

Demonstration of field measurements of heat pump systems in buildings: Good examples with modern technology

The aim of this study was to present examples of domestic heat pumps with good performance. Data from 12 domestic properties was analysed in detail to illustrate the principles of design and installation that ensure good performance.

Background and Objectives

There are many published examples of field trial data from domestic heat pumps. The aim of this project was to carry out detailed analysis of monitoring data from a selection of heat pump sites with good performance and to make recommendations for system designers and installers.

Methodology

For each site, the analysis included: ...

- ... Calculation of the annual seasonal performance factor as SPF3. This factor describes the annual efficiency of the heat pump, taking into account the electricity used by the inlet fan or ground loop pump, the electricity used by the compressor and any back up electricity used for space heating or domestic hot water immersion.
- ... Calculation of the CO₂ emissions relative to a gas or oil boiler. CO₂ emissions have been calculated using the EU average CO₂ coefficient of electricity and the appropriate national coefficient.
- ... Calculation of the cost of running the heat pump, as compared to the cost of a gas or oil boiler or the cost of electric storage heating.

More detailed analysis was carried out on a selection of sites, including: ...

- ... Calculation of SPF1-4 for each month of the monitoring period.
- ... Calculation of SPF3 for each year of the monitoring period, for those sites with long monitoring periods.
- ... Daily average seasonal performance factor (SPF3) as a function of external temperature
- ... Separate calculation of space heating and water heating efficiencies (as SPF3)

Heat source	Heat sink	Domestic hot water provision	Heating capacity	Annual heat load (space + water)
6 ground source, 6 air-source	Underfloor, underfloor + radiators, and radiators	9 out of 12 systems	5–14 kW (average 7.6 kW)	12,400–25,100 kWh (average 17,500 kWh)

Table 1: The heat pumps were located in Switzerland (5 heat pumps), the UK (4), and Sweden (3). A range of configurations was covered, as illustrated.

Results and Conclusions

Figure 1 shows the annual seasonal performance factors, as SEPAMO SPF3, for the 12 sites examined. The average performance of the air-source systems is 3.2, while the average performance of the ground-source systems is 4.1.

1 Heat pumps can reduce CO₂ emissions.

In Sweden and Switzerland, where the carbon content of electricity is low (0.04 kgCO₂/kWh, 2009 figures), using a heat pump resulted in savings of more than 5 tonnes as compared to an oil boiler. In the UK, the default fuel is gas and the carbon content of electricity is considerably higher (0.49 kgCO₂/kWh), but the average saving was still 1.25 tonnes CO₂/year.

2 Substantial cost savings can be made with heat pumps,

depending on the heat pump efficiency and the relative prices of electricity and alternative fuels. Cost savings were highest in Sweden (which has cheap electricity and expensive oil) and lowest in the UK (which has expensive electricity and relatively cheap gas). In all cases, the cost savings increased as the amount of heat delivered increased.

3 Space heating is more efficient than water heating,

but good water heating efficiencies (SPF>2.5) were found.

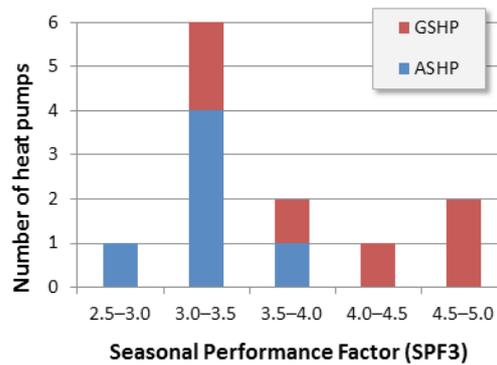


Figure 1: Histogram of heat pump performance factors (SPF3).

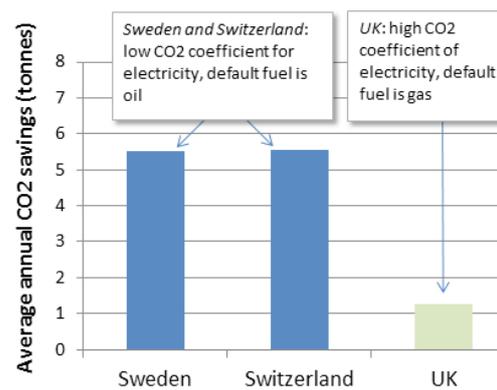


Figure 2: Average annual CO₂ savings using a heat pump as compared to oil or gas boilers.

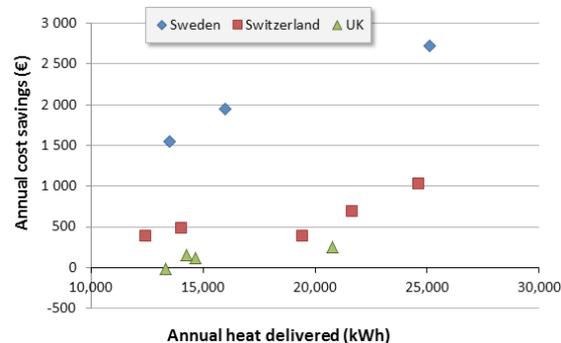


Figure 3: Cost savings compared with oil or gas boilers as a function of annual heat delivered.

Good examples

The study finishes with recommendations to installers.

Further information

Contact person: Operating Agent was SP Technical Research Institute of Sweden in Borås, Sweden, represented by Marcus Olsson, SP Technical Research Institute of Sweden, hpc@heatpumpcentre.org

Participating countries: Sweden, Switzerland, and the United Kingdom

Publications: Final report of Annex 37, Executive Summary of Annex 37, Recommendations to installers, and Twelve two-page leaflets for the heat pump sites (available at www.heatpumpcentre.org)

