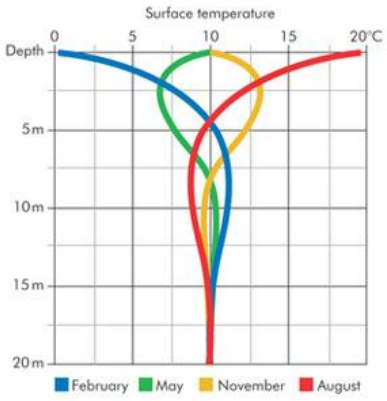
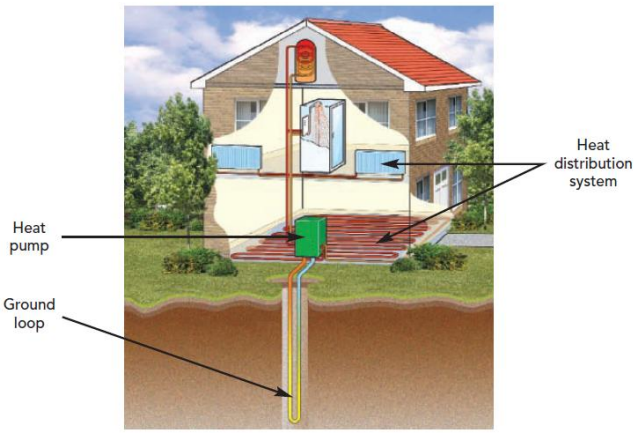
CLASP. Climate Change Local Area Support Programme

Planners' reference guide no. 11: Heat pumps





Introduction

Heat pumps operate by moving and compressing heat from low grade to a higher grade. Heat is taken from a heat source and 'dumped' to a heat sink through the use of a heat pump system which briefly comprises of the following equipment:

- Compressor – Drives the heat pump system
- Evaporator – Absorbs heat from the heat source
- Condenser – Releases heat to the heat sink

The heat source could be a variety of mediums, including air, water, ground or other bodies at a raise temperature. The two most common applications are ground source heat pumps and air source heat pumps. Ground source heat pumps use the ground's stabilised temperature as the heat source, with ground temperature below a depth of around 15m being generally stable all year round. This means that ground temperature below these depths is approximately the average temperature across the year for that location – typically 10-13°C in the UK, around 11-12°C in the North West.

Air source heat pumps operate on a similar principle but use the air as the heat source rather than the ground. This approach reduces capital cost as there is no borehole digging required, but also reduces the operational efficiency since air temperature fluctuates across the year by a much greater extent than ground temperature.

The Coefficient of Performance (CoP) can vary significantly between 1.0 – 6.0 depending upon the heat source and the time of year. Air source heat pumps are particularly susceptible to poor CoPs during the wintertime where outdoor air temperatures drop to low temperatures and the heat pump operates very inefficiently.

Rating & output

Heat pump systems come in a range of sizes, from small domestic units to larger commercial units which may consist of multiple banks of heat pump units. Heat pump systems are usually reversible and can therefore provide both heating and cooling to the

building (since the reversible process means that heat can be moved in both directions – i.e. both in and out of the building).

One of the main considerations with heat pump systems is the temperature at which they supply heat. Heat pumps generally operate much more efficiently with a small temperature gradient, i.e. where the heat supplied is at a lower temperature. This means that the heat emitter (e.g. a radiator) needs to be much larger to provide the equivalent amount of heat output compared to a higher temperature system such as a gas-fired boiler. For new developments this can be considered within the design process and underfloor heating can be used as an alternative, but retrofit applications can be more problematic unless peak heating demands can be reduced through coordinated energy efficiency improvements.

Dimensions

The physical dimensions of a heat pump system are roughly comparable to a gas-fired boiler system in terms of equipment inside the building however there is also the requirement for an outdoor component, either an outdoor unit for an air source heat pump or a ground coil for a ground source heat pump. The image below shows a typical heat pump system that would be located within a property to serve the heating system.

A ground source heat pump can consist of either a vertical or horizontal ground loop and can be open or closed loop. Vertical boreholes are generally more expenses than horizontal but reach ground with greater temperature stabilisation at greater depth. There is also a reduced footprint requirement through using vertical ground loops. Horizontal boreholes are generally cheaper but perform at slightly lower efficiencies than vertical loops due to larger ground temperature variation. The land area required to horizontal ground loops can also be substantial for anything other than the smallest of buildings.

A significant number of ground source heat pumps that are currently operational are closed loop systems, which means that the circulating fluid within the ground loop is completely sealed and separated from the ground. An open loop system, however, extracts water directly from the ground (either from the aquifer or from a surface water body such as a lake) and so there are additional regulations and licenses required for abstracting and injection water. These consents are obtained from the Environment Agency.

Rules of thumb and costs

Price ranges for different size systems are given below (as at June 2011).

- Typical capital cost (small scale):
  - £800-£1,400/kW horizontal GSHP
  - £1,800 - £2,800/kW vertical GSHP
  - £700-£1,200/kW ASHP

- Output capacity:
  - 40-60W/m length of vertical borehole (closed loop)
  - Typical 1MW per borehole (approx 30l/s abstraction rate)
- CO_2 savings are dependent upon the CoP achieved
  - Gas = 0.198 kgCO_2/kWh
  - Elec = 0.517 kgCO_2/kWh
    - Therefore need CoP of at least 2.6 to 'break even'!
- Renewable Heat Incentive:
  - Ground source systems <100kW - 4.3p/kWh heat generated
  - Ground source systems >100kW – 3.0p/kWh heat generated
  - There are currently no RHI subsidies for Air Source Heat Pumps

Planning considerations

There are generally few planning considerations for the indoor heat pump units itself (aside from suitable positioning to avoid vibrating noise disturbance) however the outdoor heat source may need planning consideration, in particular for ground source systems. Consent from the Environment Agency may be required (e.g. for water source heat pumps) and such consents can take some time to be obtained, and should therefore be programmed into the design process from an early stage. Consideration should also be given to other nearby ground source systems which may already be drawing heat from the ground are injecting heat into the ground through cooling applications.

Further information

Planning for Renewable Energy: A Companion Guide to PPS22 - http://www.communities.gov.uk/publications/planningandbuilding/planningrenewable

Environment Agency –

http://www.environment-agency.gov.uk/

Heat Pump Association

http://www.feta.co.uk/hpa/

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