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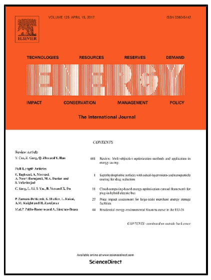

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Integration of solar thermal systems in existing district heating systems

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Abstract

The integration of large solar heating systems in district heating (DH) networks with large combined heat and power (CHP) plants is rarely considered. This is often due to low costs for heat but also due to subsidies for the electricity by CHP plants. Possible changes in subsidies and requirements in the reduction of fossil fuel based CO_2 emissions raise an awareness of improving the operational flexibility of fossil fuelled CHP plants. This paper provides a rather simple but detailed methodology of including large solar heating systems in an existing district heating system, where heat is supplied by a large CHP plant. It uses hourly data of load and temperature patterns as well as radiation data and collector efficiency data to determine collector field size and storage size. The possibility of largely independent operation of sub-networks is analysed, which allows different system temperatures. It is demonstrated that a sub-network can operate without a back-up boiler and that both network parts benefit from the interaction.

Keywords: *district heating, solar district heating, solar thermal systems*

Highlights:

- Integration of solar heat into existing DH systems brings benefits when heat is supplied mainly by fossil CHP plants.
- A solar thermal system enables a DH network to react better on future changes in the electricity price market.
- Accuracy of dimensioning a solar district heating system highly depends on the quality of the input data used.
- The methodology leads to more detailed results and avoids over-dimensioning of solar fields and storage volume.
- A short-term storage with a specific volume below 40 l/m² is sufficient under the given load pattern.

1. Introduction

The integration of solar thermal systems in DH systems is a more and more common practice in some countries. The general idea behind including solar collector fields in DH networks is to lower or even completely supply the low heat demand of a DH network during the summer months. Previous studies have shown that a high solar fraction in solar district heating is feasible only by introducing a large scale seasonal storage into the system: Since the 1980s Denmark and Sweden have built many solar heating plants [1]. In some of these cases a seasonal storage is used to provide a solar fraction even above 50 % of the total system demand. The high taxation of primary energy sources supported the ambitions in Denmark that lead to seasonal storages which are only feasible in a very large scale [2]. In comparison to the Danish and Swedish developments solar DH systems in Germany started to be built later, at the beginning of the 1990s. The reason for this development can be explained due to the fact that large DH systems in Germany are generally supplied by large CHP plants. These plants are often operating as base load power producers and can supply heat and electricity at a cost-efficient level during summer and winter due to funding through the CHP production law (KWKG) [3]. In addition to the availability of low-cost heat, high and very high system temperatures in the DH systems also prevented solar heat generating systems [4]. In the example cases of the DH system in Chemnitz and Salzburg, only a large