

#SES4DH2017



3RD INTERNATIONAL CONFERENCE ON SMART ENERGY SYSTEMS AND 4TH GENERATION DISTRICT HEATING

BOOK OF ABSTRACTS



COPENHAGEN, 12-13 SEPTEMBER 2017

Eftim Popovski began work at the Fraunhofer ISI in May, 2016. He obtained his Masters at Kaiserslautern University of Applied Sciences on the topic “Assessing Technical Options for a Renewable and Energy-Efficient Heating and Cooling Supply in a City District”. His work focuses on design and analyses of heat generation units used in district heating networks, with the main focus on the economic feasibility of solar thermal panels and large-scale heat pumps.

Cost-effectiveness of large scale heat pumps in district heating networks - a simulation model for a case study in Germany

Eftim Popovski, Eftim.Popovski@isi.fraunhofer.de, +49 (0)721-6809-208 Fraunhofer Institute for Systems and Innovation Research, Breslauer Str. 48, 76139 Karlsruhe, Tobias Fleiter, Ali Aydemir, Jan Steinbach, Fraunhofer Institute for Systems and Innovation Research Richard Büchele, Lukas Kranzl, Marcus Hummel, TU Wien*

Keywords: Heat pumps, district heating, energy system analyses, policy recommendation, energy planning, decarbonisation, levelized cost of heat

The market share of the DH (district heating) in Germany is around 13 %. Even though there is still a space for future expansion of the DH network, Germany has one of the biggest DH market shares in the EU. Heat production is dominated by large-scale CHP plants that are driven by either coal or natural gas and together account for about 80% of total DH production. With the goal of the German energy transition to reduce greenhouse gas emissions by -80 to -95% compared to 1990 up until 2050, there is an increased pressure on the DH operators to increase the share of renewable energy source (RES) in the supply mix. With the increasing share of RES in the electricity generation, heat pumps represent one of the possible options of de-carbonizing the DH network. While countries like Denmark show a substantial market introduction of large scale heat pumps, they are not yet applied in Germany. This study analyses the technical and economic aspects of integrating large-scale ground source heat pumps in the DH network. Our assessment is based on real circumstances of a small size city in Germany (Herten) with an existing district heating system currently supplied by coal-fired CHP. The study is conducted in the frame of the Horizon 2020 project progRESsHEAT (www.progressheat.eu).

The methodology consists of energy system modelling using the simulation software energyPRO. Heat demands and possible expansion of district heating are based on detailed assumptions about the future development of the thermal energy demand of the building stock in Herten. The levelized cost of heat (LCOH) of the heat pumps is compared with the costs of the existing coal-fired CHP plants, which are currently supplying the DH network in Herten. As the city of Herten and its neighbours are former coal mining cities, the pit water from the past activities has to be pumped to prevent flooding. Therefore, the pit water can be used as a heat source for the heat pump. The investment costs are about 1500 EUR/kW of installed thermal capacity and lifetime of 20 years, with a variable operation cost of 3 EUR/MWh and fixed operation cost of 1% of the initial investment. In order to assess all relevant dimensions of the cost-effectiveness we systematically adapt the following levers in sub-sequent simulations:

- Heat pump size
- Heat source temperature
- Heat sink temperature (lowering temperature in DH network)
- Electricity tariff (inclusion of taxes and charges)
- Capital expenditure

Results show that neither from a (simple) socio economic perspective nor a private perspective the heat pump is cost competitive with the existing coal-fired CHP units at today's energy prices and policy framework. In order to improve the competitiveness, several policy measures and recommendations have been proposed and assessed. Due to the high electricity price in Germany, investment grants or loans are not sufficient to make heat pumps cost-effective. A measure that has a large influence on the LCOH is electricity tax reductions similar to the ones for the energy intensive industries. If these measures are implemented and the heat pump is sized in the manner that will have the largest amount of full load working hours, the LCOH of the heat pump can be reduced to the same level of the coal-fired CHP plants.