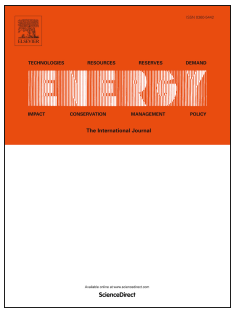
Accepted Manuscript



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Torben Ommen, Jan Eric Thorsen, Wiebke Brix Markussen, Brian Elmegaard

PII: S0360-5442(17)30954-4

DOI: 10.1016/j.energy.2017.05.165

Reference: EGY 10973

To appear in: *Energy*

Received Date: 31 October 2016

Revised Date: 20 April 2017

Accepted Date: 28 May 2017

Please cite this article as: Ommen T, Thorsen JE, Markussen WB, Elmegaard B, Performance of ultra low temperature district heating systems with utility plant and booster heat pumps, *Energy* (2017), doi: 10.1016/j.energy.2017.05.165.

Performance of ultra low temperature district heating systems with utility plant and booster heat pumps

Torben Ommen[a,*], Jan Eric Thorsen[b], Wiebke Brix Markussen[a], Brian Elmegaard[a]

[a] *Technical University of Denmark, Kgs. Lyngby, Denmark*
[b] *Danfoss Heating Segment, Nordborg, Denmark*

Abstract

The optimal integration of booster heat pumps in ultra low temperature district heating (ULTDH) was investigated and compared to the performance of low temperature district heating. Two possible heat production technologies for the DH networks were analysed, namely extraction combined heat and power (CHP) and central heat pumps (HPs). The analysis focussed on the characteristic heat demands of newly build multi-story buildings and the results were based on the ratio of the individual demands compared to the total. It was found that the optimal return temperature was dependent on the forward temperature and the heat consumption profile. For reference conditions, the optimal return of ULTDH varies between 21 °C and 27 °C. When using a central HP to supply the DH system, the resulting coefficient of system performance (COSP) was in the range of 3.9 (-) to 4.7 (-) for equipment with realistic component efficiencies and effectiveness, when including the relevant parameters such as DH system pressure and heat losses. By using ULTDH with booster HPs, performance improvements of 12 % for the reference calculations case were found, if the system was supplied by central HPs. Opposite results were found for extraction CHP, were ULTDH with booster HPs resulted in decreasing COSP of 20 %.

Keywords: 4gDH, Ultra low temperature district heating, Heat pumps, Combined heat and power

1. Introduction

In areas with temperate climate and high population density, district heating (DH) has proven to be economically competitive, and to show significant energy savings compared to individual heating solutions, e.g., for Denmark [1]. Both energy and economic savings may also be obtained in urban areas with warmer climates [2]. However, with decreasing space heating (SH) heat demands in newly built dwellings and multi-family buildings, DH is challenged by other technologies for cost efficient supply of residential heat services [3, 4]. This is the case as heat losses and investment costs of distribution networks become increasingly important in both socio-economic and private economic analyses, with a decrease in the total amount of delivered energy. On the other hand, economy of scale decreases production costs of the utility plants.

Each of the above factors should consequently be carefully considered in the analysis of new developments or expansion of existing systems. To add to this, DH may further improve cost effectiveness of other sectors, as it is a key component in the Smart Energy Systems approach [5] stating that the "*Smart Energy Systems concept is essential for 100 % renewable energy systems to harvest storage synergies and exploit low value heat sources*".

A reduction in DH supply temperatures is proposed in order to increase district heating efficiency, as well as to allow more heat sources to be easily integrated in the heat network [6]. Lowering DH supply

*Corresponding author
Email addresses: tsom@mek.dtu.dk (Torben Ommen), jet@Danfoss.com (Jan Eric Thorsen), wb@mek.dtu.dk (Wiebke Brix Markussen), be@mek.dtu.dk (Brian Elmegaard)