AN INTERNATIONAL COMPARISON OF DISTRICT HEATING MARKETS

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FJÄRRSYN

AN INTERNATIONAL COMPARISON OF DISTRICT HEATING MARKETS

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PREFACE

This report scrutinizes and compares the district heating markets in Sweden, Denmark, Finland, Lithuania and Austria. It provides an understanding of the similarities and differences between the markets, and thus entails a promise to enlighten any discussion on regulatory or, more broadly, institutional change in district heating markets.

The study has been conducted within the realm of the research program Fjärrsyn. This program is financed by the Swedish District Heating Association and the Swedish Energy Agency. The research has been carried out by Britt Aronsson and Stefan Hellmer at Blekinge Institute of Technology. The project has been followed by a reference group appointed by the Swedish District Heating Association. The members of this group were Erik Larsson, the Swedish District Heating Association, Jonas Holmberg, Borås Energi och Miljö, and Daniel Ahlbom, Göteborg Energi.

Jan Berglund
Chairman of the Market Board of the Swedish District Heating Association

The report presents results and conclusions from the project. Publication does not mean that the Swedish District Heating Association or Fjärrsyn has taken position to the content of the report.

SUMMARY OF THE STUDY

The markets under scrutiny in this study show both similarities and large differences in a verity of respects. The district heating markets, being natural monopolies, are treated differently by the countries' respective authorities focusing on different aspects of the market with different market outcome. In for example Denmark it is seen as crucial that district heating plants also produce electricity, hence the large proportion CHP-plants. CHP-plants in Denmark stands for 80% of the electricity supply. Denmark's dependence on electricity imports means that the authorities via regulation makes it difficult to use electricity for heating, it is banned in new houses. This results in a strong position for the district heating plants in their natural monopoly position. The lack of substitute techniques for space heating reduce the relevant market to, in most cases just, district heating. The result is an obvious need of price regulation. However, this non-profit price regulation in place in Denmark means that the price risk is taken by the end costumers and the somewhat increased dependence on own gas supply as a fuel in often small plants has lead to large price spreads across Denmark as shown in figure 8.7. The price spread shown in this figure gives however not a fair overall picture of the Danish situation. The prices presented in the figure are not weighted against the size of the plants and it is in fact a limited number of small plants and thus consumers that actually meet these high prices, still they exists and must be considered to represent the downside of the Danish system.

In the urban areas in Denmark, especially in greater Copenhagen, there exists an interesting and relatively well developed wholesale market. Having vertically separated the plants (CHP, waste incineration and waste heat) from the transmission and distribution network we can here observe a wholesale market between the municipality owned networks and the heat producers and a retail market between the often municipality owned distribution network and the final costumer. The final costumer can however not choose between different suppliers so the system cannot be regarded as having third party access (TPA).

The district heating market in Sweden has no price regulation. The companies are assumed to work in a businesslike manner and are consequently free to set prices. The market is, however under the surveillance of both the Swedish Energy Market Inspectorate and the Swedish Competition Authority. Also, Sweden has introduced an independent district heating board that mediate in issues between companies and their customers in accordance to the district heating law.

The availability of alternative ways of heating varies across the country and foremost across the type of building. Small, detached houses have often more alternatives than residential buildings with many flats. Consequently, these smaller houses are seen to be less locked-in by earlier decisions on heating source compared to larger residential buildings. Having available substitutes means that the natural monopoly situation is weakened in Sweden compared to Denmark. Charging too high prices can trigger a substitution from district heating to another system such as heat pumps or pellet burners. The obvious effect of this is that many of the Swedish district heating companies openly set their prices for district heating, not in accordance to their respective costs, but in accordance to the nearest available alternative. The debate, and cases handled by the district heating board, reveals that there exists an opinion that district heating

companies in urban areas, such as Stockholm, might be taking some advantage of their dominant position. This is because they sell and distribute district heating in residential areas which in turn have less available alternatives and can thus not react to higher prices through substitution. The relatively high prices in these areas (the high end in figure 8.7) are by the Swedish authorities seen as "problematic".

Among the countries included in the study Sweden has the lowest share of heat produced in CHP-plants, below 40%. This is a natural consequence of historically having vast access to low cost hydro electric power and, in more recent history, nuclear power. Comparing the use of waste heat in DH-production puts Sweden in a not so favorable position. With its share of waste hot water usage of around 10%, Sweden has the lowest utilization ratio among the included countries.

The Finnish district heating market is similar to the Swedish in many respects with no price regulation and access to alternative systems especially for smaller, detached houses. In spite of a less favorable price trend during the last ten years, the Finnish prices are lower than the Swedish and show smaller price range compared to Sweden. This has no obvious explanation, but two features that differ between the countries can be mentioned. First, Finland has a much higher utilization rate of waste heat; around 30% of total DH production compared to the Swedish rate at 10%. Second, as pointed out in the earlier referred report by Vanhanen et.al. (2006) the Finnish district heating market show a high level of transparency in prices, production and trade of energy between companies. The report emphasize that it see no reason for the authorities to further intervene in the market as prices are transparent and no abuse of dominant position is seen yet.

The Lithuanian district heating market is a market under transition. It has a cost-based price regulation and although the Lithuanian prices still are among the lowest in comparison, the price trend and the increasing price range is less favorable. The transition process involves many issues including leaving a previous one-price system to introduce businesslike behavior, new ownership conditions etc. Even if the prices comes out low in an international comparison they are still high with respect to living standard as a relatively high share of the income goes to living expenses including heating. The new ownership conditions and, foremost business issues for each plant, are probably the factors behind the substantial increase of the price range as depicted in figure 6.12. The price range has more than doubled in Litas between 2002 and 2008. In addition the, by the Lithuanian District Heating Association, proposed price increases for the future are substantial.

It has been difficult to dig deep into the district heating market in Austria, mainly because of the limited data available. District heating in Austria is, by comparison, a small sector of the total heat market, around 20%. Still, Austria has lots of small, bio-fueled plants serving limited areas especially during the winters. There is no obvious legislation, or special authorities involved in the district heating market, at least not at national level. At the länder level there do exist some legislations and subsidy systems promoting district heating in certain areas. The price path in Austria shows no particular trend and the lack of plant data makes it impossible to do a deeper price analysis.

There is no evidence of the prices on average being lower or higher as a response to price regulation, but one obvious conclusion from this study is that price regulation, of the forms presented, shifts the price risk down to the final consumer. This might not be a major problem in that it is the authorities in each country have presumably the consumer interest at hand. It must be pointed out that a price regulation can be in place for other welfare reasons than keeping the district heating prices under control.

Questions that need further investigation concern the eventual connection between the price level and price range and different regulatory models as well as other variables such as the choice of fuel and business model. Other issues for further investigations are market systems influence on market performance.

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1. INTRODUCTION

Background

District heating markets are different from many other energy markets. The major difference is that district heating markets almost always are well defined within boundaries such as a small village area, a small town or even a large city. All these markets of different sizes, use different technology and fuels and charge different prices. The observed presence of different prices in markets providing space heating should, according to economic logic, lead to a certain amount of trade between in order to generate arbitrage profits. However, different obstacles such as technology and/or some economic barrier to entry, hinders this trade and keeps these district heating markets isolated from each other.

Since district heating is a technology for providing space heating as well as hot tap water is used worldwide, the question in this report is if and how these more or less isolated markets are treated in different countries. How are these different markets, often referred to as natural monopoly markets, function in different countries? Do different countries have different regulations, and if so, how do these regulations affect the markets and market solutions with respect to, for example price and quantity?

The Project and its Mission

This project makes an international comparison between the district heating markets in different countries with a special emphasis on questions regarding market functioning. Particular interest will be focused around:

- District heating market conditions and organization in different countries.
- Ownership and ownership structure in different countries.
- The political situation in these markets with respect to competition law and European environmental law.
- The eventual use of subsidies for, for example, increased use of renewable fuels and increased production in CHP-plants
- The presence and purpose of specific regulations and their impact on, for example prices.
- The competitors to district heating and their eventual position in different countries.
- The eventual presence of district heating in the political debate in different countries.
- Etc.

Purpose

The main purpose is to provide a deeper knowledge and understanding for the district heating market's preconditions and functioning in different countries. The different situations in the countries' preconditions with respect to technology, economy, climate, political situation, raw material endowments etc. generates most probably many different solutions aiming to satisfy both the need for space heating and contribute to the climate work.

Enhanced knowledge on different conditions regarding, for example, ownership, market structure and law will contribute to the possibility for creating competitive strength for district heating. The study's primary aim is to describe and analyze differences and similarities in the district heating market conditions in different countries and compare these with Sweden.

The Countries

Apart from having Sweden in the study we have included Denmark, Finland, Lithuania and Austria. Denmark was included mainly because it is close to and similar to Sweden in many respects but differ in one important aspect for the study; the presence of a specific regulation of the district heating market. Finland is included because of its many similarities to Sweden and the fact that Finland is a country close to us that, as Sweden, has an un-regulated district heating market. Lithuania was included because of its closeness to Sweden and because of the ongoing transition process in this country including also the district heating markets. Finally, Austria was included because of it's, in a European perspective, relatively high dependence on district heating. Another important factor for the choice of countries was the, ex. ante, knowledge concerning the availability of data. The study also includes one more region, the district heating network in St. Paul, Minnesota. This concerns just a single network in one city and is consequently not significant as a country in the study and the conclusions. However, that particular network has some special features that might be of some interest and is therefore included.

Method

This research has been conducted in collaboration with the Swedish District Heating Association and a reference group. This group has had three meetings. The research has followed a number of steps including the determination of relevant theoretical base, collecting relevant quantitative and qualitative information with respect to purpose and theoretical base, visits to different countries and different organizations and authorities, analyzing the material and writing the report.

Primary sources of information comprise the official statistical authorities in the chosen countries as well as the district heating associations and other authorities of relevance for the district heating markets in the these countries. Other research reports of relevance as well as other investigations concerning these issues have been studied.

Theoretical Base

The theoretical framework as well as the analytical model used in the study is presented in the following chapters 2 and 3. It is in chapter 2 argued that district heating markets is a special kind of physical network and has as such special features like being a natural monopoly. This chapter also presents the ideas behind the eventual need of regulations in these kinds of markets and describes very briefly some regulatory models.

Chapter 3 continues to present the used analytical model, the so called SCP-model. SCP stands for Structure-Conduct-Performance, i.e. argues for that a special markets structure generates a special conduct that in turn generates a performance. However, not only these three aspects are analyzed. One very important aspect of the studied markets is the presence of policy and policy makers influencing both the market structure and the possibility to conduct in different ways.

Outline

After the theoretical base and analytical model in chapters 2 and 3 follows a thorough description of the district heating markets in the chosen countries; Sweden, Denmark, Finland, Lithuania and Austria. These chapters include, for each respective country, a description of market development, a description of public policy of interest for the district heating markets including legal framework, institutional settings etc. Basic conditions and market structure is then described for all countries including choice of fuel and technology, ownership and cost structures. The last part of each chapter includes a description of market conduct in each country including, for example, price development. A description of the district heating network in St. Paul, Minnesota is also included in a separate chapter.

Chapter 10 then analyzes the entire material and compares the included countries with respect to common variables and other features. Some general conclusions and suggests for future research ends the study.

Acknowledgements

We are thankful to a lot of individuals and organizations that has contributed significantly to our knowledge and understanding of the district heating markets. We wish to extend a huge thank you to all people that we have interviewed face-to-face, over the phone or over e-mail. Our work would have been impossible to finalize without your knowledge sharing and frequent opinions on all matters. We also want to thank all people that have given us access to data and other kinds of significant material, thank you all.

We are especially thankful to two persons; Giedre Nordström who helped us translate some Lithuanian reports and Erkki Koivurova that helped us translate a Finnish report, thank you both.

The responsibility for errors, misunderstandings or interpretations of data and facts are our own.

2. THEORETICAL FRAMEWORK

Network Industries

A district heating operation consists generally of a heat plant that heats water that is distributed out to the consumers through a network of pipes. The heat plant can use different kinds of fuel such as for example waste hot water, other types of waste, wood chips or pellets. Even if the use of fossil fuels is declining worldwide, oil, natural gas and coal are other examples of fuels being used. A plant can also in the same process produce electricity, a so called combined heat and power plant (CHP). A district heating operation fulfils in principle the fundamental characteristic used to describe any other network industry: the value for the consumer of connecting to the network depends on the number of people about to connect to the network or already connected to it. The fact that the value of the network is increasing with the amount of consumers connected means that the industry being scrutinized enjoys economies of scale, i.e. the average cost is decreasing with output and the amount of connected consumers. A district heating operation is however significantly different than most other physical network industry. While other networks such as for example electricity, railways and telephones are national and international, district heating operations are at the most regional but most often local. Due primarily to geography, the size of a network for hot water distribution is limited in length and the distance between different district heating operations reduce the technical possibility as well as the economic value of connecting different networks. The result is that each network generally is fed by one plant and serves a geographically limited area.

High initial sunk cost and supposedly relatively low marginal cost makes it thus less attractive to have more than one district heating network in each area. Either each consumer use district heating from the single provider or use a different system for the individual supply of heat and hot tap water such as, for example, electricity or heat pumps. As in any other network industry, once a consumer has decided to connect to one of the available networks she has imposed switching costs on herself, a switching cost that in some cases is regarded as a lock-in partly depending on the size of the switching cost and the replaceability of the available systems.

The district heating industry and market is therefore a special kind of network industry. The electricity market with its transmission and distribution network is more competitive in that many providers of electricity can feed the network and sell it on a competitive basis to the consumers. Electricity is also traded between countries. District heating markets are however small isolated, frequently local, markets without any competition regarding the feeding of hot water into the pipelines, no third party access and no trade between different networks. Still, the district heating industry and markets must be regarded as any network industry: the value of the service increases with the number of consumers, economies of scale and the presence of switching costs. It is thus an industry with high initial sunk investment cost, falling average costs, existing switching costs that is working on small isolated markets which impose the idea of district heating markets being natural monopolies. In any case of a natural monopoly situation it is common to discuss and impose some kind of regulation depending on the strength of the natural monopoly. The issue of natural monopoly is always presence in any analysis of district heating markets and it is hardly regarded as especially controversial to assess this

market structure to district heating. However, since the strength of any natural monopoly is of importance when discussing regulation etc. the following section will briefly discuss the issue of natural monopoly and district heating.

