

Synthesis of recent Swedish district heating research

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ABSTRACT

In Sweden, district heating meets currently above half of the heat demands in buildings. District heating research in Sweden has a long tradition dating back to 1975. The latest research program period included 34 projects and was executed between 2013 and 2017. In this paper, a synthesis is performed on the Swedish research frontier by assessing these recent research projects. The three study purposes was to provide an overview over the executed projects, to identify new research questions, and to identify future challenges to the Swedish district heating industry. The assessment was based on six defined key areas, such as demand, resources, system frameworks, technology, cold supply, and international perspective. The subsequent content analysis was performed from three perspectives: the perspective of energy system transition, the customer perspective, and the sustainability perspective. Final conclusions include the three future challenges for the Swedish district heating industry. These are future strategies to communicate the value of district heating, vision for district heating beyond the transition to fossil free supply, and technology development for efficient use of low temperature heat sources.

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1. Introduction

District heating is the dominant heat supply system in Sweden. For decades, district heating has expanded on the Swedish heat market and continuously obtained higher market shares. Above half of the heat demand in Swedish buildings is today met by district heating, mainly in multifamily and service sector buildings. The main competitor to district heating today is individual heat pumps, having a market share of almost a quarter of the heat supply to buildings [1].

The implementation of energy efficiency in existing buildings, improved energy performance and stricter building codes for new buildings as well as changes to a warmer climate are all drivers that reduce the heat demand on the Swedish heat market. The shrinking heat demand necessitates business changes for the district heating industry such as revised technology, revised business models and discussions about the DH companies' natural monopoly position, and customer relations. In Sweden there is no price regulation for heat. The uneven relationship between DH supplier and customer arising from lock-in effects and the customer's dependence on a

single supplier, poses a risk for customers that district heating suppliers in different ways may exploit their stronger position in the business relationship. This fact enhances the importance of good customer relations. From an environmental perspective, district heating in Sweden has successfully phased out fossil fuels from its heat production. Currently, the fuel mix consists primarily of biofuels, waste, and excess heat. The overall emission factor has gone from about 90 g CO₂/MJ heat delivered to less than 10 g CO₂/MJ during 40 years [1]. In the future, the current high use of waste and biofuel in the fuel mix may become problematic if (or when) these fuels are becoming more scarce because of more efficient recycling higher up in the waste recovery chain, as well as greater competition for the biomass fuels from other businesses or other countries.

As a result of high interest in district heating for many years, research about district heating has been conducted for a long time through research financed by the district heating industry and the Swedish Energy Agency. Since 1975, there have been several different research programs dedicated to district heating in Sweden. These research programs have mostly excluded research about the supply side, i.e. about heat production, ashes, extraction of timber from the forest and the like for which there have been other research programs available. In Fig. 1, the numbers of publications per year from these dedicated programs are shown. Totally, 1019

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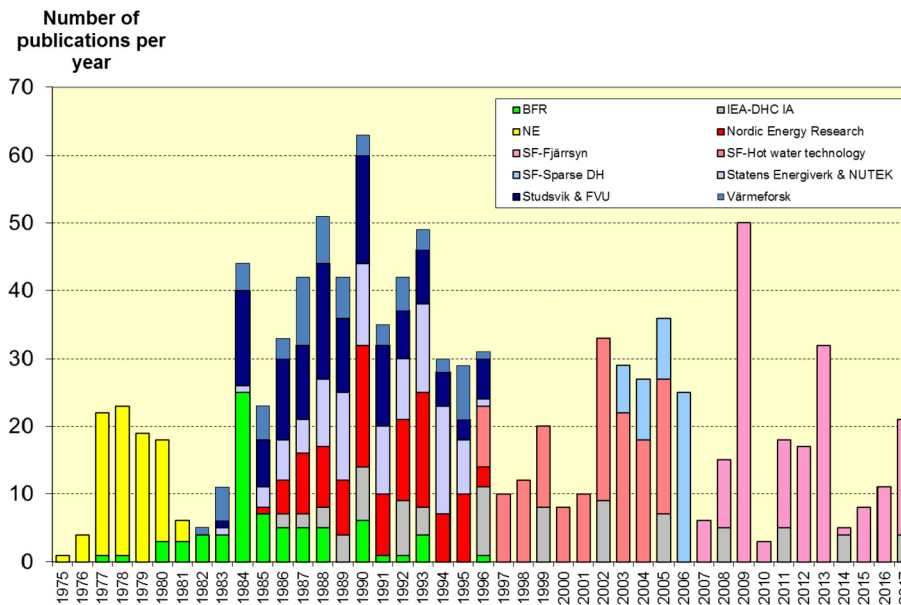


Fig. 1. Overview of number of district heating research publications written with financial support from the Swedish energy research program, and shown in terms of the eight national and two international research boards that supplied the financing. Reports from the international Nordic Energy Research program have not been included after 1996.

research reports have been published from these ten different research programs.

Sweden is a country with a long tradition of district heating, making the challenges to the Swedish district heating companies relevant both to parties interested in expanding current district heating and in investing in new district heating. In this article, we aim to make a content analysis and a synthesis of the latest district heating research in Sweden conducted within the third period of the Fjärrsyn research program (Fjärrsyn III). This period was going on between 2013 and 2017, included 34 research projects, and had a total turnover of 6 million euro.

The three purposes of this study were to provide an overview over the included projects in Fjärrsyn III (1), to identify new research questions that need to be addressed in future research (2), and to identify future challenges to the Swedish district heating industry (3).

2. Method

The results in this study are based on a content analysis of the 34 projects that have been included in the Fjärrsyn III research program. Content analysis is applied when the purpose is to interpret the contents of a text [2]. The first step in this content analysis was to identify common denominators between the projects in order to classify and briefly describe the contents of the 34 projects. Doing so, six key areas for knowledge identification and interpretation were singled out in order to use as tool for a deeper content analysis in the screening phase. The six key areas are presented in Table 1.

In order to identify new research issues for district heating research, we have considered and analyzed the 37 project reports that were written within the 34 projects, based on three different perspectives that are expected to provide interesting angles from a research perspective. The projects have been analyzed based on the following three perspectives:

- Project contributions to strategies for energy system transition
- Project contributions concerning customer perspectives

Table 1

The six key areas applied for the content analysis in the screening phase.

	Key areas
4	Demand
5	Resources
6	System frameworks
7	Technology
8	Cold supply
9	International perspective

- Project contributions concerning sustainability perspectives

The energy system transition is reflected through the project contributions to knowledge about the six key categories already mentioned in Table 1. Heat demands are changing. The resources used for heating and cooling are revisited. The system frameworks will be revisited to account for the creation of the future energy system. The future energy system necessitates new technologies. Cooling is an important element of the future energy system and the demand for cold will probably grow due to the warmer climate and the increasing occurrence of heat waves.

The customer perspective is reflected in discussions on customer trust in district heating suppliers and in the attractiveness of the product of district heating and district cooling. Knowledge is generated on new customer segments and on new district heating applications reflecting a new form of customer demand. The role of the customer in an efficient energy system is also outlined.

The sustainability perspective is reflected in knowledge created in certain dimensions on economic, ecologic and social sustainability. For economic sustainability the focus has been on knowledge generated on sustainable production and consumption. For ecologic sustainability the focus has been on knowledge generated about district heating and cooling's contributions to pollutants to air, soil and water, and impact on climate change in the form of

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