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COMPETITION BETWEEN HEAT PUMP AND OTHER HEAT TECHNOLOGIES ON THE GERMAN HEAT MARKET

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OVERVIEW

Ameliorations in the building stock insulation and the exchange of heating systems will have to take place within the next years and decades in order to lower heat demand and associated carbon emissions. Nevertheless earlier investments in heat technologies are necessary due to constant replacement activities. Beside heat pumps, combined heat and power (CHP) plants and gas heating units are essential possible technologies to cover heat demand. As the efficiency of CHP is depending on the heat consumption, the existence of a sufficient heat sink is of great importance for a profitable application. Out of densely populated areas investment possibilities are therefore reduced to other heat technologies. In this study potentials for different heating systems are analysed.

METHOD

For a quantification of the economic effects of different heat demand scenarios the stochastic European electricity market model (E2M2s) is used. Assuming functioning competitive markets, the E2M2s model determines market results through optimization. As a result cost efficient power plants and heat technologies are used to cover (price-inelastic) demand. This approach is formulated as a linear, stochastic programming model encompassing different regions and different time steps (typical days and typical hours). It is implemented in the General Algebraic Modelling System (GAMS). A detailed description of the model equations can be found in [1].

In order to describe adequately the production possibilities of CHP units, regional heat grids are defined as subsets of electrical grid zones. The CHP units located in a heat region can only be used to produce heat for this specific area, but the electricity may be used to match overall electricity demand in the corresponding electrical zone. In addition to regional heat grids where all investment technologies are available other heat regions exist. In these heat regions CHP is no alternative due to sparsely population and therefore the optimisation can only choose between heat pumps and other heating systems.

Besides decisions on power plant and heat technology operation also investments in new generation capacities are determined endogenously in the model in order to reflect the continuous adaptation of competitive power systems to increasing demand, shutdown of old units and changing framework conditions. Therefore also annualized investment costs are considered in the objective function for newly built capacities. This leads to investment decisions in line with the Peak load Pricing approach as developed e.g. by [2] and [3], with the yearly full load hours being a key driver for technology selection. In case that there is only need for new capacities during short periods in time, less capital intensive technologies will be preferred, in case that there is a capacity need for long periods in a year, base load technologies with low variable cost become more attractive.

RESULTS

In general there is a differentiation between regions where investments in CHP plants are possible or not. In CHP regions district heating related heatboilers compete with different types of heat pumps and other heating technologies that produce heat in the heat grid. Based on a peak load pricing approach heatboilers are always advantageous. Beyond these CHP regions heat pumps dominate in the case of more than 1800 full load hours (cf. Fig. 1).

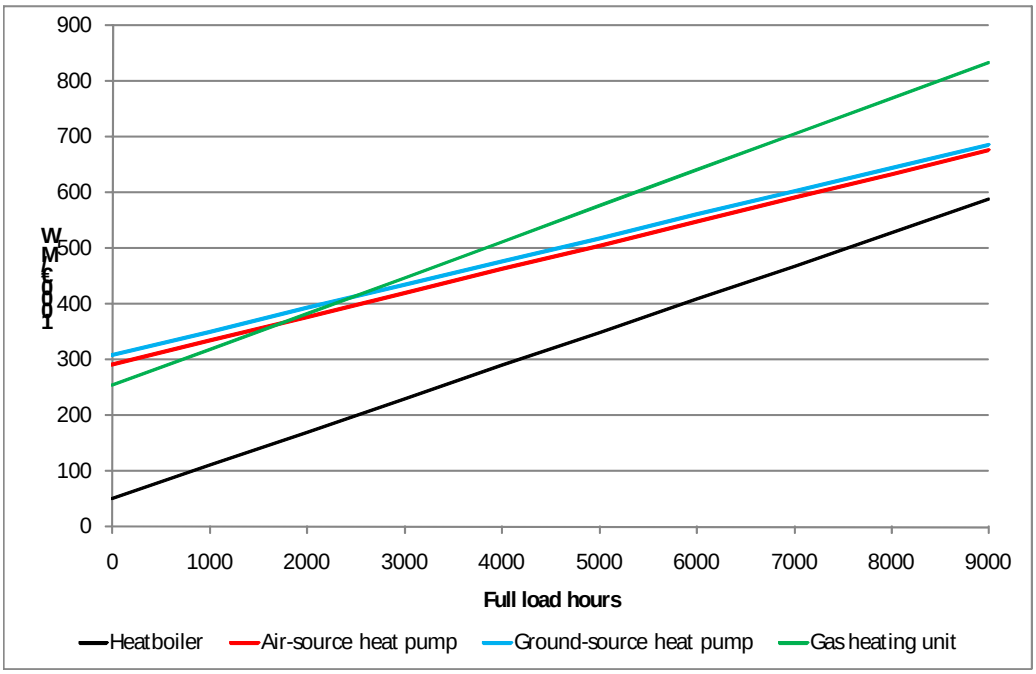

Fig. 1. Comparison of heat pump, gas heating unit and heatboiler

CONCLUSIONS

In regions where all heating technologies are available CHP plants dominate heat pumps and gas heating units in the chosen scenario. In regions where no heat grid is laid the heat pump is the leading technology from 1800 full load hours upwards. There are high potentials for heat pumps in comparison to other heating systems. As CHP power plants are restricted to areas with dense population the heat pump is the leading technology especially in regions with sparse population.

REFERENCES

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