Natural Monopoly and Monopoly Strength and Relevant Markets

A company is regarded to have a natural monopoly position in a market if there are economies of scale within the entire demand range, i.e. the average cost of production is decreasing as production increases up to at least the point where all demand is satisfied. This means that one single company always can provide the entire market with the good more efficiently that two or more companies. See Figure 2.1

A non-regulated profit maximizing natural monopoly would choose a level of production where marginal cost is equal to marginal revenue according to the figure with the resulting profit equal to the shaded area. This profit maximizing price is socially inefficient in that it creates welfare losses. The level of production is too low and the price is too high with a resulting decrease in consumer surplus.

However, the market needs to be without close substitutes for a company to be able to fully exploit a monopoly power. Any close substitute decreases the monopoly power in that the consumer can switch between producers or systems. District heating companies might have the natural monopoly power concerning district heating but not when the good is defined as just heat and the market is defined as the heat market. District heating is not the only means of providing heat or hot tap water to a house, there do exist alternative systems that reduces the natural monopoly power. The question is how available these alternatives are. Not only does the ability to switch to alternative systems decrease the monopoly power, a high demand response have the same effect. Close substitutes combined with high (positive) cross price elasticity and high price elasticity does thus reduce any natural monopoly power.

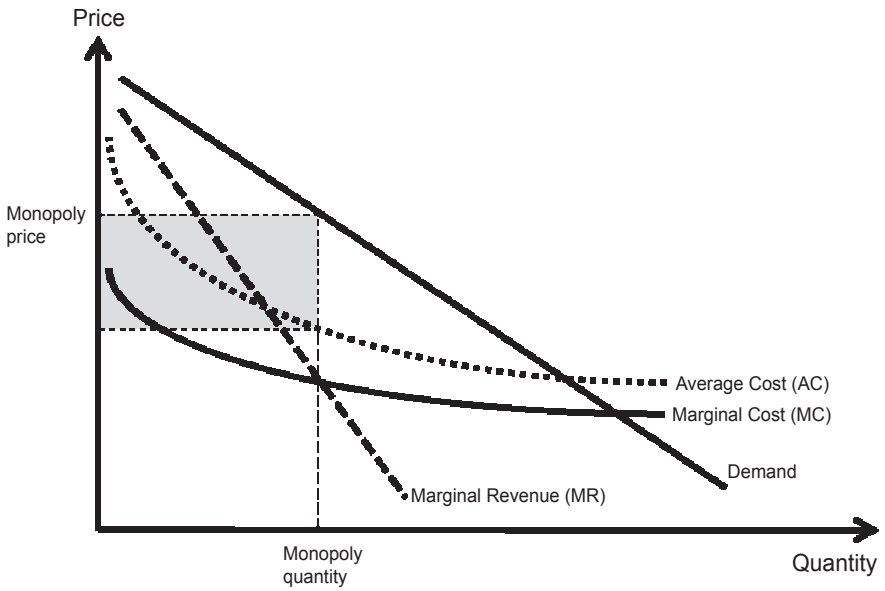

Figure 2.1 Natural Monopoly

Two main factors influence the substitution flexibility; the availability of other heat systems and the switching cost between the systems. Also, the amount of available alternative is an important factor which is influenced by, for example, geographical circumstances, presently used system and type of building, i.e. the concept of relevant market needs to be addressed. In the competition Act[1] a relevant market combines the product market and the geographic market, defined as follows:

- a relevant product market comprises all those products and/or services which are regarded as interchangeable or substitutable by the consumer by reason of the products' characteristics, their prices and their intended use;
- a relevant geographic market comprises the area in which the firms concerned are involved in the supply of products or services and in which the conditions of competition are sufficiently homogeneous.

Retail

District heating is by its described nature a local product and the district heating market itself is a natural monopoly. However, a district heating market is just one part of the total heat market including different sources of heat, like gas, electricity, oil, heat pumps, pellet burners and geothermal energy. This means that the consumers have a choice between different types of heat for their homes. Still, once the consumer has made the decision on what heating system to use there is as a risk of an "ex-post" lock-in effect[2]. It is crucial to note that the access to these different alternatives is different within countries as well as between countries.

Wholesale

It is common that the generation plant and the distribution networks are vertically integrated into one single company. However, in several cases an ability of third parties to sell heat to the main district heating company exists. The wholesale market then consists of heat generators including for instance waste heat and incineration. To ensure fairness the generation needs however to be unbundled from network operation and sales. To separate generation from transmission and distribution several models exist: ownership separation, operational separation and functional or accounting separation.

According to Sven Werner, no real case of Third Party Access (TPA) is fully working in the world[3] due to significant technical barriers and problems with the overall economical benefit. Full TPA will contain direct deliveries to customers with exact settlement of heat generation and deliveries during each hour for every producer in the network. A limited TPA is the single-buyer system, for instance when several external waste heat sources are gathered in one district heating system. According to Sven Werner, at least 5-10 producers are needed to obtain full competition.

1 Official Journal C 372 , 09/12/1997 P. 0005 - 0013
2 Hellmer, S., Switching Costs, Switching Benefits and Lock-in effects - The Swedish Market for Residential Heating
3 Werner, S., District Heating Systems Institutional Guide

Analysis model: Structure – Conduct - Performance

The structure-conduct performance model will serve as the base in the comparisons between the district heating markets in the countries included in the study. The basic idea behind this model is that a certain market structure gives a certain conduct that in turn generates the performance. Figure 3.1 illustrates the idea.

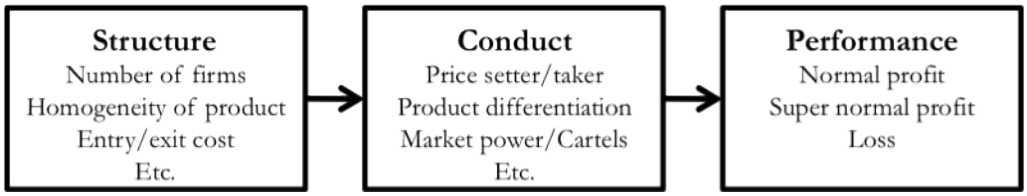

Figure 3.1 Structure – Conduct – Performance model

The performance of a company assumes, in this model, to originate from the other two factors; the competitive environment and the way each company handles the environment in which it is working. A traditional example is the basic idea of perfect competition. A very large number of companies are selling identical goods and have close to zero entry costs. The company is then by definition a price taker and the performance would probably be normal profit in that any profit above that would attract competitors with increasing supply and lower price as a consequence. In the case of super normal profit, i.e. profit in excess of the opportunity cost of capital, the reasons are usually found in the market structure and the resulting conduct.

The outcome of an analysis according to the described model has implications for social welfare. Studying the four market structures perfect competition, monopolistic competition, oligopoly and monopoly roughly, the resulting implications for social welfare are summarized in table 3.1. Social welfare is maximized in perfect competition and usually has the worst outcome in the monopoly case. The outcomes of monopolistic competition and especially oligopoly are highly uncertain. Product differentiation, contestable markets, game theoretical issues, cartels are features that can signify the oligopoly situation making a general conclusion regarding its effect on social welfare almost impossible.

Table 3.1 Social Welfare and Structure – Conduct - Performance

Structure	Conduct	Performance	Social Welfare
Perfect competition	Price taker	Normal profit	Maximized
Monopolistic competition	Product differentiation	Above normal	Less than for perfect competition
Oligopoly	Differentiation Cartel, etc.	Normal to above normal	Unsure
Monopoly	Price setter	Above normal	Less than for monopolistic competition

Source: Barney, 2001

The relationships shown in Figure 3.1 and in Table 3.1 are however too simplistic. More modern versions include, for example, "feed-back" effects and the importance of institutional settings or public policy. Today the SCP model is no longer the foundation for theory and empirical work in industrial economics[4]. But the model as such is for the purpose here still attractive because of all the built in features in the model. All these features are in this study used to compare markets and markets solutions in different countries.

The Structure – Conduct – Performance concept and District Heating

Figure 3.2 shows how the above concept is developed for making comparisons between different countries with respect to district heating. Aside from structure, conduct and performance, two more features are added; basic conditions and public policy.

Basic conditions and Market structure

Basic conditions are somewhat exogenous conditions that every company or any other actor in the market are exposed to and affect the market structure. These basic conditions are different in different countries and are therefore important for the companies in each of the chosen countries. Some of the basic conditions that need attention are, for example, the choice of and availability of different fuels (i.e. gas, waste, coal, oil, bio) the available and chosen technology (i.e. CHP), the eventual availability of substitutes for district heating, (i.e. heat pumps, natural gas, oil, electricity) and the rate of growth of the district heating market. Another basic condition is the need of balancing district heating systems.

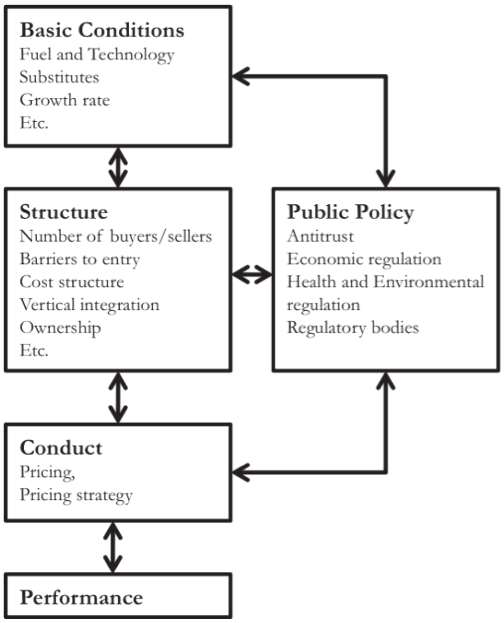

Figure 3.2 Structure – Conduct – Performance and District Heating

4 Viscusi, W.K. et al. Economics of Regulation and Antitrust

The market structure of the relevant market is characterized by the number and size of the buyers and sellers, barriers to entry of new firms, the shapes of cost curves and the degree to which firms are vertically integrated. Another important parameter is ownership. Sven Werner has identified four main alternatives of ownership models for District heating utilities[5]:

- Full public control by the state or municipality
- Full private control
- Mixed ownership and management – public and private
- Not-for-profit community-owned cooperatives

As being pointed out, district heating markets are special markets in that they are local with no trade or other exchanges between the local networks. This means, among other things, that special features in one network do not in any way either influence or put any market pressure on any other network in the close or distant vicinity. This means also that every district heating company and network has a natural monopoly for district heating in a specific area. As also discussed, the strength of this natural monopoly depends on the availability of substitute products and alternative ways of heating an area or as a provider of hot tap water. Depending on how the market is functioning, the availability of alternative, different public policies, the strength of the natural monopoly is presumably very different between countries as well as within a country.

Market conduct

Market conduct in the district heating market refers mainly to pricing and pricing policies. The suppliers of fuel to the district heating market may face buying power (countervailing power) from district heating companies. This may happen when the district heating company is the only buyer to for instance waste heat. Another situation when countervailing power may come up is when the district heating company faces a strong buyer in for instance the public sector.

Public policies

The importance of public policy is also added. The presence or non-presence of taxes and subsidies on district heating influence the market and the market conditions. The district heating markets in some countries are regulated while it is a totally free market in other countries. This fact surely influences the market conditions as do the choice of regulatory model. The presence of other types of price controls or market surveillance is also important in the analysis as is the antitrust laws. Public policy might also be of the form of technology support and many different authorities with different goals might be involved.

5 DHCAN project, District Heating Systems Ownership Guide

Market performance

Based on quantitative and qualitative data and information regarding all the factors in Figure 3.2, the report will focus on the functioning of markets in different countries. Having a market structure of natural monopolies with different strengths and presumably high barriers to entry the report pays special attention to pricing and pricing strategy, substitute availability and relative prices as well as marketing strategies.

Public policies play most often an important role in these matters. The presence of regulation reduces the monopoly strength in a magnitude dependent on the type of regulation. Antitrust laws, price control and market surveillance have also an impact on market performance. The presence of authorities like energy agencies promoting technology shifts towards increased use of renewable fuel also have impacts on the market's way to function.

Natural Monopoly and Regulation

From a social point of view, the price should reflect the marginal cost of production. The consumer surplus and the producer surplus are in that case maximized and no excess profit is transferred from the consumer to the producer. This is at least the theoretical outcome of perfect competition.

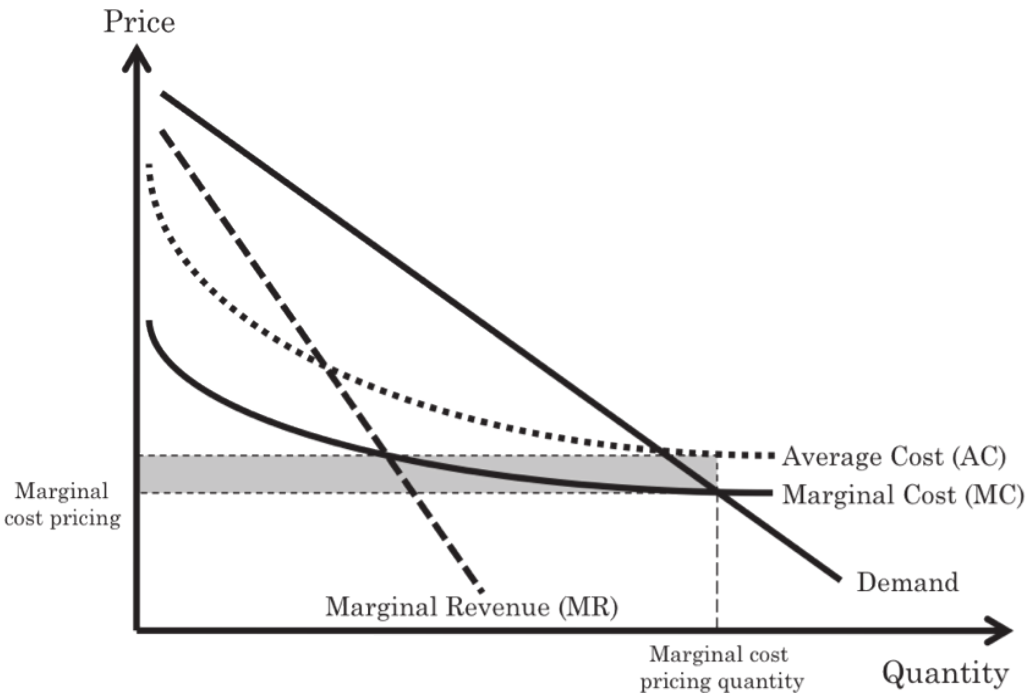

Figure 2.2 Marginal cost pricing and natural monopoly

There is, however, a crucial problem with marginal cost pricing in natural monopoly. Since the average cost, and thereby the marginal cost, is decreasing throughout the entire demand range any attempt to set price equal marginal cost will result in an economic loss according to the shaded area in Figure 2.2.

