.lindegaard@dorsetcc.gov.uk
Dorset Energy Advice Centre	0800 512012	www.deac.co.uk
Dorset Agenda 21	01305 213721	www.dorsetagenda21.org.uk