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Review

International review of district heating and cooling

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ABSTRACT

The purpose with this review is to provide a presentation of the background for the current position for district heating and cooling in the world, with some deeper insights into European conditions. The review structure considers the market, technical, supply, environmental, institutional, and future contexts. The main global conclusions are low utilisation of district heating in buildings, varying implementation rates with respect to countries, moderate commitment to the fundamental idea of district heating, low recognition of possible carbon dioxide emission reductions, and low awareness in general of the district heating and cooling benefits. The cold deliveries from district cooling systems are much smaller than heat deliveries from district heating systems. The European situation can be characterised by higher commitment to the fundamental idea of district heating, lower specific carbon dioxide emissions, and higher awareness of the district heating and cooling benefits. The conclusions obtained from the six contexts analysed show that district heating and cooling systems have strong potentials to be viable heat and cold supply options in a future world. However, more efforts are required for identification, assessment, and implementation of these potentials in order to harvest the global benefits with district heating and cooling.

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1. Introduction

According to [1], the fundamental idea of district heating is 'to use local fuel or heat resources that would otherwise be wasted, in order to satisfy local customer demands for heating, by using a heat distribution network of pipes as a local market place'. Traditional excess heat resources are combined heat and power (CHP) plants, Waste-to-Energy (WtE) plants, and industrial processes. During recent decades, some renewable heat from geothermal wells, solar collectors, and biomass fuels have been introduced into the global district heating systems. Hereby, a combination of heat recycling and renewable heat is the current focus for district heating systems. This provides a substitution of ordinary primary energy supply for various societal heat demands, while achieving lower environmental impact. Hence, the district heating economy can be characterised as economy-of-scope instead of economy-of-size that characterise other parts of the energy system, giving a fundamentally different business situation for district heating.

Globally, district heating systems have been able to fulfil this fundamental idea to very different extents with respect to market penetration, use of local resources, size of heat distribution networks, and environmental impact. In countries with strong driving forces, district heating systems provide heat to about half of the national building stocks. In other countries, very few systems appear because of low awareness or competitiveness of district heating.

The primary merit of district heating is lower heating costs when international fuel prices are high and when lower environmental or climate impacts are valued by internalisation of external damage costs into national taxes or fees. The heat distribution costs are low in dense urban areas with concentrated heat demands. The shortcomings are lower competitiveness at low international fuel prices and high distribution costs in suburban and rural areas with less concentrated heat demands.

Established expertise of district heating has paved the way for introduction and deployment of district cooling systems, mainly for covering space cooling demands in buildings. However, this district cooling development has been more recent compared to the development of district heating. District cooling systems are therefore neither as common nor as extensive as district heating systems.

Assessments, reviews or surveys of district heating in the world have been available since the 1930s. The early surveys between the 1930s and 1970s contained information about the pioneering countries of USA, Germany, and Russia as presented by Refs. [2–8]. The two international oil crises in the 1970s, with considerable higher international fuel prices, created a higher interest in district heating and this renewed curiosity was reflected in Refs. [9–13]. More recent surveys have shown interest in the use of renewables in district heating systems [14,15]. An international review about district heating and cooling has never been published in a scientific energy journal.

European assessments, reviews or surveys of district heating have been available since the late 1940s. Early experiences from Germany, France, the Nordic countries, and Poland were reported in Refs. [16–20], while the first complete European survey was presented in 1974 in Ref. [21]. Further surveys in the aftermath of the international oil crises were provided in Refs. [22–24]. Only one review has been published in a scientific energy journal [25]. Two more recent surveys have focused on the possible expansion of district heating in Europe [26,27].

Russian surveys concerning the recent situation after deregulation of the Soviet planned economy have been provided by Refs. [28,29]. A current North American review perspective has been published in Ref. [30]. The current Chinese perspective is summarised in Ref. [31]. The situation for district heating systems in transition economies after the deregulation of the planned economies in East European countries around 1990 was the core theme in Refs. [32–34].

The first attempt concerning a global statistical survey was provided by Ref. [35]. The first complete international overview was published by a dedicated district heating committee of the World Power Conference in 1968 [36]. Nowadays, corresponding statistical information is easily available in the heat column of the world energy balances provided by the International Energy Agency (IEA) in Paris [37]. This compilation of international and national energy balances has been the main information source for the market, technical, and supply contexts in this article. These energy balances are not perfect, since discrepancies appear for some national district heating sectors. However, this database is currently the best available statistical information source concerning the global energy system.

Euroheat & Power, the European trade association for district heating and cooling (earlier called Unichal), have published statistical information about the status of district heating in European countries since 1978. This statistical information has been provided in special survey reports every second year since 1991. The most recent survey report is [38].

Fewer surveys and reviews are available about global district cooling installations and statistics. One technology review has recently been published in Ref. [39]. Some global information is also provided in two international district cooling books [40,41]. No appropriate worldwide statistical information is available for district cooling. Some European market information is available from two EU-projects in Refs. [42,43], while statistical information about district cooling is also available from Ref. [38].

The basic issues in this review are the market, technical, supply, environmental, institutional, and future contexts for district heating and cooling in the world with some deeper insights for Europe and the European Union. However, the review is heavily unbalanced with a more comprehensive description of district heating, since district cooling is still in its early days and publications about these systems are rare. An article with the same review structure has also been written concerning the national perspective of Sweden [44].

2. Market context

The market context considers the positions of district heating and cooling in the international heating and cooling markets with respect to introduction, expansion, current volumes, specific demands, market shares, and user categories.

2.1. District heating

District heating was first commercially introduced in cities as

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