The profit maximizing behavior results in a social inefficient production while a price according to prefect competition results in an economic loss. This illustrates the dilemma of the regulator for any natural monopoly. The general "middle" solution is represented by the output Q_R and the price P_R in Figure 2.3.

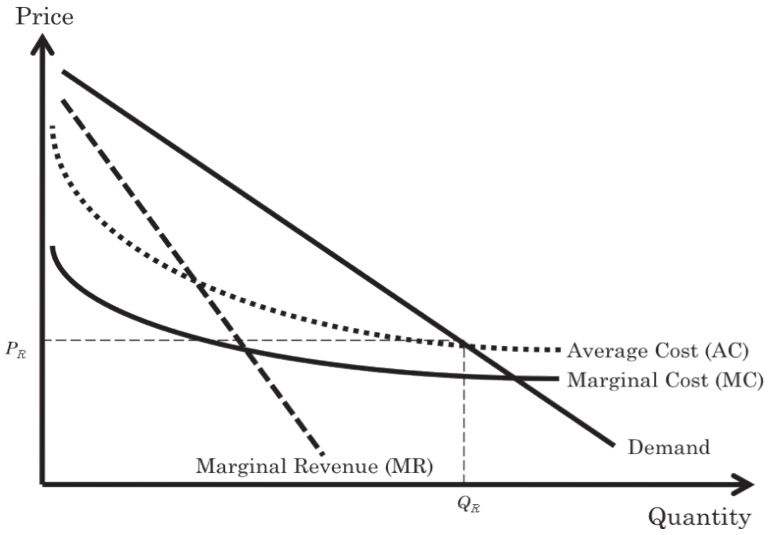

Figure 2.3 Ramsey Pricing in Natural Monopoly

This combination of price and output where price equals average cost is known as the Ramsey price, a price that is maximizing social benefits subject to non-negative profits. To regulate a natural monopoly with Ramsey pricing seems easy enough. However, one major issue makes it difficult; to determine the long run average cost which at least normally should include a "normal" rate-of-return on invested capital. Without going too deep into the problems of assessing the content of the long run average cost, three price regulation forms will here get some special attention: rate-of-return regulation, price-cap regulation and other incentive regulation.

Rate-of-Return Regulation

This type of regulation ensures firms to receive a minimum rate of return on capital. The regulator fixes the required rate of return on capital *r*:

$$r = \frac{Total\ revenues - Total\ costs}{Capital\ employed}$$

The firms are thus guaranteed r in that the regulator allows firms to set a price which cover costs and a mark-up to allow an updating of the equipment. Prices are usually reviewed frequently under this regulation.

Price-Cap Regulation

This type of regulation places a maximum limit on the price that the firm can charge and it is usually in the form of a retail price index (RPI) minus an "X" factor. The RPI

factor represents the inflation and the "X" factor represents the expected productivity gains during a specified time. If, for example the inflation is expected to be 5% the upcoming period and the productivity gain is expected to be 4% then the industry is allowed to increase prices by 1% during the period. Any cost savings is thus passed on to the consumers while on the same time the firms have an incentive to even more increase productivity and keep any additional saving. Depending primarily on the regulatory time for fixed RPI and X this regulation contains some incentives for the firm. The longer the tine span the higher the incentives to do better than X. In this sense price-cap regulation can be seen as an incentive regulation, which is a far broader concept than just a usual price-cap regulation.

Other Incentive Regulations

The idea of incentive regulation is to keep the firm's incentives to profit maximize and improve productivity etc. in spite that the firm is regulated. Price-cap regulation is usually mentioned as the most common incentive regulation, but there are more. Profit sharing, for example, is a regulation in which costumer directly participate in excess profit. Banded rate-of-return regulation lets the firm keep excess profit within a specified band. Only rates-of-returns outside the band trigger the regulator to bring the firm back into the specified band. Yardstick regulation makes the prices the regulated firm can charge dependent on the performance of other firms.

The position of district heating in the EU policy framework

District heating is not directly regulated in the EU policy framework. However, district heating is addressed in current legislation just as in draft legislation. District heating is mentioned in all energy efficiency plans and is eligible for support programs. Examples of EU directives relevant for district heating:

- Emission Trading Scheme (ETS) based on Directive 2003/87/EC The European Parliament wants from 2012 that electricity generators shall receive free allowances for district heating.
- The Buildings Directive 2002/91/EC. This directive includes a common method to calculate the energy performance of buildings. It sets minimum energy performance standards to new buildings and existing buildings being refurbished.
- The CHP Directive 2004/8/EC. A framework for promotion of cogeneration.
- The Energy Services Directive 2006/32/EC. A directive for energy end-use efficiency and energy services. It includes an indicative energy savings for the Member States, obligations on national public authorities as regards energy savings and energy efficient procurement, and measures to promote energy efficiency and energy services.

One explanation why district heating is not directly regulated in EU is that the district heating in Europe mainly consists of local markets and therefore doesn't fall within the competence of EU.

National public policy

To describe the national public policy it is possible to divide it in different categories. A simple classification is between

- competition-based approach including direct competition between district heating and other heat sources and competition between heat producers at the wholesale level, e.g. Sweden and Finland
- regulatory approach including district heating zones, tariff regulation and energy plans, e.g. Denmark

Sven Werner describes the national policies in three broad categories:

- countries with no specific district heating legislation but with some fiscal levers e.g. Sweden
- countries with no district heating legislation nor fiscal instruments e.g. Finland, Romania, and Germany
- countries with specific district heating law e.g. Denmark, Lithuania, Hungary, Estonia.

Another way of dividing public policy is on basis of the purpose:

- Market driven regulation, including control by antimonopoly services, e.g. Sweden, Finland
- Social regulation, including for instance unified heat prices orientated to economical power of consumers and set by municipality, ministry or some other state institution e.g. China, Russia
- Economical regulation, including price regulation separated from ownership and that the consumers have to pay reasonably costs for the heat supply, e.g. Lithuania

The countries involved in this study have different designs of government authorities of significance for the district heating markets. Examples of government authorities besides ministries are Competition Authority and Energy Agency.

Outline

Each of the following chapters contain a description of each country with respect to relevant variables defined by the Structure – Conduct – Performance model described in this chapter. We will cover the market development in each country as well as the public policy and legal framework of interest for the district heating markets. The chapters will also cover and describe the basic market condition in each country such as, for example, technology and fuel mix, number of companies and plants as well as ownership conditions. Market conduct and performance including a presentation prices will also be included.
The final chapters will summarize the country data and compare the markets in the included countries with respect to, for example, market solution, regulatory issues as well as price and technology evolvement over time.

3. SWEDEN

The first district heating system in Sweden came into operation in 1948 in the city of Karlstad (Frederiksen & Werner, 1993). The general assumption then was that the hydropower capacity was close to its maximum which increased the need of combined heat and power plants. The oil crisis in the 1970's also implied the need of new district heating plants, often relatively small, which aimed to reduce the need for oil as a source of heat. Later in the 1970's and 80's the introduction of nuclear power in Sweden reduced the need of combined heat and power plants with a following focus on heat only plants. However, the low prices for electricity worked in favor for using electricity for heating both as space heating in houses and also as fuel in district heating plants. It was first after the de-regulation of the electricity markets in the 1990's and later in the 2000's that electricity prices increased which turned an increased focus on district heating and combined heat and power plants (Frederiksen & Werner, 1993). Table 3.1 summarizes some facts for the Swedish district heating sector in 2005.

Table 3.1 Basic facts for Swedish District Heating Sector, 2005

Number of DH companies	131
Number of CHP DH plants	49
Maximum heat output capacity (exclusive industrial contribution)	29 000 MW
With combined heat and power production	6 000 MW
Without power production	23 000 MW
Fuels used for DH	
coal	5 %
oil	5 %
natural gas	3 %
waste	12 %
renewable	40 %
other fuels	35 %
Heat delivered with electricity production	19,4 TWh
Heat delivered for industrial use	13,3 TWh
Heat delivered by industry to the pipeline systems	6,4 TWh
Heat delivered to consumers	47,5 TWh
Total route length of DH pipeline system	14 700 km

Source: Country-by-country report 2007, Sweden

Market Development

The total energy use for heating and for hot water in Sweden has decreased from slightly above 90 TWh in the year 2000 to slightly below 80 TWh in 2006. District heating is the dominant source of heat and hot water and the share of oil is steadily decreasing, see figure 3.1.

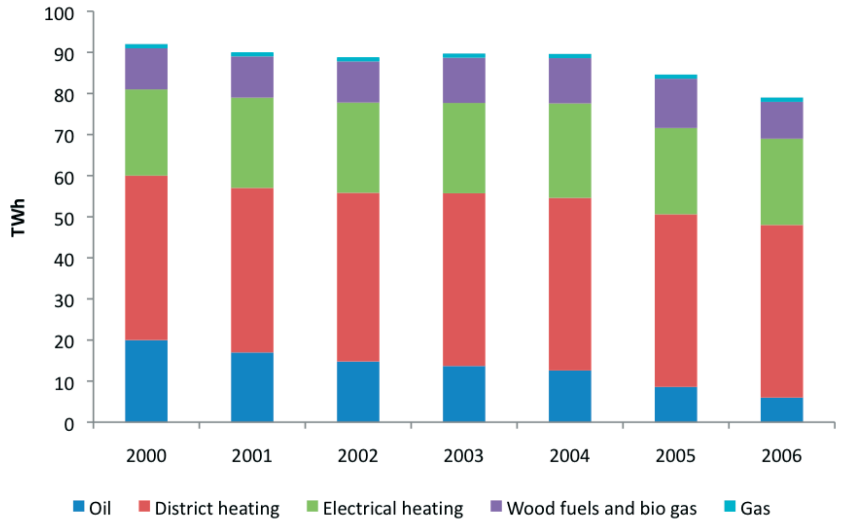

Figure 3.1 The heat market in Sweden 2000-2006 in TWh

Source: Swedish Energy Agency and SCB

Over 50% of the total market for heat was provided through district heating in 2007 which is an increase from approximately 22% in 1978 (Swedish Energy Agency). This increased share for district heating has taken place primarily on the expense on the use of oil and, since the beginning of the 90s, also on the expense on the use of electrical heating both the use of electrical panels and the use of water based electrical heating (Andersson & Werner, 2003).

District heating is the most commonly used system in residential and public buildings, making up for around 90% of space heating and the provider of hot water with industrial buildings representing the remaining 10%. Figure 3.2 depicts the total production and consumption (the difference being representing heat losses) of district heating from 1990 to 2007 divided on industry and residential and public buildings.

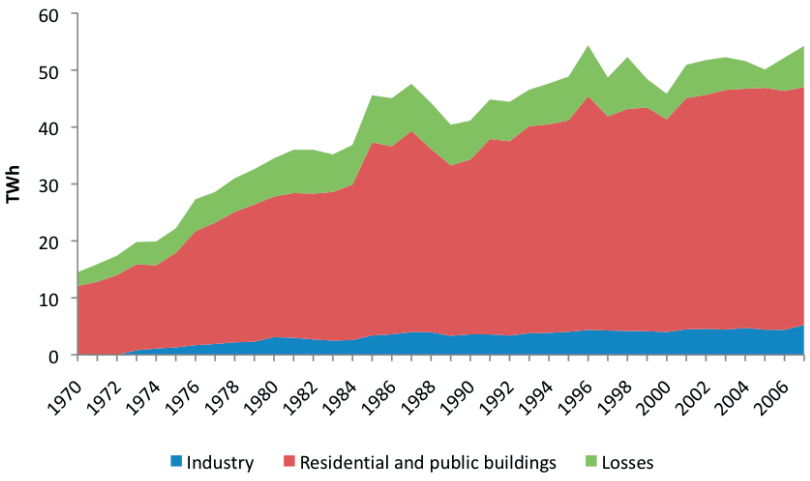

Figure 3.2 District heating production and usage in Sweden 1970-2007 in TWh

Source: Swedish Energy Agency

Public Policy and Legal Framework

No price regulation

The Swedish market for district heating is a unregulated market. Prior to the de-regulation of the energy markets January 1, 1996 all district heating plants and distributing networks was owned and operated by each municipality. Then the district heating "companies" acted under the municipality law stating that no municipality owned company are allowed to make a profit, a type of price equal cost regulation with no specific target on district heating, just the ownership condition.

After the de-regulation all companies engaged in the energy sector is supposed to operate in a business-like manner. There is one exception, energy transmission and distribution, which is regarded to be a natural monopoly and has as such to undergo regulation. This means that the earlier municipality law is replaced by the electricity law with the above business-like condition so after January 1 1996 pricing of electricity, natural gas and district heating is free. Many previously municipality owned district heating plant and network have since then been sold to private operators such as FORTUM, E.ON and Rindi as well as the state owned Swedish company Vattenfall.

Legal Framework

As any other industry or market, the district heating market has to comply with the competition act. Being an unregulated natural monopoly the most important part of the competition act for this market is the prohibition against abuse of a dominant position. Such abuse may in particular consist of: directly or indirectly imposing unfair purchase or selling prices or other unfair trading conditions; limiting production, markets or technical development to the prejudice of consumers; applying dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage; or making the conclusion of contracts subject to acceptance by the other parties of supplementary obligations, which by their nature or according to commercial usage, have no connection with the subject of such contracts. It is up to the Competition Authority to prove that a company may have abused its dominant position.

A new law on district heating came into action on July 1, 2008. This new law (SFS 2008:263) aims at strengthen the consumer's position in the market through an increased transparency into the district heating companies. This will take place partly with higher demands and clarifications on the conditions in all formal agreements between buyers and sellers, rules around obligations to negotiate, protections against stoppage, transparent and clear price information and the use of open accounts of all facts regarding district heating companies operations and finance.

According to the Ministry of Enterprise, Energy and Communications, the law aims at maintaining the unregulated heat market at the same time as the consumer's position is strengthened. A district heating board is also established that has as its major task to mediate in negotiations according to the new district heating law.

