Task 1: Market Overview

IEA-HPT Annex 45: Hybrid Heat Pumps

Germany

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1 Field of Application

For working out the appropriate application area for hybrid heat pumps a simple excel-tool was developed which combines the most important correlations to determine

- Switching temperature between HP and boiler and
- Share of space heating contribution between HP and boiler

regarding the optimization goals $CO_{2\text{-eq}}$-emissions, primary energy and consumption cost for the following applications:

a) new building, under floor heating (max. T for space heating: 35°C)
b) retrofitted existing building, radiator heating (max. T for space heating: 50°C)
c) un-retrofitted existing building, radiator heating (max. T for space heating: 65°C).

Figure 1 shows the results for the combination of a medium efficient gas boiler and a medium efficient air source heat pump.

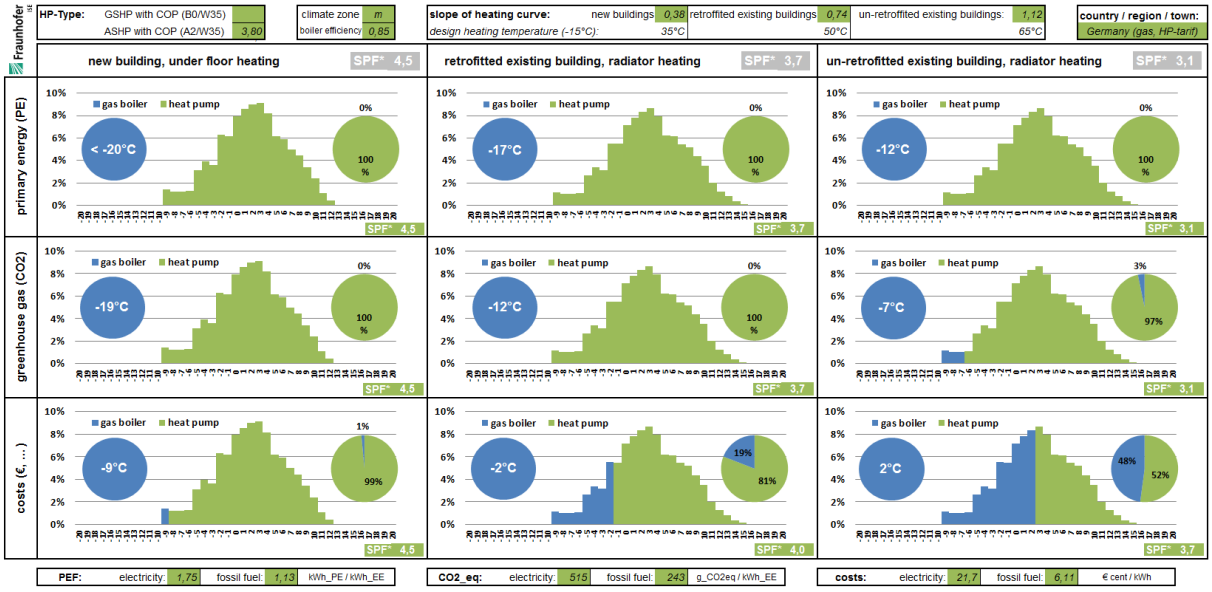

Figure 1: Input and output values to determine appropriate application areas for hybrid heat pumps

