



# Short-term impact of green certificates and CO<sub>2</sub> emissions trading in the Swedish district heating sector

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Received 2 October 2005; received in revised form 20 December 2005; accepted 28 January 2006  
Available online 17 April 2006

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## Abstract

Swedish district-heating (DH) systems use a wide range of energy sources and technologies for heat-and-power generation. This provides the DH utilities with major flexibility in changing their fuel and technology mix when the economic conditions for generation change. Two recently introduced policy instruments have changed the DH utilities' costs for generation considerably; the tradable green-certificate (TGC) scheme introduced in 2003 in Sweden, and the tradable greenhouse-gas emission permit (TEP) scheme introduced in the EU on January 1, 2005. The objective of this study is to analyse how these two trading schemes impact on the operation of the Swedish DH sector in terms of changes in CHP generation, CO<sub>2</sub> emissions, and operating costs. The analysis was carried out by comparing the most cost-effective operation for the DH utilities, with and without, the two trading schemes applied, using a model that handles the Swedish DH-sector system-by-system. It was found that the volume of renewable power generated in CHP plants only increased slightly owing to the TGC scheme. The TGC and the TEP schemes in force together, however, nearly doubled the renewable power-generation. CO<sub>2</sub> emissions from the DH sector may either increase or decrease depending on the combination of TGC and TEP prices. The overall CO<sub>2</sub> emissions from the European power-generation sector would, however, be reduced for all price combinations assuming that increased Swedish CHP generation replaces coal-condensing power (coal-fired plants with power generation only) in other European countries. The trading schemes also lower the operational costs of the DH sector since the cost increase owing to the use of more expensive fuels and the purchase of TEPs is outweighed by the increased revenues from sales of electricity and TGCs.

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**Keywords:** Tradable green-certificates (TGCs); Tradable emission permits (TEPs); Combined heat-and-power (CHP); District heating; Systems analysis; Sweden

## 1. Introduction

District heating (DH) is the dominant source of heat for buildings in Sweden, with a current market share of about 47% [1]. This position has been achieved through the creation of hundreds of local DH systems all over Sweden during the past six decades. Compared with many other countries with major DH sectors, the use of fossil fuels (oil, coal, and natural gas) in the Swedish DH sector is very limited. The major reasons for this are the lack of such resources domestically in Sweden and the active Swedish policy-making discouraging fossil-fuel use. The set of heat production in the respective DH system is, instead, primarily based on the energy resources available locally, for instance industrial waste-heat, municipal solid-waste and, wood waste from forestry. Fossil fuels are used mainly as complements to these energy sources, for instance in periods of peak demand. Another difference from other countries that use a great deal of DH is that only a small part of the Swedish DH production is based on combined heat-and-power (CHP). The main reason for this is the historically good access to cheap electricity, owing to the dominant resources of hydropower and nuclear power in Sweden, which have made CHP investments unprofitable. A great deal of the heat generated in the Swedish DH sector comes instead from heat-only boilers (HOBs). Electric HOBs and electricity-powered heat-pumps are also commonly used in the DH sector owing to the historic abundance of electricity. The implication of these facts is that the Swedish DH utilities today all utilise several fuels and technologies for DH production. Fig. 1 shows the development of the Swedish DH sector from 1970 to 2003.

In the respective DH systems, the different energy-sources and production units are used in combinations that satisfy the demand for heat at the lowest overall cost to the system. This is achieved by operating the production units with the lowest *heat-generation cost* whenever possible and by operating the production units with the highest *heat-generation*

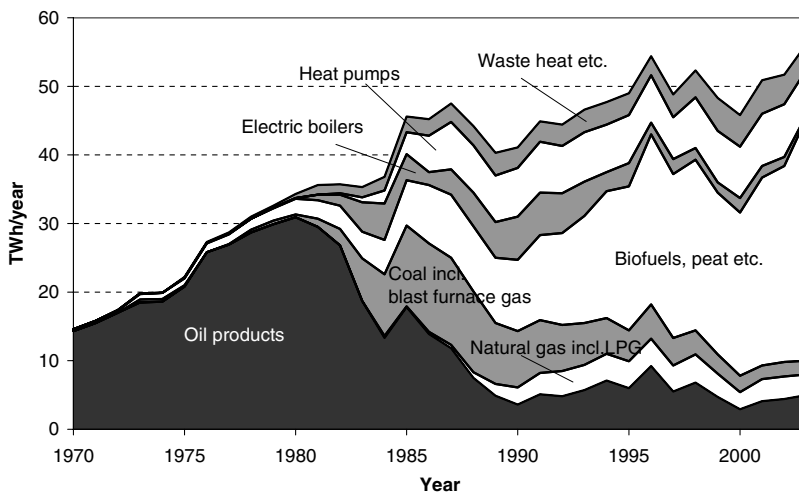


Fig. 1. Development of the district-heating sector in Sweden 1970–2003 [2].

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