System Conversion Subsidies

Even if there are no price regulation in place for district heating some subsidies concerning stimulating the conversion from oil or electricity panels to district heating as well as the

use of primarily different heat pumps are in place. The law (SFS 2006:125) states that the subsidy can be given to single and double household houses as well as to residential buildings and "other types" of buildings, which usually means official buildings. The law started on the first of January 2006 and runs through to December 31 2010. The total amount of subsidies to be handed out during this period is set to 1.5 billion SEK.

A subsidy support is given to conversions from electricity panels to district heating, heat pumps or the use of some sort of bio fuel such as chips or pellets, conversion from an oiled based heating system is no longer subsidized only replacement of electricity panels. For conversion to heat pumps of any type subsidies are given only if the electricity consumption during peak hours is at maximum 35% of the total heat demand per building. For a conversion to district heating subsidies are given to the cost of material for the distribution system (rebuilding to water based heating system), radiators and heat exchangers with main central. For conversion to a bio fuelled system subsidies are given for the cost of material for water based distribution system, radiators, chimney and equipment for accumulation. In this case the bio fuel must represent at least 70% of the total heat demand per household.

Up to 30% of the cost of material and labour are subsidised with a maximum amount of SEK 30 000. These subsidies are very unevenly spread throughout the country with a strong bias towards counties and municipalities with low cost district heating and high proportion of earlier usage of electricity panels, thus the conversion also included a change to a water based in-house distribution system.

Government Authorities of Significance for the District Heating Market

One of the significant institutions for the district heating markets is the *Swedish Energy Markets Inspectorate*, the regulator which is a government authority that works for efficient energy markets. The Inspectorate's operations are regulated by the Government through the Agency's instructions. The guidelines for current operations are set out in our annual appropriation directions. The aim of the Government's energy market policy is to promote efficient markets with well-functioning competition that ensure a reliable supply of energy at internationally competitive prices. This means that efforts have to be made to establish markets where the utilization of resources and price formation are efficient.

The Inspectorate serves as the direct regulator of electricity transmission and distribution since this is to be regarded as a natural monopoly. In addition, the Inspectorate's department for market surveillance and the department for market analysis continuously follow the market for district heating and produces once a year the "heat report" which includes a large section on the competitiveness and competitive position of district heating versus available substitutes. In the latest reports (2007 and 2008) the Inspectorate expresses the eventual use of the natural monopoly situation in some parts of Sweden and "problematic" and in a letter to the Swedish Competition Authority, dated 2008-10-06, the Inspectorate's Director-General expresses the eventual need of future regulation in order "to strengthen the position of the costumers". The Inspectorate has also from August 2008 a special coordinator for issues regarding district heating.

The *Swedish Energy Agency* is another important and significant authority for the

district heating market. The Energy Agency was formed in 1998 and works primarily towards transforming the Swedish energy system into an ecological and economically sustainable system. This is done in collaboration with the industry, energy companies, municipalities and the research community. As well as promoting new energy techniques and energy production, the Swedish Energy Agency maintains comprehensive research funding in order to make energy use more effective. The authority is in charge of significant areas of the system of certification in electric energy services, which will promote production of electricity from renewable energy sources. In addition, the energy agency makes special contributions to wind power.

In collaboration with the municipal energy advisors and the regional energy offices the agency disseminates knowledge and information so that consumers, industry and the public sector are stimulated toward the area of more effective energy use. The authority also works towards promoting the introduction on to the market of new energy-effective techniques.

The Swedish Energy Agency supervises net companies in accordance with electricity regulations as well as supervising the natural gas market. The agency also monitors and analyzes the electricity market and play an expert role in issues relating to the sale of electricity.

On July 1, 2008, the Swedish Energy Agency set up an independent district heating board. This board's major task is to mediate between district heating companies and their customers in negotiations regarding the terms according to the district heating law (SFS 2008:263). The board is also supposed to mediate in negotiations between district heating companies that want to access the network.

The *Swedish Competition Authority* upholds the competition act that contains prohibitions against anti-competitive co-operation and abuse of a dominant position. The Act also contains rules governing concentrations between undertakings. The Competition Authority works closely with both the Energy Agency and the Inspectorate in matters related to energy markets.

The *National Board of Housing, Building and Planning* is the central government authority for the planning and management of land and water resources, urban development, building and housing under the Ministry of the Environment. The Authority monitors the function of the legislative system under the Planning and Building Act and related legislation and proposes regulatory changes if necessary. To ensure effective implementation, the Authority also provides information to those engaged in planning, housing, construction and building inspection activities. The National Board of Housing, Building and Planning as a Division of Building Construction under which there is a Subsidy Unit. This unit administrates and supervises the national financial support to buildings and thus the conversion subsidies discussed in an earlier section. It also issues regulations and provisions for this support. Most grants and subsidies are granted by the county administrations and they range from energy efficiency improvements, reduction of radon radiation and reduction of electricity heating to subsidies for student housing and barrier free homes. The total annual amount for these purposes is around .2 billion Euros. The subsidies are distributed from the Authority, which also decides on appeals against such decisions and makes evaluations of the effects of the subsidies.

Basic Conditions and Market Structure

Fuel and Technology

During the time period from 1970 to 2007 the total production of district heating increased from around 15 TWh to almost 55 TWh. The fuel mix has during the same time changed significantly. Even if the use of bio fuels in the 1990s was relatively high, so was the use of coal and electrical boilers. As seen in figure 3.3, the use of bio fuels are clearly dominating in 2007, making up for almost 70% of the fuel for generating district heating. The use of oil, coal and natural gas is constantly decreasing as is the use of electrical boilers which is almost down to zero now in 2007.

Almost 40% of the district heating production, i.e. around 20 TWh, in 2005 produced in CHP-plants a share that is increasing, see figure 3.4. The amount of electricity produced in CHP-plants is however still marginal compared to the total Swedish electricity production.

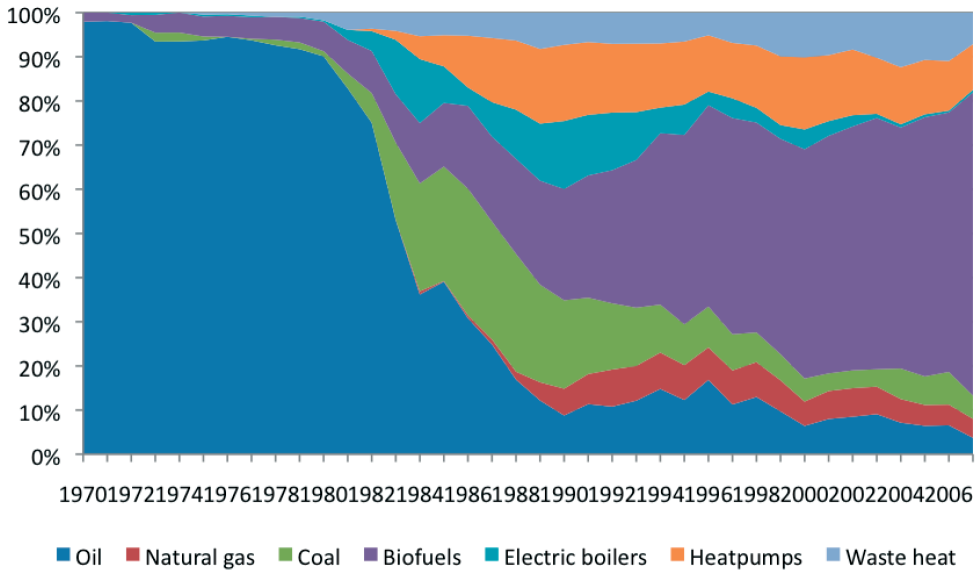

Figure 3.3 Share of fuel usage of total production in Sweden 1970-2007

Source: Swedish Energy Agency

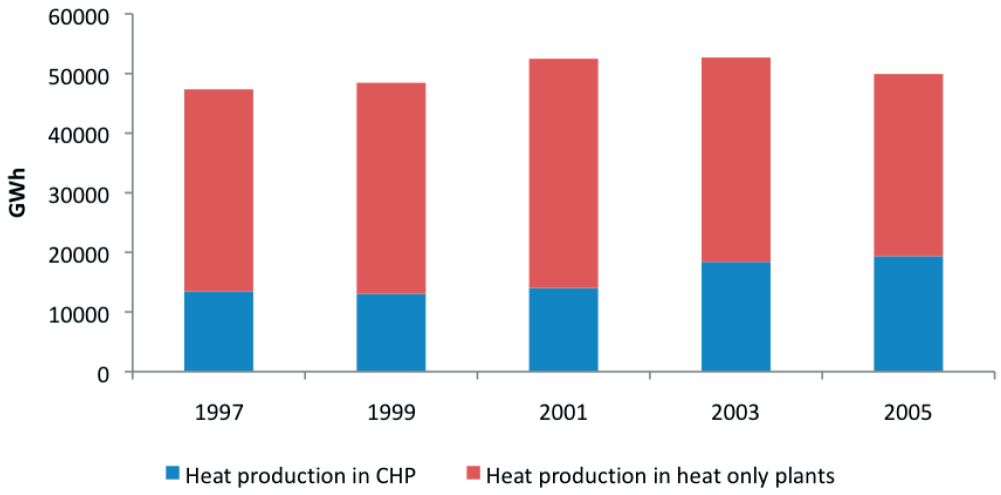

Figure 3.4 Production of district heating in CHP-plants and heat only plants, selected years in GWh
Source: Country-by-country survey, 2007

Figure 3.5 shows that the electricity production in CHP-plants is slowly increasing, from around 5 200 GWh in 2002 to 7 200 GWh in 2008. This means an increase in share from around 3% to slightly below 5% of total electricity production which in Sweden is dominated by hydropower and nuclear power which together stand for almost 90% of the electricity production.

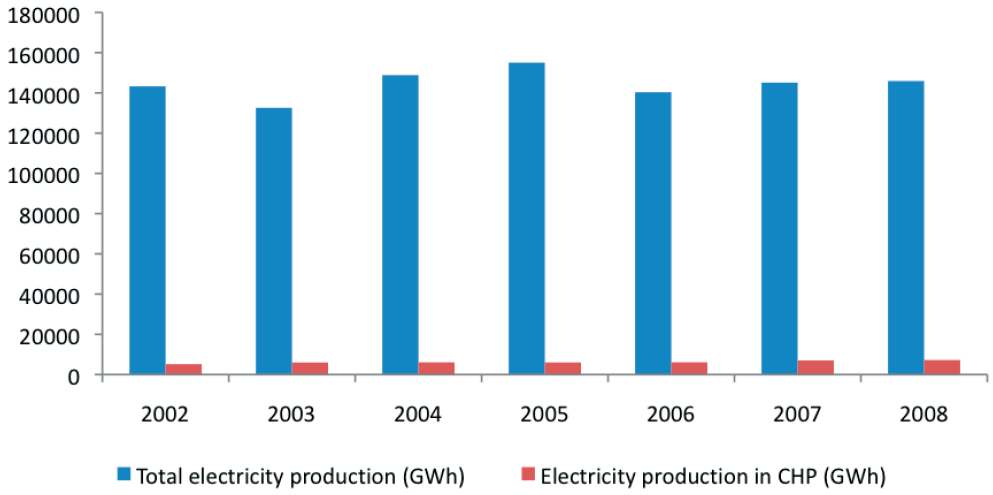

Figure 3.5 Total electricity production and electricity production in CHP-plants 2001-2006 (GWh)
Source: Swedish Energy Agency

Although the total usage of energy for heating and hot water is decreasing, most probably due to efficiency gains, the market for district heating in Sweden is a growing slowly and had in 2007 a market share exceeding 50%. Bio fuels are the dominating

fuels used for district heating generation with a share of 70% and increasing. More than half of the heat produced in district heating plants is produced in CHP-plants and the share of electricity produced in CHP-plants is slowly increasing and was in 2007 just below 10%.

Market Structure

The 2005 statistics regarding the members of the Swedish District Heating Association, which cover 98% of the entire market, provides a detailed picture of the condition in the market. Sweden had in 2005 344 district heating networks operated by 133 companies. The combined length of all the networks was 14 700 km. Table 3.2 summarize some facts for a number of significant companies regarding the number of networks (5 or more) or heat production (over 1 000 GWh).

The Finnish company Fortum is by far the largest single provider of district heat in Sweden (15.6% market share) mainly because it is serving Stockholm. The German company E.ON is also a significant player with a large number of networks and as it is serving Malmö, also with respect to heat production. Vattenfall, the Swedish state owned company and the municipality owned company Göteborg Energi, are of almost equal size with respect to heat production. Göteborg Energi serves Gothenburg and Vattenfall's major area of service is Uppsala north of Stockholm.

Table 3.2 Number of networks and fuel consumption 2005 for some chosen companies

Company	Number of networks	Fuel consumption in GWh
Fortum	13	9172
E.ON	42	6400
Vattenfall	25	4364
Rindi	11	308
Göteborgs Energi	2	4289
Skellefteå Kraft	12	783
Jämtkraft	13	740
Tekniska verken Linköping	3	1666
Umeå Energi	5	967
Öresundskraft	1	1294
Other	217	28877
Total	344	58860

Source: Swedish District Heating Association

Of the companies in table 3.2, Fortum, E.ON and Rindi are private actors, Vattenfall is state owned while the rest of the companies (including the row others) are municipality owned companies. Table 3.3 shows how the number of networks and fuel consumption is divided on ownership (Vattenfall is included in private companies).

In 2006 the total number of district heating costumers was almost 287 000. As one residential building is regarded as one costumer, single household buildings dominate in number of costumers. Sweden had in that year 208 000 costumers living in single houses and

approximately 50 000 residential buildings, the rest being "other premises" and industries.

Table 3.3 Ownership on network and fuel consumption, 2005

Ownership	Number of networks	Fuel consumption in GWh
Municipality owned companies	253 (74%)	38 616 (66%)
Private companies	66 (19%)	15 818 (27%)
State owned	25 (7%)	4364 (7%)
Total	344	58 860

Source: Swedish District Heating Association

The picture for district heating deliveries on costumer groups is different. Figure 3.6 shows how the final use of the delivered heat in 2006 was distributed. Over 50% of the delivered district heating was delivered to multifamily houses. In spite the fact that one- and two-family houses makes up more than 70% of the subscribers, less than 10% of the delivered heat is for this category.

