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A review of the pricing mechanisms for district heating systems

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ABSTRACT

Heating represents the largest proportion of energy use as supplied to consumers across all end energy uses. Therefore, there is huge potential for energy savings in the heating sector in order to reduce the emission of CO_2. District heating (DH) has been considered an efficient, environmentally friendly and cost-effective method for heating in buildings, and is playing an important role in the mitigation of climate change. In the interest of fairness and in the highly competitive market the DH companies operate, there is a strong need to develop a novel heat pricing mechanism in order to promote sustainable development of DH systems. In this paper, existing methods and models regarding heat pricing have been reviewed. The features of different pricing mechanisms have been analysed, including advantages and disadvantages. Insights into developing an advanced pricing mechanism for DH systems have been offered.

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Contents

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1. Introduction

Heating represents the largest proportion of energy use as supplied to consumers across all end energy uses worldwide. In 2009, heating represented 47% of final energy consumption, compared with 17% for electricity, 27% for transport; and 9% for "non-energy use", for example, using oil to make plastics [1]. Oil, coal and gas account for more than two-thirds of the fuel used in meeting this significant demand for heat. Because heating accounts for such a large share of the world's final energy consumption, it is of significant importance to explore the potential for energy savings in this sector in order to reduce the emission of CO_2 and mitigate climate change.

A District Heating (DH) system is a centralised system that supplies heat to end-users by distributing steam/hot water through a pipe network. The centralised heat generation benefits from using large combustion units that have a higher energy efficiency and are equipped with more advanced control over air pollution. Therefore, DH has been considered as an efficient, environmentally friendly and cost-effective method for heating in buildings, and is playing an important role in the mitigation of climate change. For instance in Europe, DH alone is responsible for a reduction of at least 113 million tons of CO_2 emissions per year, representing 2.6% of the total amount of CO_2 emissions at present [2].

However, due to the continuous rise in cost of DH, it faces big challenges to further improve efficiency, reduce cost and enhance profitability. The competitiveness of DH systems for a particular building/house owner depends on three factors: (I) the price of the DH, (II) the price of the fuel or electricity used to heat the building and the expected increase in those prices, and (III) the efficiency with which that fuel is used compared to the efficiency of the potential DH [3]. According to the Energy Markets Inspectorate (EMI) [4], DH, bedrock heat pumps and wood pellets are on the same competitive level for the typical multi-dwelling buildings in Sweden. For example, according to Fortum, a large energy company operating in the Nordic countries, Russia, Poland and the Baltics, the price for heating was 802 Swedish kr/MWh heat excluding tax in 2013 [5]; while the price for electricity was 800–950 Swedish kr/MWh heat including tax during the same period. However, given these figures, DH systems do not have a price advantage over heating systems where heat pumps are integrated. Heat pumps, an important alternative to space heating, normally have a coefficient of performance (COP) of 3–5, which means that a heat pump can deliver 3–5 kWh heat by consuming only 1 kWh electricity. Considering the increasingly competitive environment faced by DH companies, redesigning the pricing mechanism for DH systems could be an effective way to motivate DH companies to improve production methods with a view to reducing operating cost and increasing profitability [6]. Moreover, an effective pricing mechanism could also assist in further energy saving and CO_2 emission reduction, given that price is considered the most important factor that can incite consumers to change their behaviour. Therefore, developing a novel pricing mechanism is essential to promote sustainable development of DH systems.

For more than a decade, energy market participants and European regulatory authorities have been committed to improving market transparency and liquidity, with the ultimate goal of creating a single European market in electricity and gas [7]. To ensure that the prices emerging on the wholesale market reflect the supply and demand, market participants need to have access to all relevant information on production and consumption in a non-discriminatory manner. At the retail level, transparency is also needed to enable consumers to better manage their choice of supplier as well as their energy consumption. In Europe, the legislative package plans various dispositions for consumer rights [7]. Despite the fact that less work has been done regarding DH, resulting in DH prices being far from transparent, more and more attention has been paid to the DH market. Greater regulation has increased the transparency of DH pricing in order to promote trust and reduce the number of complaints. For example, the EMI's regulation, enforced in Sweden, defines companies' obligations to provide price information and how this should be achieved. DH companies are, since 2007, required to submit separate accounts for their various divisions in order to avoid cross subsidisation. In 2009, these companies also began to report operational and business details to the EMI. The purpose of this was to give a greater degree of transparency within the market and to counteract overcharging. Increasing concerns about transparency in the DH market and fairness to both DH companies and consumers demand a novel pricing mechanism.

This paper studies the mechanisms and methods of DH pricing. The objectives include: to review the current status of heat pricing, to identify the knowledge gaps, and to provide insights into developing an advanced pricing mechanism for DH systems, which can motivate DH companies to reduce costs and consumers to save energy, and improve the transparency of the DH market.

This literature review collected information from peer-reviewed articles and reports from DH companies, governments and international organisations with the key words such as pricing models, costs for DH and DH markets. As Sweden is a pioneer in reforming the DH market, a lot of Swedish experience has been highlighted and discussed in this study.

The paper is organised as follows: the monopolistic nature of the DH market and price elasticity are discussed in Section 2; after the price components are introduced in Section 3, Section 4 describes the two types of DH markets and the corresponding pricing principles; and Section 5 further investigates the different pricing methods for the marginal cost.

2. Monopolistic nature and price elasticity of district heating

The Swedish DH sector experienced a transition from a regulated to a deregulated market during the past two decades. After deregulation, many municipalities sold their DH companies either to the private sector or municipality- or state-owned large energy companies, such as FORTUM, E.ON, Rindi, and Vattenfall [8]. As a result of these changes, the price of DH increased rapidly, and the increase in DH price since 2004 can be seen in Fig. 1. The rising DH price led to protests and much national media debate. The protesters argued that the energy companies were taking advantage of their natural monopoly [9].

The natural monopoly enjoyed by DH companies has unique characteristics, i.e. customers are tied to only one heating supplier

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