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Calculating the marginal costs of a district-heating utility

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Abstract

District heating plays an important role in the Swedish heat-market. At the same time, the price of district heating varies considerably among different district-heating utilities. A case study is performed here in which a Swedish utility is analysed using three different methods for calculating the marginal costs of heat supply: a manual spreadsheet method, an optimising linear-programming model, and a least-cost dispatch simulation model. Calculated marginal-costs, obtained with the three methods, turn out to be similar. The calculated marginal-costs are also compared to the actual heat tariff in use by the utility. Using prices based on marginal costs should be able to bring about an efficient resource-allocation. It is found that the fixed rate the utility uses today should be replaced by a time-of-use rate, which would give a more accurate signal for customers to change their heat consumptions.

Keywords: District heating; Marginal costs; Modelling; Combined heat and power

1. Introduction

Distribution of district heating is a natural monopoly and there is a possibility for monopoly behaviour in tariff pricing and enrolling of customers. With the liberalisation of the Swedish electricity market in 1996, old regulations stating cost pricing and an equal treatment of customers were recalled from the Swedish district-heating sector [1]. Now there is a question of how to price district heating in the liberalised energy market.

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District heating (DH) can be found in about 80% of the Swedish municipalities and has a large share of the heat market. However, there is a limited occurrence of combined heat-and-power (CHP) generation. Whereas more than 43 TWh of DH were supplied to end-use customers in 1999, no more than 4.5 TWh of electricity were generated via the CHP mode. The EU average of the DH fraction produced in CHP plants was in 1999 higher than 60%. The total Swedish residential heat market has been estimated to be 94 TWh, while the national electricity consumption in 1999 totalled 143 TWh [2–5].

Average revenues from district heating vary among Swedish utilities between approximately 300 and 600 SEK[1] per sold MWh, excluding the 25% value-added tax, VAT [6]. Prices can differ due to the number of customers, heat density, age of the district-heating system, loan circumstances, profit expectations, cost-effective use of energy resources, and cross-subsidisation. Small DH utilities having CHP generation can be regarded as price takers of electricity, while being price setters for district heating. They operate on two different markets and face the issue of allocating joint costs and revenues from CHP generation.

The aim of this study is to demonstrate three models for calculating a utility's marginal costs for district heating. The structure of the paper is as follows. First, marginal costs are briefly discussed. Second, some general features of cost and revenue allocation in CHP systems are reviewed. In the third section, a case study is performed. A utility's technical energy-system is analysed using three different methods for calculating marginal costs. One is a manual spreadsheet method, another method involves an optimising linear-programming framework, and the third method uses is a least-cost dispatch simulation model. In a closing discussion, the resulting marginal costs are compared to the utility's actual heat-tariff.

2. Costs and pricing

A basic presupposition here is that optimal prices from a societal point of view should equal short-range marginal costs (SRMC) of DH generation. These prices reflect the scarcity of resources in society, and are the best means for optimal resource allocation. However, such prices do not guarantee full cost coverage for the producer. Consequently, a fixed charge, besides variable prices, can be justified. With monopoly, the producer can use his market power when setting tariffs. Monopoly pricing, when the producer tries to maximise his revenues, tends to keep production down and prices high. Rather, prices can be set to reflect marginal costs, and a fixed charge can be set to cover investment costs. More elaborated discussions on utility pricing, and SRMC versus long-range marginal costs (LRMC), can be found in e.g. [7–9].

Alternate cost pricing is a pricing policy in common practice. The heat price is set just below the price customers would pay for an alternative heating technology. In Sweden, common alternatives to district heating are electric boilers and oil boilers.

[1] One Swedish Krona (SEK) equalled 0.110 Euro in March 2003.