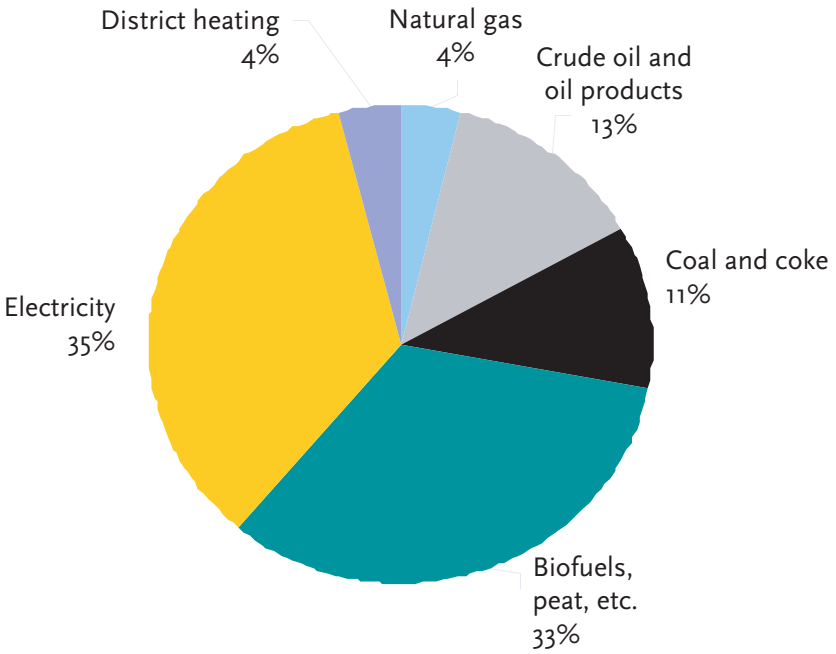

Figure 3.6 Proportion of deliveries and proportion of subscriptions 2006
Source: Swedish Energy Agency

Even if the amount of district heating costumers living in single houses is by far the largest in comparison with other residential forms, district heating is not the most common used system in one- and two-family houses. If more than 70% of the area in residential buildings was heated with district heating in 2006 the same number for single households was limited to 10%. Instead it is different sorts of and combinations of heat pumps that dominates the market for single houses. Table 3.4 shows the figures for 2003 and 2006.

Table 3.4 Percentage share of heated area in single houses on heating system

Heating system	2003	2006
Oil	9%	3%
District heating	8%	10%
Electricity	29%	31%
Heat pumps	17%	32%
Others	37%	24%

Source: SCB

Dominating systems for providing heat and hot water are thus heat pumps, electricity and district heating. Also worth mentioning are wood based and pellet based burners (included in "others" in table 3.4). District heating in Sweden has faced increasing competition from two obvious close substitutes; heat pumps and pellet burners. The amount of yearly sold heat pumps to small houses is show in figure 3.5.

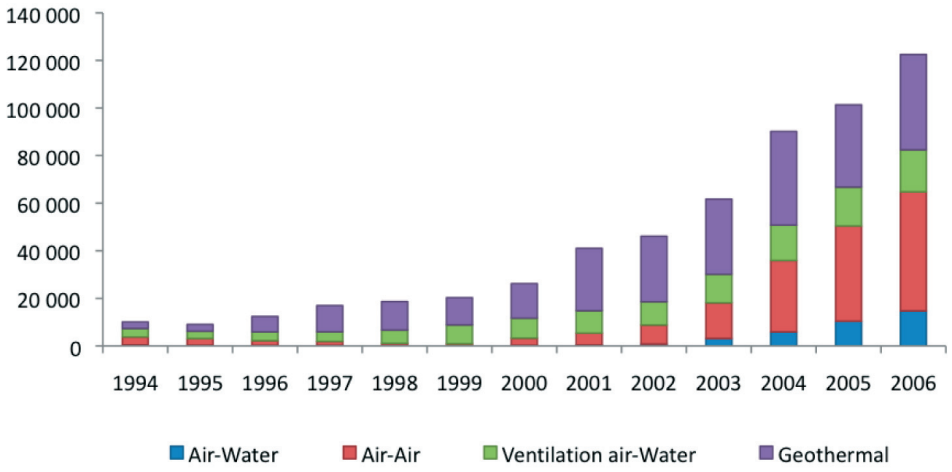

Figure 3.7 Yearly sold heat pumps to small houses

Source: The Swedish Heat Pump Association (SVEP)

The upward trend for both types, especially for geothermal pumps, is clear. Data for the number of sold pellet burners are not available, but the National Association of the Pellet Industry (PIR) has estimated the amount of sold pellets to small houses. The numbers, depicted in figure 3.8, show a similar trend as for the amount of sold heat pumps.

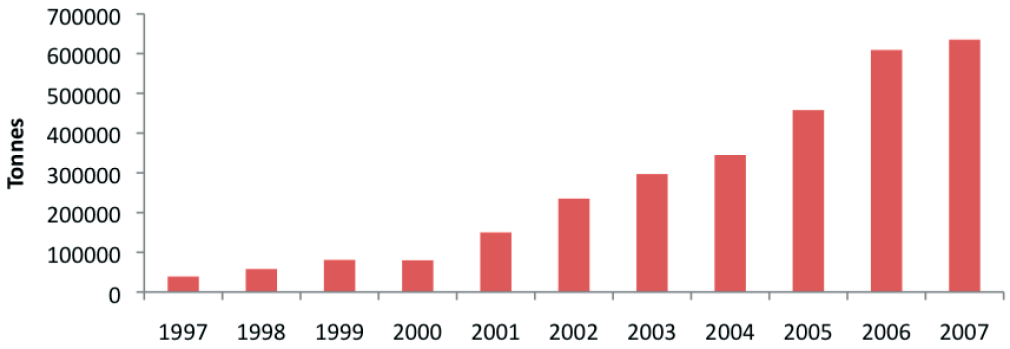

Figure 3.8 Tonnes of sold pellets to small houses, 1997-2007

Source: National Association of the Pellet Industry (PIR)

Starting in 2008, the Swedish Energy Markets Inspectorate demands and receives financial data for the Swedish district heating companies. The data available now in 2008 concerns the fiscal year 2007 and consists of 185 companies of which 172 was completed by the time of this study. Figure 3.9 shows the revenue structure and figure 3.10 shows the cost structure.

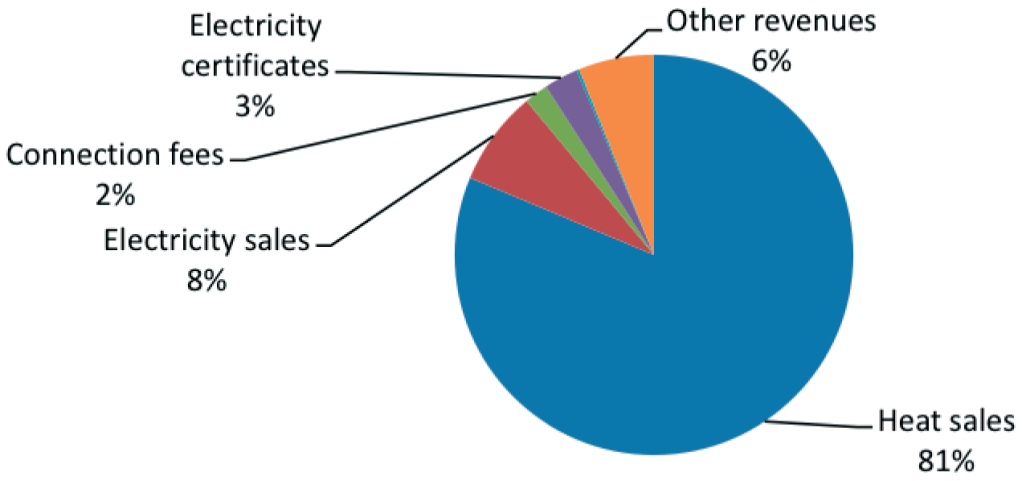

Figure 3.9 Total revenues for 172 reporting district heating companies in Sweden 2007
Source: Swedish Energy Markets Inspectorate

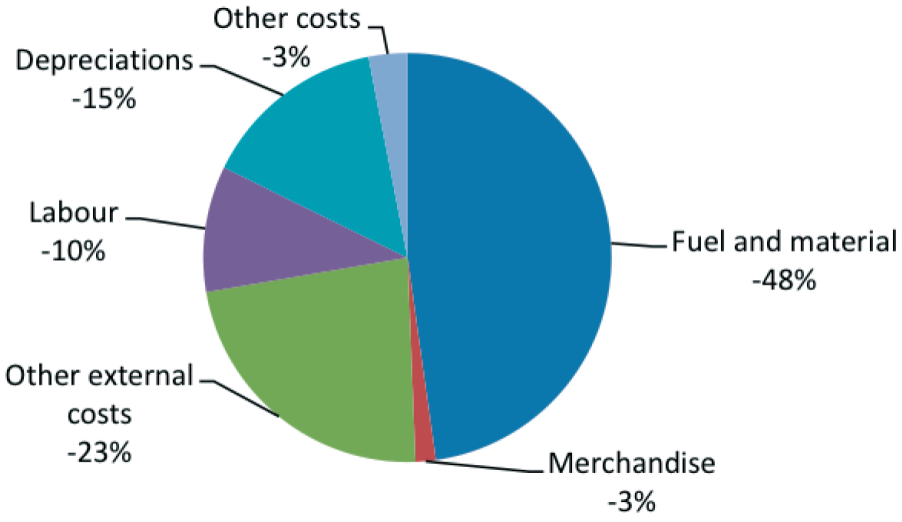

Figure 3.10 Cost structure for 172 reporting Swedish district heating plants 2007
Source: Swedish Energy Markets Inspectorate

Based on the information from 172 companies almost 80% of the revenues for the district heating industry come from selling the heat itself. The second largest source of revenue is from electricity sales from CHP-plants while revenues from connection fees, electricity certificates and emission permits are marginal.

As expected, it is the cost of fuel that constitutes the dominant part of the costs for a district heating company. A side from "other external costs" it is the cost of labour and depreciation that together makes up around 25% of the costs.

All Swedish district heating companies are vertically integrated, i.e. all companies own and operate both the district heating plant and the network. Still there exists some kind

of wholesale market between certain district heating companies and nearby industries that in their respective production produce waste heat that can be used as input in a district heating plant. This waste heat, in for example the form of hot waste water or gas, is a residual product that has no obvious alternative use for its producer but can be used as a valuable input in the production of district heating. Note that waste heat defined here does not include hot water generated in electricity production may it be in combined heat and power plants or steam condensing power.

Table 3.5 depicts the district heating operations and their main supplier of waste heat for those operations using at least 50% waste heat in their operations.

Table 3.5 DH-operations using at least 50% waste heat and their respective supplier, 2005

Company	Net	Waste heat usage (GWh)	Percent waste heat	Main supplier of waste heat
Oxelö Energi AB	Oxelösund	97	100	SSAB Oxelösund
E ON Värme Sverige AB	Rundvik	2	100	Rundvikssågen
E ON Värme Sverige AB	Bollstabruk	6	100	Mondi Dynäs
Vattenfall AB	Vänersborg	143	100	Vargön Alloy
Norrtälje Energi AB	Hallstavik	17	100	Hallsta pappersbruk
E ON Värme Sverige AB	Mönsterås	53	100	Södra Cell Mönsterås
Perstorps Fjärrvärme AB	Perstorp	41	99	Perstorps AB
Skellefteå Kraft AB	Ursviken	29	99	Rönnskärsverken
Lysekils Energi AB	Lysekil	44	99	Scanraff
E ON Värme Sverige AB	Timrå	75	98	SCA Östrand
E ON Värme Sverige AB	Broby	4	98	Tarkett
PiteEnergi, AB	Piteå	200	98	Smurfit Kappa Piteå
Luleå Energi AB	Luleå	732	96	SSAB Luleå
Linde Energi AB	Frövi	15	94	Korsnäs Frövi
Stenungsunds Energi & Miljö	Stenungsund	61	94	Perstorp Oxo
Karlshamn Energi AB	K-hamn, Asarum	140	91	Södra Cell Mörrum
Älvkarleby Fjärrvärme AB	Skutskär	24	90	Skutskärs Bruk
Linde Energi AB	Vedevåg	5	88	Korsnäs Frövi
Linde Energi AB	Lindesberg	66	87	Korsnäs Frövi
Varberg Energi AB	Varberg	87	83	Södra Cell Värö
Gotlands Energi AB	Slite	17	75	Cementa
Ulricehamns Energi AB	Ulricehamn	28	73	BrikettEnergi AB
Göteborg Energi AB	Göteborg	2572	61	Raffinaderier
Hammarö Energi AB	Skoghall	20	58	Stora Enso
Köpings Kommun	Köping	122	57	Yara
Göteborg Energi AB	Ale	40	57	Nearby industries
Smedjebacken Energi AB	Smedjebacken	26	55	Ovako
Strängnäs Energi AB,	Åkers styckebruk	7	50	Åkers
		4672		
Others (30 companies)		1672	1 - 49%	
		6344		

Source: Swedish District Heating Association

These operations used in 2005 4695 GWh of waste heat and the total use of waste heat were 6367 GWh. This means that of the total usage of fuel in 2005 which was 58860 GWh, around 11% was waste heat.

The largest user of waste heat is Göteborg Energi which use 2572 GWh of waste heat, 61% of its total fuel usage. The waste heat used by Göteborg Energi comes primarily from oil refineries close to Göteborg. Other large users of waste heat comprise Luleå Energi in Luleå and PiteEnergi in Piteå which both use almost 100% waste heat from a nearby steel mill and paper mill respectively.

Market Conduct and Performance

Since the market for district heating doesn't consist of one single market but rather a number of different more or less isolated local markets, one single price cannot be observed. Figure 3.11 depicts the nation average price in SEK/kWh for the years 1997-2007. The market was deregulated in 1996 and was stable for a couple of years. Starting in 2002, the prices have increased well above the increase in consumer price index.