The heat distribution is according medium climate conditions but typical design temperatures in Germany range from -12 to -16°C. According primary energy only case c) would enable the boiler to run when the temperature is below -12°C. According $CO_{2\text{-eq}}$-emissions the only relevant switching temperatures occur in cases b) (-12°C) and c) (-7°). For the highest switching temperature of -7°C the boiler would only cover 3% of the space heating demand considering the heat distribution of medium climate. Applications with an oil boiler instead the gas boiler or a ground source instead an air source heat pump would decrease both values, switching temperature and energy share for the boiler, even more. The predicted further expansion of renewable energies in the electricity sector also supports this tendency. With the applied assumptions it can be concluded that the application of a hybrid system is rather unsuitable in terms of ecological values. It especially counts for the new acquisition of a hybrid system considering the higher invest costs. For already existing boilers the small advantage that offers an add-on hybrid system might advisable to use, however, the additional effort in terms of hydraulic implementation and control has to be considered, too. When looking at the costs as optimization goal the results are very different. Whereas in new buildings the switching temperature accounts for -9°C in the older buildings switching temperatures of -2°C and 2°C are calculated. These values count for the special heat pump electricity tariffs. Considering the standard household tariff the switching temperatures would increase up to 0°C, 5 and 8°C. Thus, according consumption costs a hybrid heat pump is an appropriate heating system; especially in older buildings but also (with high electricity prices) in new buildings. These results indicate a major problem: the divergence between ecological and economical goals. Whereas in terms of ecological reasons the hybrid system is rarely useful compared to the single heat pump the system operator would choose it because of economic advantages. In this

context the following limitations of the calculation are important to note. The mentioned preferences of using the single heat pump instead of hybrid heat pump systems are only valid for heat pumps which are able to cover the necessary heating temperatures for space heating and domestic hot water (DHW). Especially in multi-family-buildings the requirements for hygienic DHW preparation are high and a challenge for standard heat pumps. Thus, hybrid heat pumps might still be useful for practical reasons. Another reason for applying the hybrid system is the flexibly which it offers within the whole energy supply system. According the current wind and photovoltaic power situation it can be chosen between using the heat pump or the boiler. Therefore the aspect of flexibility is independent of the application cases considered in the calculation.

The above mentioned calculation indicates an application of hybrid heat pumps rather in buildings with high heating temperatures as a result from the specific energy demand and the installed heat transfer system. Figure 2 shows the distribution of the number of buildings and the living space area of single-family houses, terraced houses, multi-family-houses and apartment blocks to the different classes of the construction ages. For both, numbers of buildings and living space, 94% belongs to building built before 2002. It can be assumed, that the majority of these buildings are not refurbished in order to provide space heating on a low heating temperature around 35°C. Accordingly, in Germany exists a very large potential application field for hybrid heat pump applications.

