Heat Pumps

How do they work?

Heat pumps work on the principle of drawing heat out of the ground, out of water or air, and transferring it to a heating system such as radiators or under-floor heating. Heat pumps work in a similar way to refrigerators but in reverse, gathering heat from outside and bringing it in to heat a building. Thus it is possible to gather heat by making already cold air, soil or water even colder, by a few degrees , then concentrating that heat in a system to heat a property to a higher temperature.

Heat pumps require electrical power to operate. The ratio of the quantity of electrical power they require to operate to the quantity of heat they supply to a building is termed the Coefficient of Performance (COP). A heat pump with a COP of 3 would provide 3kWh of heat for every 1kWh of electrical power consumed.

Ground Source Heat pumps (GSHP)

Ground Source Heat Pumps can be split into three components, a ground loop, the heat pump itself and an accumulator. A liquid is pumped around the ground loop and warmed by the ground as it circulates. The heat pump absorbs the heat from the ground loop and concentrates it, then transfers the heat to water in an accumulator tank. The accumulator tank stores the hot water and feeds it through to the heating system in the building e.g. radiators or underfloor heating.

A **vertical ground loop** is a large length of pipe fed down a bore hole which can be up to 100m deep. The larger the heat demand, the larger the length of pipe required for the borehole. A **horizontal ground loop** is a large length of spiral coil/pipe, often called a 'slinky', which is buried in a shallow trench. This trench is usually situated between 750mm and 2 metres below the ground. Horizontal loops are generally less expensive than boreholes and are a more financially optimal solution if space is available.

Air Source Heat Pumps (ASHP)and Water Source Heat Pumps

Air Source Heat Pumps are a development of air conditioning technology. Air conditioning is the maintenance of an internal building environment to a desired level of temperature and humidity. In order for a building to feel warm or cool, the air in the building needs to be adjusted with reference to the air outside.

An Air Source Heat Pump absorbs heat from the air outside the property and returns the air to the outside environment at a lower temperature (making cold air colder). The heat pump then concentrates the heat it has gained from the air and brings it indoors to heat water, which in turn will heat the rooms by a radiator system. which can also provide hot water. *(See the example of Waulkmill in Elgin)*

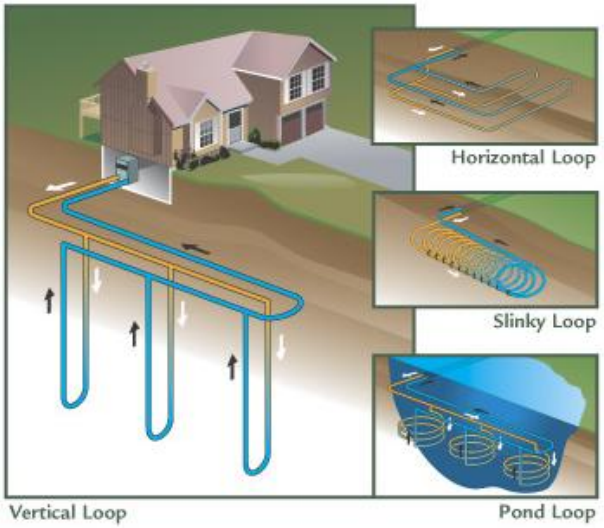
A simpler version of an Air Source Heat Pump relies on cooling outside air to produce heat which is then used directly to provide a current of warm air within a building. These 'air to air' pumps are used for space heating only. *(See the example of Dalavich Social Club)*

An **Exhaust Air Heat Recovery System (EAHRS)** comprises an electrical unit which gathers warm air from a sealed house. Warm, moist and stale air is sucked from intakes in living areas, kitchens and bathrooms. The Exhaust Air Heat Recovery System removes heat from that air before expelling it. The heat the unit gathers by chilling this exhaust air is concentrated and returned to heat the rooms via a radiator or underfloor system, which can also provide hot water. *(See examples of Skye and Lochalsh Housing Association, Port Righ and Moray Housing Partnership Burghead)*.

A **Water Source Heat Pump** works on the same principle as a ground or air source heat pump but instead utilises a body or flow of fresh water, or the sea. A Water Source Heat Pump reduces the temperature of a large volume of water by a few

degrees and returns it to the loch or sea. The heat absorbed will be concentrated and used in radiators or coils. *(See example British Waterways, Auchinstarry and Gairlochy)*

The Daikin Altherma Air Source Heat Pump, Active Energy, Inverness



Heat pump ground loops
http://www.engineer.gvsu.edu/house/altenergy.html

Most common uses

Heat pumps are commonly used to provide heating and/or hot water to buildings. Heat pumps work more effectively in well-insulated buildings which have a heating system that distributes heat at a low temperature. Under-floor heating distributes heat at a relatively low temperature (30-50 degrees). Conventional radiator systems use a higher temperature (50-55 degrees). In order to deliver heat at a high temperature a heat pump would require to use more electrical power which in turn reduces the COP.

Underfloor heating is less responsive than traditional radiators and therefore complement buildings that require to be maintained at a constant temperature and are less suited to buildings with heat requirements which vary throughout the day. For the same reason they are appropriate for buildings which are in regular daily use.

Site and area suitability

The following is a general guide to choosing the appropriate heat pump for site and area suitability options apply. Professional advice should be sought, however, before making a decision.

- Energy efficient building with access to considerable grounds and suitable soil – GSHP with slinky coil
- Energy efficient building with limited grounds – ASHP or GSHP with boreholes
- Energy efficient building with no access to grounds – ASHP
- Sealed building with mechanical ventilation– Air Source Heat Recovery System
- Building with access to body of fresh or salt water – Water source heat pump.

Questions and Answers

Is it expensive? – Bore holes are often the most expensive option when installing a heat pump. Air Source Heat Pumps tend to be cheaper than Ground Source Heat Pumps to install but often have a lower COP so may not work out cheaper in the longer term.

Added expense can be incurred if the radiator heating system in an existing building has to be adapted or changed to underfloor heating to accommodate the heat pump.

All types of heat pumps require electricity to operate and this will be an ongoing cost for the life of the heat pump.

What are the environmental impacts? –Heat pumps reduce the temperature of the soil / water/ air from which they extract heat and the installation of a slinky system will require substantial digging. Check with your local council if you need to apply for planning consent for the heat pump. Heat pumps reduce dependence on fossil fuels as they source the renewable heat from the ground which is replenished by the sun. If the electricity to run the heat pump is sourced from a wind turbine, then dependency on fossil energy can be reduced further.

Where can I find more information and advice? – Read more about heat pumps in the Scottish Government's Community Renewable Energy Toolkit, available at http://www.scotland.gov.uk/Publications/2009/03/20155542/8, or contact your local CES Development Officer who will be able to advise you on the possibilities and support available - http://www.communityenergyscotland.org.uk/team.asp. There is more information on heat pumps and how they work at http://www.heatpumps.org.uk/

See for yourself

Ground Source heat pumps with a micro wind turbine

Seann Sgoil Shawbost

Port Mor Centre Islay www.islandofislay.com

Ground source borehole – (to underfloor)

Moray Art Centre, Findhorn

Dochas Gallery, Lochgilphead

Ground source slinky – (to underfloor)

Ardfern (Craignish) Village hall

Orinsay Hall

Air Source heat pump (to radiatiors)

Lochalsh and Skye Housing Association

Barra Learning Centre

Exhaust Air Heat Recovery System (to underfloor heating and oversized radiators)

Fyne Homes Campbeltown

Moray Housing Partnership, Burghead