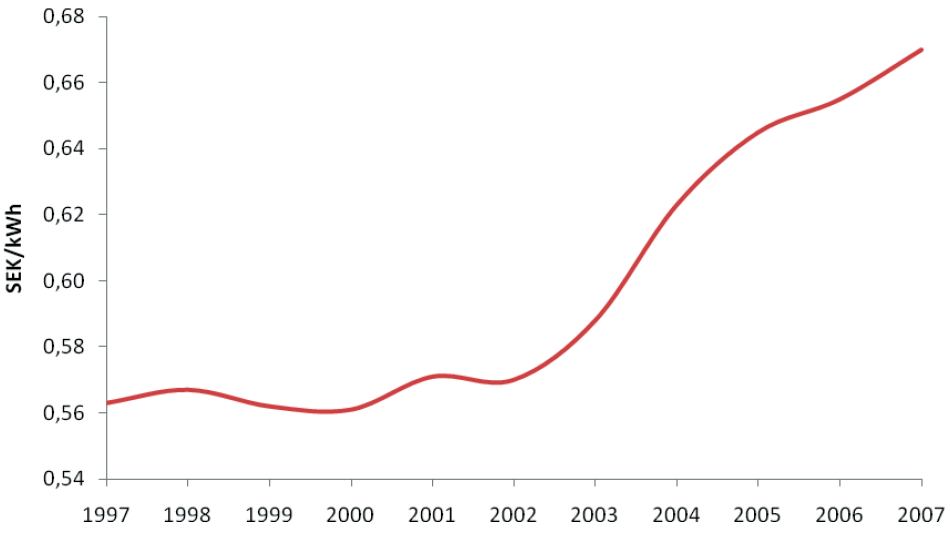

Figure 3.11 Development of average prices for district heating in SEK/kWh, 1997-2007

Source: Energy Markets Inspectorate

Table 3.6 shows the price spread around the national average and median in SEK/MWh for the years 2001 to 2007. For every year there are more or less a 100% difference between the lowest and the highest price in the Swedish market for district heating.

Table 3.6 Price average and price spread in SEK/MWh, 2001-2007

Year	2001	2002	2003	2004	2005	2006	2007
Highest	741	761	741	771	784	793	796
Lowest	338	351	371	371	381	405	405
Average	542	556	578	611	628	642	662
Median	540	557	577	609	629	644	663

Source: Avgiftsgruppen

Table 3.7[6] depicts the average prices and price spread in SEK/MWh on ownership for the year 2007. The Finnish company Fortum, which in principle serves the Stockholm grater city area, has the highest average price and the lowest spread. However, the highest price, 815 SEK/MWh, is charge by the state owned company Vattenfall in Värmdö situated east of Stockholm. The lowest price, 405 SEK/MWh is charge by the municipality owned company Luleå Energi in Luleå in the north of Sweden.

Table 3.7 Average price and price spread for district heating in SEK/MWh on ownership, 2007

Owner	Average price	Standard deviation	Minimum	Maximum
Fortum (private)	748	34	684	784
Vattenfall (state)	719	52	606	815
E.ON (private)	684	44	598	748
Other private	701	41	626	770
Municipal	648	80	405	796

Source: Swedish Energy Markets Inspectorate

The cost of installing any of the systems, district heating, heat pumps of pellet burner, varies depending on, for example, type of house and location. The Swedish Energy Markets Inspectorate provides the following rough estimates for the installation costs. District heating installation varies from SEK 25 000 to 140 000, pellet burner between 80 000 and 160 000 and geothermal heat pump between 80 000 and 500 000. The numbers include both residential buildings and small single houses which accounts for some of the large variation. Also the connection fee for the district heating varies throughout the country and depends on the policy of the district heating provider. Another source of uncertainty is if the house from the beginning uses direct electricity panels. In that case an estimated cost at SEK 5 000 per radiator must be added. It must also be emphasised that not all households or houses have access to all three alternatives, i.e. the relevant market varies across the country.

The Swedish Energy Markets Inspectorate also calculates the yearly cost of each system for "standard" both single houses and residential buildings[7]. Figure 3.12 shows how the (nation average) variable and fixed cost varies between the alternatives for single houses.

6 Table 3.6 and 3.7 differ slightly du to different bas of calculation. The Energy Markets Inspectorate use prices for every single network while "Avgiftsgruppen" use a company average for larger units.

7 The "standard" single household's heat consumption is assumed be equivalent to 25 000 kWh/year and the "standard" residential building is assumed to contain 15 apartments with a total need of 193 000 kWh/year for heating, i.e. almost 13 000 kWh/year per apartment. The assumed depreciation time for a pellet burner is 15 years, for the exchanger used in district heating 20 years and for a heat pump system 10 years for the tourniquet, 25 years for the drilling hole and 15 years for the remaining part of the investment. The interest rate is set to 4.8%, which was the average 10 years interest rate in March 2007 (Swedish Energy Markets Inspectorate, 2007).

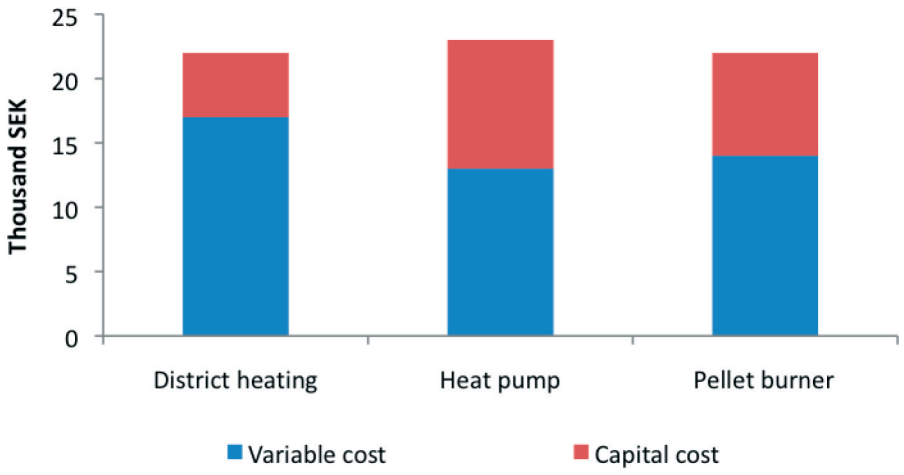

Figure 3.12 Total yearly cost per alternative in thousand SEK, single houses.
Source: Swedish Energy Markets Inspectorate.

As expected, the fixed cost is highest for heat pumps followed by the use of pellets. District heating have the highest variable cost. However, there are only marginal differences in their respective total costs.

The picture is somewhat different for residential buildings. In these calculations the Inspectorate use a standardized building containing 15 flats using 193 000 kWh per year. Here district heating comes out as the most expensive alternative at SEK 140 000 per year followed by heat pumps and pellets as shown in figure 3.13. The high portion of variable cost in district heating and pellets makes these markets a bit more sensitive to market conditions regarding the variable cost, fuel.

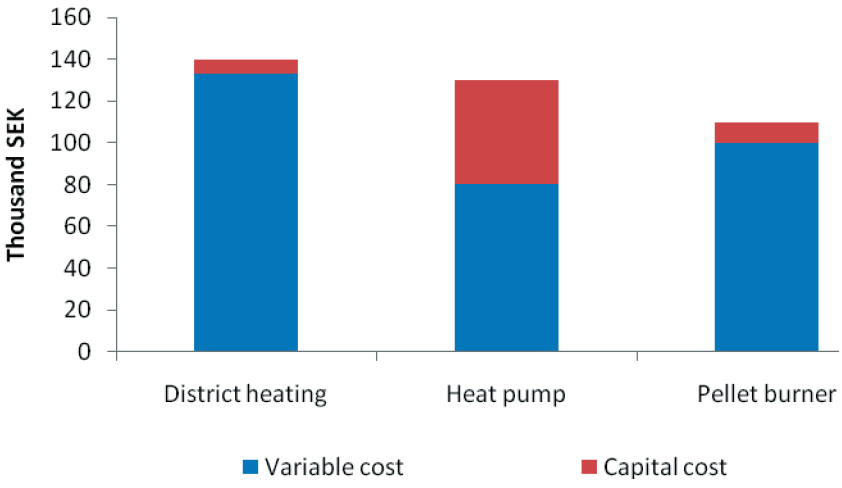

Figure 3.13 Total yearly cost per alternative in thousand SEK, residential buildings.
Source: Swedish Energy Markets Inspectorate.

The Swedish District Heating Association launched in June 1, 2005 a system for quality assessment of district heating companies called "REKO fjärrvärme". The system was created in collaboration between the members of the Swedish district heating association and different organizations for large consumer groups.

The member companies can apply to be a "REKO-company" by, among other things, use separate accounting for the district heating part of the operation. In 2008 the Swedish District Heating Association lists 79 companies that are approved for the REKO-system. These included companies delivers in total around 40 000 GWh of heat to the networks, i.e. stand for around 85% of the heat deliveries in Sweden.

Summary

The Swedish district heating market had a market share at almost 45% in 2007 and the consumption of district heat has increased substantially during the last 40 years with consumption just above 10 TWh in 1970 to 45 TWh in 2007. The market is deregulated and is consequently run in a businesslike manner. Still, the Swedish market is significantly influenced by a number of governmental organizations and institutions such as an inspectorate, a competition authority and energy agency. During the past 40 years, from 1970, Sweden has reduced its use of oil as a fuel for district heating generation dramatically, from above 90% to below 5% in 2007. The oil has predominantly been replaced by bio fuels. Sweden produces district heating in both heat only plants and combined heat and power plants (CHP). Production in heat only plants is dominating, having a share of almost 60%. The electricity produced in CHP-plants has only a very marginal contribution to the electricity production, below 5%. The district heating companies in Sweden are owned by both municipalities and by private companies (including a state owned company). Municipality owned companies dominate with 74% of the networks and 66% of the heat deliveries. Depending how the relevant market is defined the competition comes primary from different kinds of heat pumps and pellet burners; the substitutability is especially present for small houses. The district heating prices has been increasing in nominal terms since 1997 with a nationwide spread between approximately 400 and 800 SEK/MWh in 2007 with a slight tendency for private companies to, on average, charge a higher price.

4. DENMARK

District heating in Denmark has a long tradition. The first "recognized" district heating operation in Denmark is Frederiksbergs Forbræningsanstalt which started in 1903 with a network covering the hospital and the poor-house (Danish District Heating Association). The real development started in the early 1930s with the modernization of electrical plants. District heating has since then gained a dominant position in Denmark and the general situation as it was in 2005 is presented in table 4.1

Table 4.1: Basic facts for the Danish District Heating Sector, 2005

Number of DH companies	405
Number of CHP plants	300
Number of CHP DH plants	105
Maximum heat output capacity (exclusive industrial contribution)	160879 MW
With combined heat and power production	13 244 MW
Without power production	3 735 MW
Fuels used for DH	
coal	27 %
oil	5 %
natural gas	31 %
renewable	17 %
waste	19 %
Total heat delivered to the pipeline system	34 574 GWh
Heat delivered with electricity production	26 968 GWh
Heat delivered to consumers	27 659 GWh
Total route length of DH pipeline system	27 067 km

Source: Country-by-country report 2007, Denmark

Market Development

Denmark's total net heat requirement was almost 220.000 TJ[8] (61.100 GWh) in 2007. Figure 4.1 shows that the total heat demand between, at least 1980 to 2007, has been stable around 60000 GWh and that oil has reduced its significance as a heat provider while district heating has gained market together with natural gas and "other" including what is called renewable energy in the statistics presented by the Danish Energy Authority.

8 Danish Energy Authority

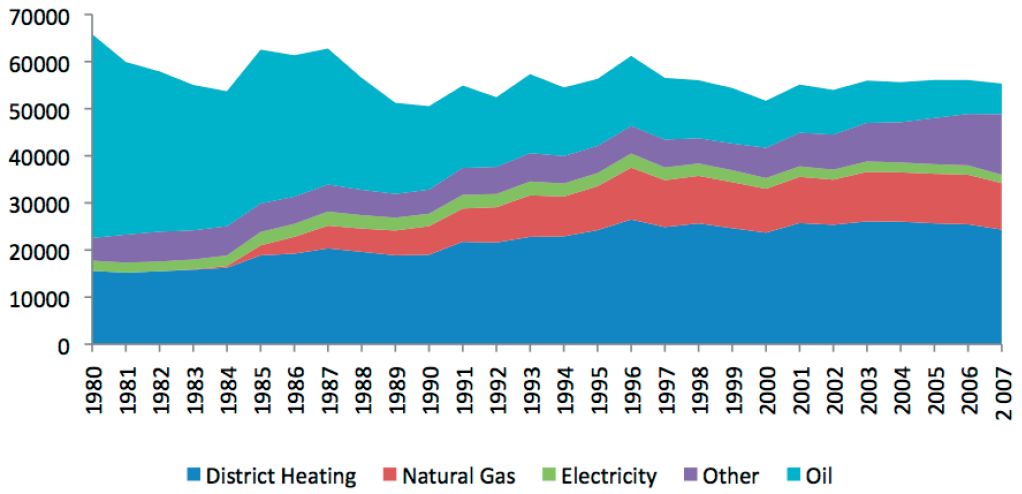

Figure 4.1 Growth of heat production on heat sources 1980-2007 in GWh

Source: Danish Energy Authority

Focusing on district heating, figure 4.2 shows the development of how the consumption of district heating is divided between residential (households) and the industry. In 2007, the households consumed 50% of the produced district heating and the industry stands consumed 30%. The transmission and distribution losses amounted to 20%. Since 1980 it has been minor changes in the division of the consumption, the losses have however decreased from 25% to 20%.

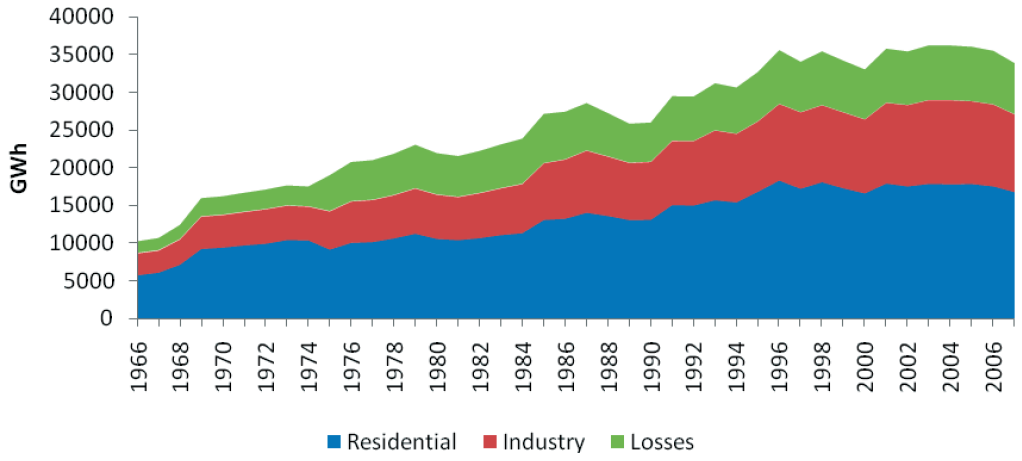

Figure 4.2 Growth of district heating production and consumption 1966-2007

Source: Danish Energy Authority

Public Policy and Legal Framework

A regulated Market

The public policy in Denmark has a regulatory approach with a specific heating law, including tariff regulation, zoning etc. District heating has a strong position in the Danish heat market. Two major issues in the Danish law (Act on heat supply) have large effects in the market. First, since 1982 there is an obligation to connect new and existing buildings to public supply. Second, there is since 1988 a ban on installing electrical heating in new buildings and since 1994 there is ban on installing electrical heat systems in existing buildings with water based central heating.

