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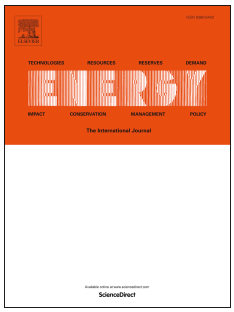

Dynamic modeling of local district heating grids with prosumers: A case study for Norway

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Dynamic modeling of local district heating grids with prosumers: A case study for Norway

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Abstract

District heating (DH) will play an important role in the future fossil-free energy systems by enabling increased utilization of waste heat and renewable heat sources to cover buildings' heat demand. A prerequisite for this is a reduction in the distribution temperature and shift towards decentralized heat production. In this study, dynamic modeling has been applied to study the technical, energetic and environmental impacts of including prosumers – customers who both consume and produce heat – in a local low-temperature DH grid. Four different scenarios were studied for a planned building area in Trondheim, Norway: high- and low-temperature scenarios with the entire heat demand being covered by a heat central, and two low-temperature scenarios including heat supply from prosumers. A data center and two food retail stores were considered as the prosumers, each with different location and individual characteristics for the heat supply, allowing to study their impact on the water flow in different parts of the grid. The results show that utilizing local surplus heat is a significant measure to reduce the heat demand and the environmental impact of the DH grid. Decentralized heat supply additionally contributes to reduced heat losses, due to overall lower distances to transport the heat.

Keywords: Low-temperature district heating, Thermal system modeling, Prosumers, Surplus heat, Energy planning

1. Introduction

District heating (DH) is an important technology in that it enables efficient and economical utilization of energy sources, that would otherwise be wasted, to cover buildings' heating demands [1]. DH will play an important role in the future fossil-free energy systems by enabling increased utilization of waste heat and renewable heat sources; however, a prerequisite for this is a reduction in the distribution temperatures and shift towards decentralized heat production [2, 3, 4]. With this, DH will allow reducing the load from the electric grid by utilizing DH for heating purposes instead of electricity wherever possible, hence promoting the utilization of electricity for other purposes where high-quality energy is needed, such as transport.

Reduced supply temperature level in DH provides a number of advantages. These include: (i) Reduction in the distribution heat losses [5, 6, 7]; (ii) Improved utilization of low-temperature waste heat sources from buildings and industry [3, 8]; and (iii) Improved efficiency and production capacity for solar thermal and higher COP for heat pumps [9]. Highlighting the new era of district heating, the concept of 4th generation district heating (4GDH) has been introduced by Lund et al. [3]. 4GDH refers to low-temperature DH systems with waste heat utilization, integration of renewable heat and an ability to be an integrated part of smart energy systems, including thermal, electric and gas grids.

Conventionally, DH systems have been based on large, centralized combustion plants or utilization of industrial waste heat sources, characterized by high capacities and temperature levels. Potential for utilization of industrial

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