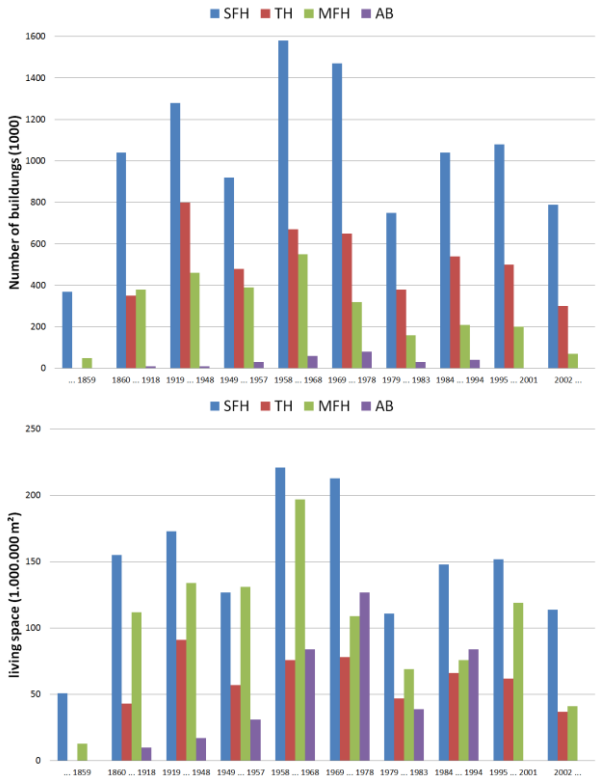

Figure 2: German building stock according number of buildings and living space

2 Market and Politics

In [IWES/IBP 2017; BCG/PROGNOS 2018; DENA 2017] the most cost efficient expansion paths for the supply system are calculated in order to reach the defined climate goals. According these studies the space heating heat pump stock has to increase from 800.000 to values between 3,4 Mio and 8,1 Mio in 2030. That would be equivalent to annual growth rates from 283.000 to 675.000 heat pumps. According [BWP 2018] in 2018 84.000 heat pumps for space heating were installed. These numbers confirm the gap between the necessity and the currently realizable. In 2017 the share of heat pumps in new buildings was 37,2% and in old buildings 5,5%. Among all heat generators the share of heat pumps sales amounted to 10,9%.

The increasing growth rates for heat pumps in the last three years are also influenced by incentive programs. The main incentive program for heat pumps is the Marktanreizprogramm (market incentive programme, MAP) provided by the Bundesamt für Wirtschaft und Ausfuhrkontrolle (BAFA). Funding requires minimum COP and SPF (calculated) values. The basic funding can be maintained if the heat pump has a certain coefficient of performance depending on the type (3.5 air-to-water; 3.8 water-to-water; 3.8 brine-to-water). In order to maintain an innovation funding, a more efficient heat pump with a performance factor of at least 4.5 is required for all heat pump types. For electric heat pumps with air as heat source, the basic subsidy amounts to 40 euros per kilowatt of installed nominal heat output and 60 euros as the innovation subsidy, but at least 1,300 (1,950) euros per system. For capacity-controlled and/ or monovalent heat pumps, the basic subsidy amounts to 1,500 (2,250) euros per system. If the heat source is ground and water, the basic production rises to 100 euro per kilowatt of installed nominal heat output for the basic subsidy and 150 euros for the innovation subsidy, at least however on 4,000 (basic) and 6,000 (innovation) euro (heat sources terrestrial heat or water) and/ or 4,500 (basic) and 6,750 (innovation) euro with the heat source terrestrial heat, with simultaneous terrestrial probe drilling. By applying additional fossil driven heat generators the incentive decreases proportional.

According the market report 2018 of the German Heat Pump Association [BWP 2018] there are different manufacturer who offer hybrid heat pumps which can be driven optimized either ecological or economical. Compact systems are available for single- and two family houses and separate components which also enable the retrofitting in for single-, two- and multi-family-houses. But since the sales numbers of hybrid systems are still low no statistical values are available. [BWP 2018] also mentions the Federal Ministry for Economic Affairs and Energy announces the end of funding for heat generator only using fossil fuels and the improvement of the funding of hybrid systems.

3 Expected Development

The main drivers for installing hybrid heat pumps in Germany are

- Economic reasons (increasing with space heating temperatures)
- Utilization limits of heat pumps in terms of supply temperature
- Flexibility due to fuel switch.

Considering the above mentioned results the circumstances for hybrid heat pump systems are appropriate for a wider application. But it also has to be stated, that these circumstances exist since some years without a significant influence on the expansion of this technology. Thus, the further development of hybrid heat pump systems is difficult to predict.

A References

BCG/PROGNOS 2018	The Boston Consulting Group (BCG) / PROGNOS (2018): Klimapfade für Deutschland. Studie im Auftrag des Bundesverbandes der Deutschen Industrie (BDI)
BWP 2018	Bundesverband Wärmepumpe (BWP) e.V.: BWP-Branchenstudie 2018: Marktanalyse – Szenarien – Handlungsempfehlungen; Berlin, 2018
DENA 2017	Deutsche Energieagentur (2017): Gebäudestudie – Szenarien für eine marktwirtschaftliche Klima- und Ressourcenschutzpolitik 2050 im Gebäu-desektor
IWES/IBP 2017	Fraunhofer IWES/IBP (2017): Wärmewende 2030. Schlüsseltechnologien zur Erreichung der mittel- und langfristigen Klimaschutzziele im Gebäude-sektor. Studie im Auftrag von Agora Energiewende