The district heating companies (commercial, cooperatives etc.) are subject to a non-profit regulation, (Act on heat supply, chapter 4). Any attempt to "smooth out" prices over time by increasing prices one year is not allowed, but each district heating company is allowed, after approval from the regulator, to save excess "profit" for five years in order to make necessary future investment.

Authorities of Significance for the Danish District Heating Market

Foremost is the district heating market influenced by the Danish Energy Regulation Authority (DERA) which is an independent authority engaged supervision of monopoly companies in the Danish energy sector; electricity, natural gas and district heating. DERA regulates prices and terms of supply fixed by the monopoly companies. The Authority also supports structure development and improvements in efficiency within the energy sector.

The supporting authority in Denmark is the Danish Energy Agency which also is responsible for all statistics regarding the energy markets. Local authorities are an important factors in the Danish district heating market in that they have the power to require that all parts within a local authority area connects and remain connected to either a natural gas or district heating system. In principle, the only cause of dispensation is for low-energy houses having insulation enough so the cost of connection is higher than the low energy use from other sources, (Executive Order no. 581 of 22 June 2000 on connection etc., to public heat supply installations).

Another important institution in Denmark is the Energy Supplies Complaint Board which was established in co-operation between the Consumer Council and the Association of Danish Energy Companies, DONG (Danish Oil and Natural Gas), Greater Copenhagen Natural Gas/Natural Gas Middle-North, Natural Gas Funen and Danish District Heating Association. The Board is composed of a neutral chairperson and four members. The chairperson is a city court judge. The Consumer Council appoints two members, and two members are appointed to represent the respectively energy trade area. The Board has a mandate to handle disputes arising from the contractual relationship between energy consumers and an electricity supply undertaking, natural gas supply undertaking and district heating supply undertaking.

Yet another level of appeal possibilities is the Energy Board of Appeal, which is an independent appeal board under The Ministry of Climate and Energy. The Energy Board of Appeal is the final administrative appeal body for decisions by public authorities under various laws governing the energy sector. The decisions that are subject to

appeal will in most cases have been handed down by the Danish Energy Regulatory Authority, the Danish Energy Authority or one of Denmark's 98 municipalities.

Basic Conditions and Market Structure

Fuel and Technology

The composition of fuels in district heating production has changed significantly since 1980 as shown in figure 4.3. In 1980 oil constituted two thirds of the fuel consumption for district heating generation. In 2007 the share of oil is less than 5%. Renewable energy has increased from close to 14% in 1980 to 40% in 2007. During the 1980s, natural gas came into use in the production of district heating and constituted in 2007 almost 30% of the fuels used in district heating production. During the period from 1993 to 2007 the use of coal shows a decreasing trend from almost 50% in 1993 to slightly below 30% in 2007.

In 2007, Denmark produced 33 739 GWh of heat in district heating plants. 15 127 GWh (45%) was produced in CHP-plants in large cities, 11 931 GWh (35%) was produced in CHP-plants in small and medium sized cities and the rest, 6 682 GWh (20%) was produced in DH-plants. In a European perspective, having 80% of the heat from district heating plants produced in combined heat and power plants, Denmark has the highest proportion of heat produced in CHP-plants followed by the Netherlands and Finland.

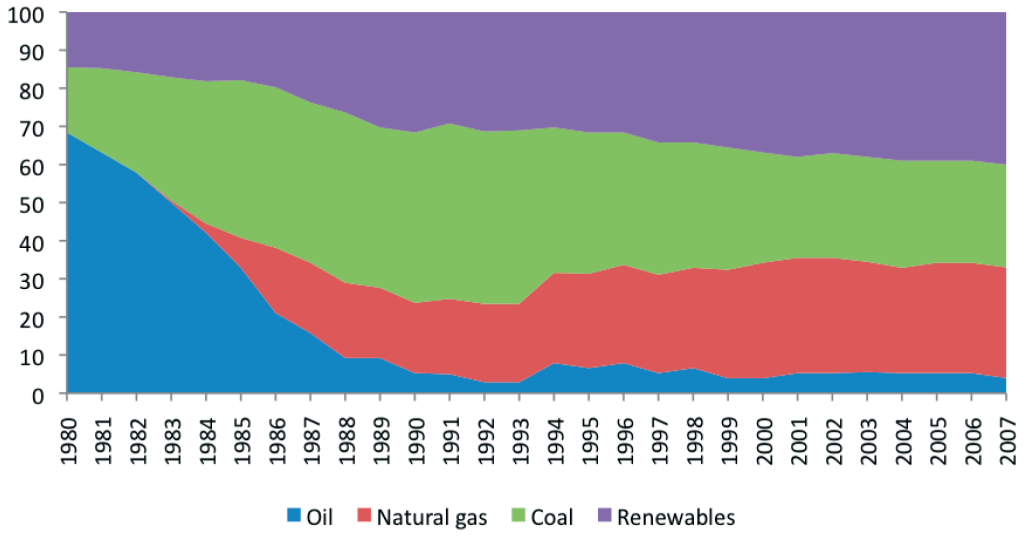

Figure 4.3 Composition of fuels 1980-2007

Source: Danish Energy Authority

Figure 4.4 depicts the Danish progress with increased usage of CHP-plants in heat production for the years 1975 to 2007. The increased heat production during the period comes solely from increased CHP capacity and the heat capacity from heat only plants has been reduced slowly from the 1990s. Denmark's increased usage of heat from CHP-plants also means that a significant share of Denmark's electricity production is generated in these CHP-plants. Figure 4.5 these amounts of electricity production.

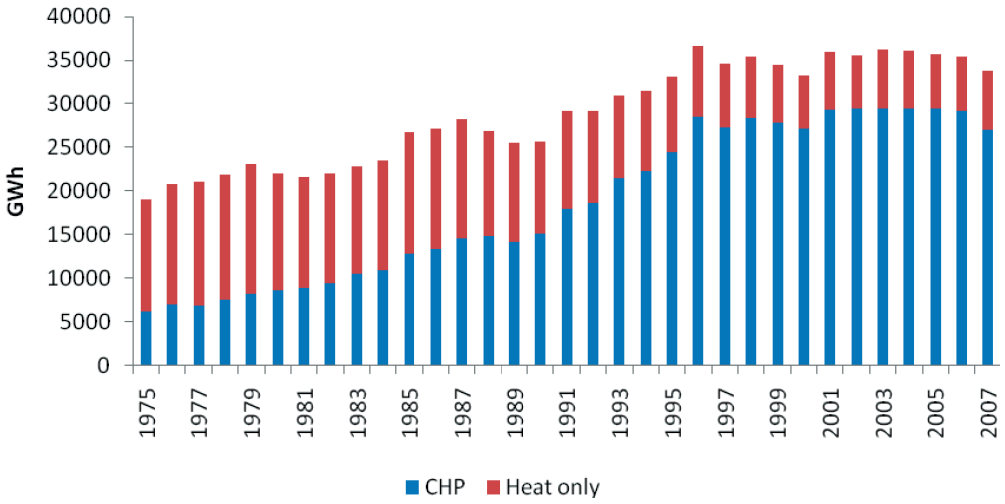

Figure 4.4 Production of heat in CHP-plants and heat only plants 1975-2007 in GWh

Source: Danish Energy Authority

As seen in figure 4.5, over 80% of the total electricity production in Denmark is generated in CHP-plants, a dependence on CHP for electricity that is unique in, at least, Europe. The remaining part of the electricity production comes mainly (18%) from wind turbines.

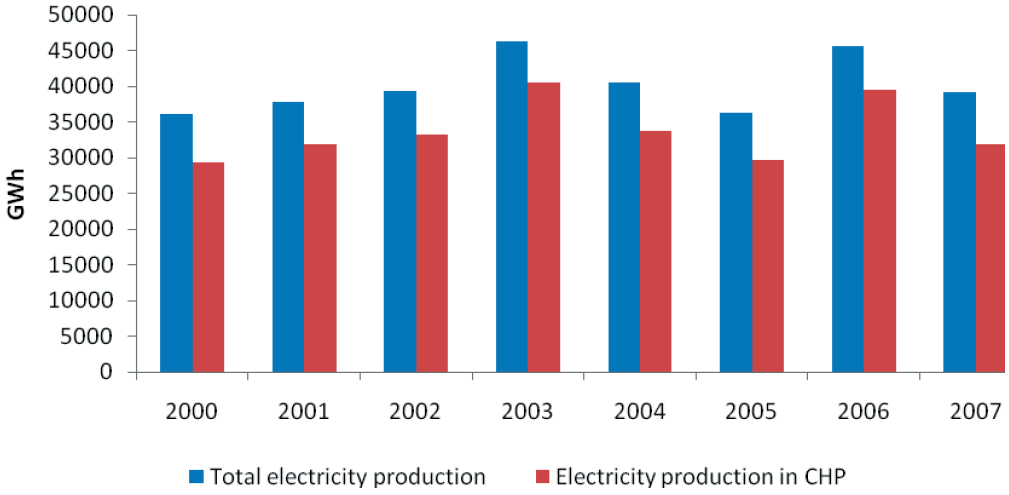

Figure 4.5 Total electricity production and electricity production in CHP-plants 2000-2007 in GWh

Source: Danish Energy Authority

Market Structure

In 2008 Denmark had approximately 2,5 million households of which a majority got their space heating and hot tap water from district heating, see the development in figure 4.6. Since 1981 the proportion of dwellings heated by district heating has increased from 34% to 61%. At the same time the proportion of dwellings heated by oil has decreased from 53% to 16%. The proportion for natural gas is in 2008 14%. District heating is the most common form of heating in both multi-dwelling houses (88%) and detached houses (47%).

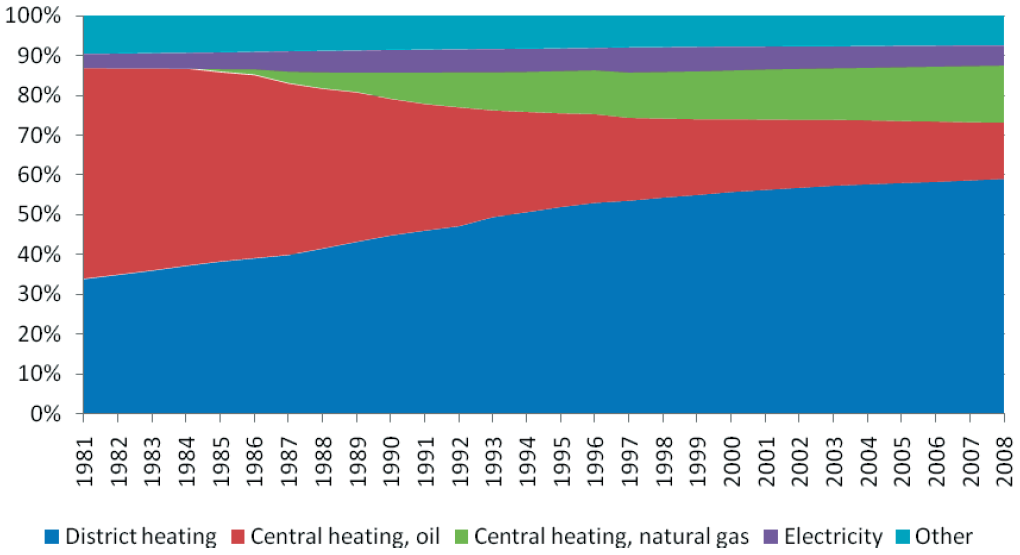

Figure 4.6 Market shares heating methods in Denmark 2007

Source: Danish District Heating Association

There are over 400 district heating plants in Denmark with a network of a total length of 29 500 km. In 2008 Denmark had 19 large-scale CHP plants that produce 45 per cent of the district heating, see figure 4.8. The 55-60 largest enterprises supply 60 per cent of the district heating, but the sector comprises of around 600 district heating supply companies which vary greatly in size etc[9]. The legislation about heat planning is the main barrier to entry. Figure 4.7 further emphasize the structural change that has taken part in Denmark since the 1980s, favouring heat production in CHP-plants over heat production in "ordinary" heat only plants.

