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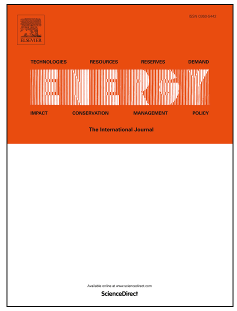

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Dynamic modelling of local low-temperature heating grids: a case study for Norway

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Abstract

Today's district heating (DH) networks in Norway are 2nd and 3rd generation systems, with supply temperatures ranging from 80-120 °C. In new developments, it is desirable to shift to 4th generation, low-temperature district heating (LTHD) in order to reduce the heat losses and enable better utilization of renewable and waste heat sources. A local LTDH grid for a new development planned in Trondheim, Norway, has been modelled in the dynamic simulation program Dymola in order to study the effect of lowered supply temperatures to heat losses and circulation pump energy use. Different cases with supply temperatures ranging from 55 to 95 °C, lowered return temperature as well as peak shaving were analyzed. Real DH use data for buildings in Trondheim were employed. The environmental impact in terms of the total produced CO_2 equivalent emissions was estimated for each case, assuming a heat production mix corresponding to that of the local DH provider. The results showed that by lowering the supply temperature to 55°C, the heat losses could be reduced by one third. The total pump energy increased significantly with reduced supply temperature, however the pump energy was generally an order of magnitude lower than the heat losses.

Keywords: Low-temperature district heating, Thermal system modelling, Energy planning

1. Introduction

District heating (DH) will play an important role in the future fossil-free energy systems by allowing an increased utilization of renewable heat and waste heat sources, however, a prerequisite for this is a reduction in the distribution temperatures [1, 2]. Through reduced supply temperature, DH production with renewable heat sources, such as solar thermal and heat pumps, becomes more efficient. Utilization of heat pumps in DH production becomes more beneficial with reduced supply temperatures as it enables improved coefficient of performance (COP) for the heat pumps, resulting into lower heat costs and primary energy use [3]. Reduced temperature level allows also improved utilization of low-temperature waste heat sources from buildings and industry [2]. Moreover, the distribution heat losses will be greatly reduced with lowered distribution temperatures [4, 5], and shifting to cheaper piping materials is enabled [2].

Current DH networks in Norway are 2nd and 3rd generation systems, with supply temperatures ranging from 80 to 120 °C. The DH companies are nevertheless interested in lowering the temperature level to comply with the lower heat demand of modern building mass, as well as to reduce heat losses. In Denmark, low-temperature DH (LTDH) systems with supply temperatures down to 50-55 °C have already been introduced [6]. In Norway, however, the minimum temperature requirement is limited to 65 °C by legislation related to control of Legionella [7], whenever domestic hot water (DHW) preparation is required. This is still a considerable reduction considering today's temperature levels.

Due to the high investment costs related to DH systems, there is a great interest in simulation and planning software to find the most optimal solutions regarding production and distribution of heat [8]. There are many software tools available for simulation of DH systems; a comprehensive overview has been given in [9]. Optimization with respect

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