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Performance of 10 heatpump systems in a field test

N.C. Sijpheer

K.J. Strootman

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Introduction

Heat pump installations use renewable energy and can thus be applied in sustainable energy systems for heating and cooling of buildings. Satisfaction of users of such systems is one of the main factors for successful large-scale implementation. Good technical performance and reduction of exploitation costs are said to be important aspects that lead to satisfied users. But how important are these aspects? Do they guarantee satisfied users?

The Energy research Centre of the Netherlands evaluated 10 identical sustainable energy systems for heating and cooling of dwellings over a period of at least 1 year. Not only technical and energetic aspects were evaluated but also inhabitant experiences with the installations. These experiences include control, comfort and cost aspects.

Dwellings and installations

The installation supplies heating and cooling to the house. A heat pump connected to an earth heat exchanger supplies heat for space heating. A HE gas-fired boiler supplies energy for the space heating peak load on very cold winter days and for domestic hot water. The earth heat exchanger is used for 'free cooling', by cooling ventilation air with cold water from the closed ground loop.

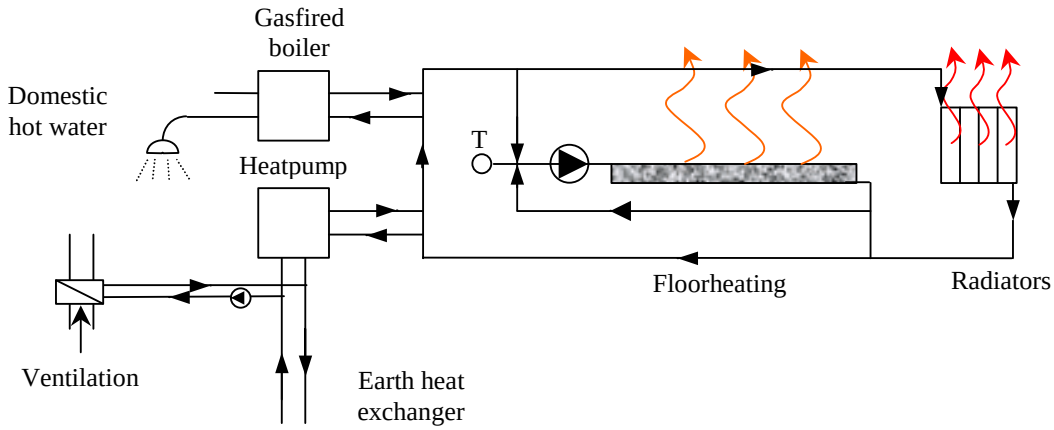

Figure 1: installation of evaluated heating and cooling system

Measurements

The efficiency of the heating systems is assessed with the so-called 'Seasonal Performance Factor' or SPF. This factor is the quotient of the amount of heat that is delivered by the heating system and the amount of energy (electricity) that is used to produce this heat.

$$SPF = \frac{Q_{hp}}{E_{hp\_tot}}$$

To define the reduction of CO2 exhaust, a comparison is made with a system without a heatpump and only a HE gas fired boiler (reference system). The measured SPF and CO_2 reduction compared to the reference system of the 10 installations is plotted in figure 2.

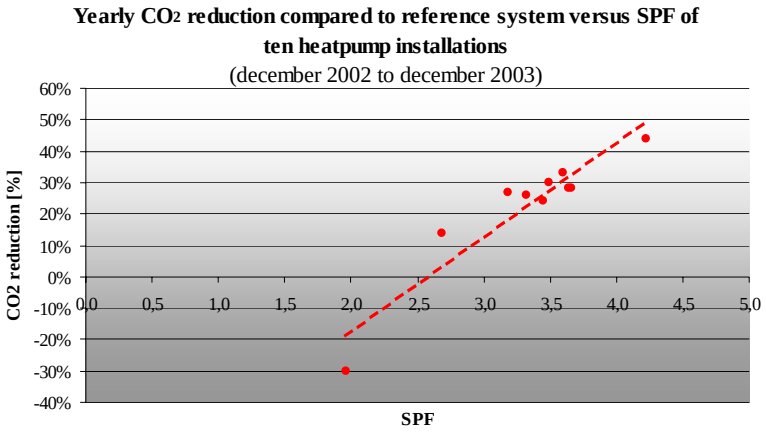

Figure 1: to realize CO2 reduction compared to a only gas fired system, a SPF of at least. 2,6 should be reached. In one dwelling the heatpump system does not meet this requirement.

The reduction in the energy costs compared to the reference system with only a HE gas fired boiler is also assessed. The energy tariffs during the time of the monitoring are used for the analysis. Figure 3 shows this result.

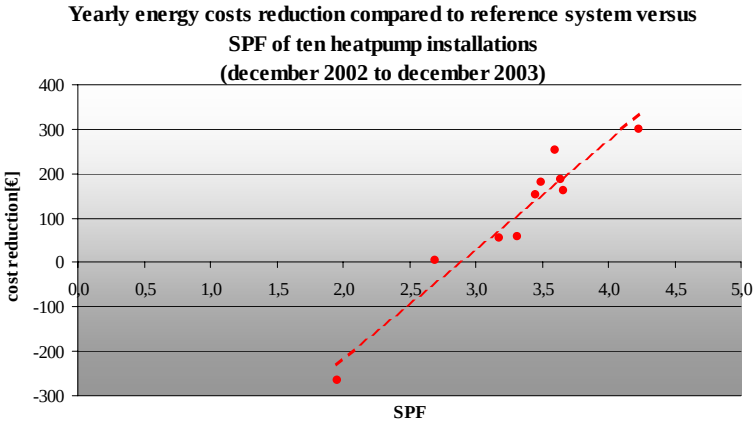

Figure 3: to realize energy cost reduction compared to a fully gas fired system, a SPF of at least. 2,8 should be reached. Two heatpump systems do not meet this requirement.

Survey

ECN conducted a survey about experiences with the heatpump installations with all inhabitants of the dwellings where the measurements took place. Only the main conclusions from this survey are published in this paper.

The surveys made clear that all inhabitants were not satisfied about their heatpump system, despite the fact that generally they all technically functioned well. The information supply about the working principles of the system and use of the system are experienced as insufficient. This resulted several times in disuse of the installation, causing complains concerning the realised comfort levels (too cold).

The installations were experienced as reliable. Technical failures of the installations where solved within acceptable time. Technical failures at the beginning of the project occurred in all installations. All inhabitants experienced high energy (electricity) costs and experienced no cost reduction compared to the reference system. They all realised that a comparison with their former (smaller) dwelling is difficult to make. Only a few inhabitants realised that they reduced costs for the use of gas.
Generally all the inhabitants mentioned that the installation is too big. They all expect system maintenance to be more expensive than the reference system with a gas fired HE boiler. All inhabitants are not satisfied with the control possibilities of the system because of the lack of a thermostat in the living room.

Conclusion

Despite the fact that the measurements show general good technical performance of the heatpump system, the inhabitants are not satisfied. Main reasons for this are;
- Lack of thermostat in living room (controls are integrated in the heatpump that is installed on the attick)
- Uncomfortable indoor climate (too cold)
- Complex controls
- High energy costs (electricity)
- Big installation

From the inhabitant's experiences the following conclusion can be drawn;
High efficiency and good technical performance of a heatpump system that reduces carbon dioxide exhaust and energy costs are of less importance than reaching the desired comfort level, a good control possibility and a small installation.

To make heatpump systems competitive with gas fired HE boilers, they still need to be improved. Feedback of inhabitant's experiences is essential for this process to realise a successful large-scale heatpump implementation.

Sources

Sijpheer, N.C.; Strootman, K.J; 2004 " Meetresultaten van 10 warmtepompinstallaties te Uithoorn", ECN http://intercms.ecn.nl/library/reports/2004/c04030.html