9 Danish Regulatory Authority, Results and Challenges 2007

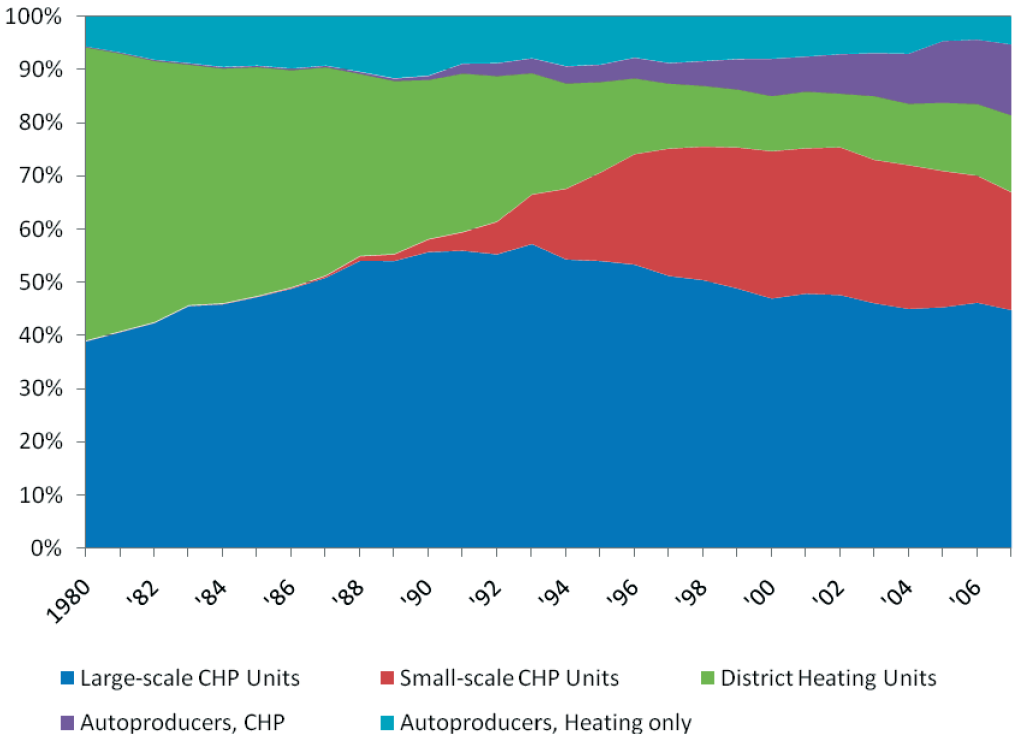

Figure 4.7 District heating producing plant types 1980-2007
Source: Danish Energy Authority

Apart from large centralized plants, the district heating plants in Denmark are by tradition owned cooperatively, with all the costumers being part owner in each respective network and plant, or owned by municipalities. According to the Country-by-country survey 2007 there has been some major changes in the Danish ownership conditions due to some takeovers. The two state owned commercial companies DONG from Denmark and Vattenfall from Sweden are dominating not only in the market for electricity but stands together also for approximately 60% of all produced heat in CHP-plants in Denmark in 2008. For example, the Swedish company Vattenfall and the Danish company DONG supply the municipality owned network in Copenhagen with hot water. Although commercial players, both Vattenfall and DONG only produce electricity on a commercial basis selling the residual hot water on a non-profit basis to the Copenhagen network and other networks and act thus on the wholesale market. The so called autoproducers in figure 4.7 contribute however with an increasing share especially the autoproducing CHP units. These autoproducers generate this heat as part of a process that not originally has as a purpose to produce heat. These units are also players in the wholesale market.

In Denmark we have identified two kinds of wholesale markets:

- within district heating: the wholesale market in, for example greater Copenhagen, consisting of the companies selling hot water to the Copenhagen network, and
- within the heating sector; any interested party has the right to initiate a heat-planning

project: DH plants, local authorities, natural gas companies, businesses or citizens groups. But the Minister has set regulations concerning the fuels and technologies to be used in plants. This is the administrative bases for heat supply projects. Project proposals must be prepared in accordance with these frameworks and regulations[10].

The market solution in the Greater Copenhagen Area is illustrated in figure 4.8 including the major players: producers of hot water (CHP-plants and waste incineration plants), transmission system, distribution system and final consumers.

The five municipalities in the Greater Copenhagen area[11] have a joint transmission company, Metropolitan Copenhagen Heating Transmission Company called CTR. The main objective for this company is to utilize the waste heat from primarily waste incineration plants and combined heat and power plants close to the area. The company purchase the heat and transport the heat through the transmission system to its five owner's municipalities who distribute and sell the heat to the final consumers.CTR also operates some back-up units that produce heat during peak load periods. CTR also delivers hot water to VEKS (Vestegnens Kraftvarmeselskab I/S), another transmission company supplying heat to 19 local district heating companies at Vestegnen west of Copenhagen. The local district heating companies then resell the heat to private consumers, business customers and institutions.

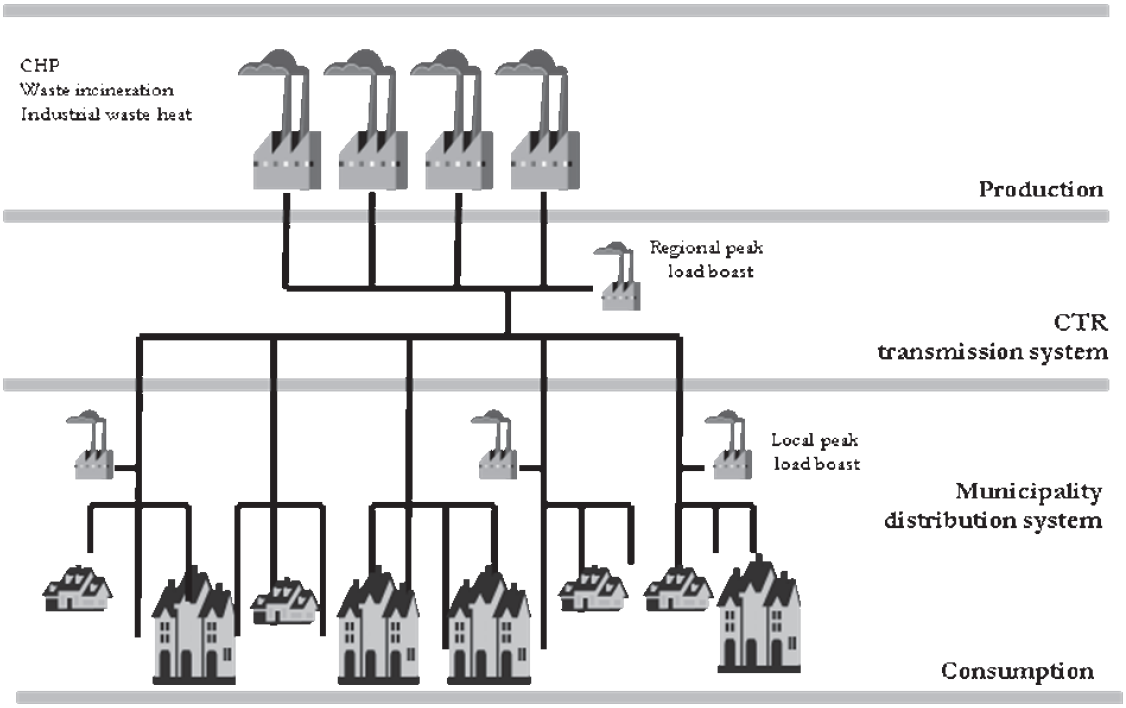

Figure 4.8 Market design, district heating in Greater Copenhagen area

Source: Metropolitan Copenhagen Heating Transmission Company (CTR)

10 Heat supply in Denmark, page 22
11 Frederiksberg, Gentofte, Gladsaxe, Copenhagen and Taarnby

A similar market solution is in place around the municipalities of Fredericia, Kolding, Middlefart and Vejle. Here it is the company TVIS[12] that purchase waste heat from nearby industries such as the Shell refinery and DONG's CHP-plant in Frederica. TVIS then leads the hot water to the local district heating companies who distribute the heat to the final consumers. The activity of the joint operations of CTR, VEKS and TVIS is above 8000 GWh, i.e. around 25% of the total district heat production in Denmark.

Even if a wholesale market can be identified in Denmark, the final consumers have, in practice, no available choice of heating system or provider within the heating system. The consequence being that no retail markets in the heat market exist.

There are significant differences in production cost between different plants in Denmark. The statistics on production cost covers around 115 plants all using charts of accounts divided on function. Figure 4.9 (ranked according to total cost) reveal the lowest total cost is around 300 DKK/MWh and the highest around 1 600 DKK/MWh.

The relatively large differences in costs between the plants have many explanations. The Danish District Heating Association emphasize the plant age, depreciation policy, earlier years result different subsidies and different taxes dependent on fuel. The Danish Energy Authority explains the cost differences in terms of fuel prices, fuel utilization, differences in operating and maintenance cost, start up costs and heat losses.

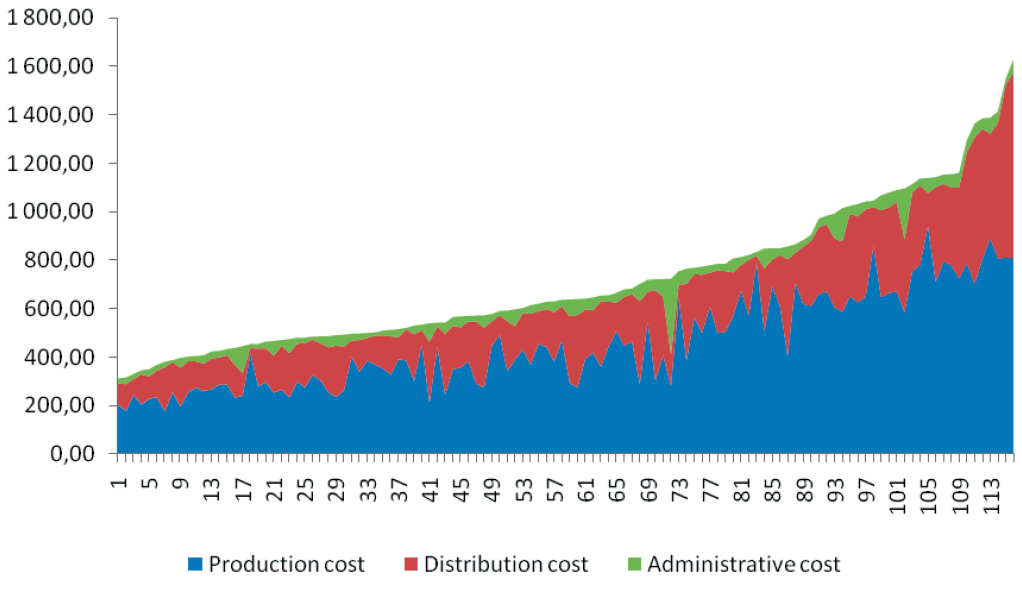

Figure 4.9 Cost ranked according to total costs

Source: Danish District Heating Association

Market Conduct and Performance

Table 4.2 shows the price development in Denmark during 2007, 2008 and January 2009. The table includes average as well as medium values and price spread.

12 Trekantområdets Varmetransmissionsselskab I/S

Table 4.2 Average price, median price and price spread in DKK/MWh

Year	2007	2008	(January) 2009
Lowest	139	206	200
Highest	1314	1388	1388
Range	1175	1182	1188
Average	562	622	624
Standard deviation	184	227	223
Median	534	579	588

Source: Danish Energy Regulatory Authority

The variations in total consumer cost for heating is reflected in the different prices charged between different district heating plants in 2007 and are shown in figure 4.10. The figure shows the total heating cost for a "standard house" defined as having an area of 130 square meters consuming 18,1 MWh/year including VAT. In order to compensate for the different plant sizes the figure also includes two averages; the solid line shows the weighted average and the broken line the simple average. The weighted average is significantly below the simple average indicating that larger plants "on average" charge lower prices.

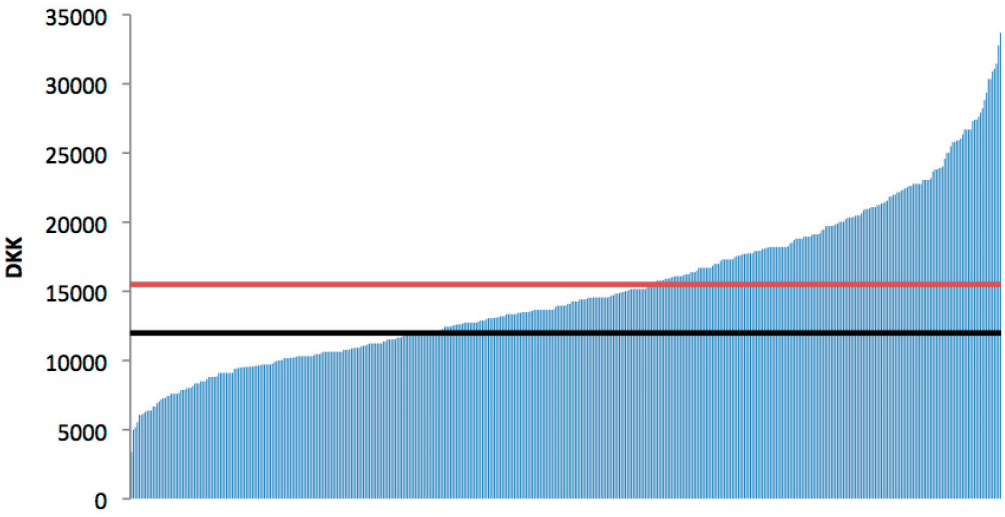

Figure 4.10 Heat costs including VAT in Denmark for a 130 square meter house using 18,1 MWh
Black line = weighted average, red line = simple average

Source: Danish District Heating Association

The plants operating at the "high end" of figure 4.10, plants charging above 20 000 DKK/year for a 130 square meter house, are usually open-field plants[13]. But, out of 215 plants it is only 27 plants that charge more than the cost for individual heating with oil

13 The Danish and Swedish term is "barmarksverk"

or gas. These 27 plants correspond to less than 3% of the district heating consumers.

Figure 4.11 shows the price distribution in DKK/MWh when the plants are ranked by production size, from lowest production in far left to largest production in far right. Even if the figure slightly shows that larger producers might have lower costs, the causality is unexpectedly small. As seen in the figure there exist small-scale as well as large-scale producers among the most expensive ones.

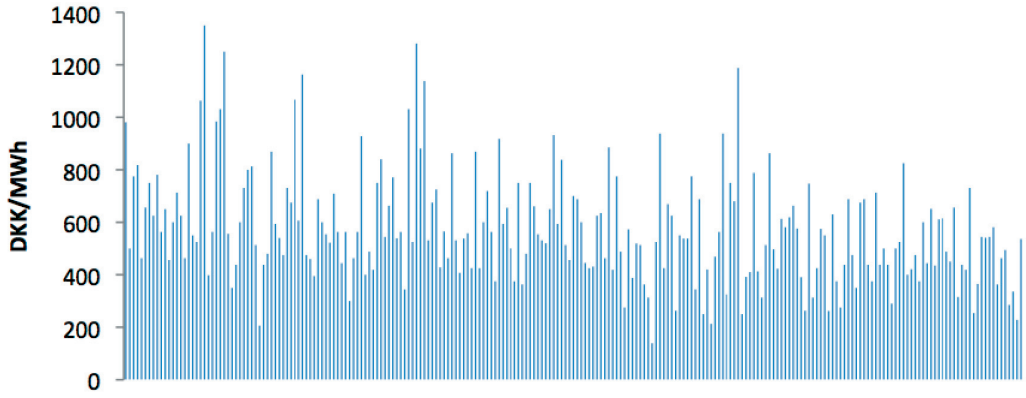

Figure 4.11 Price distribution on plant size ranked from smallest (left) to largest (right), 2007
Source: Danish District Heating Association

The total cost of heating is divided in a fixed cost and a variable cost. The distribution between these fixed and variable costs varies among the plants as shown in figure 4.11 showing the cost distribution for the "standard" house of 130 square meters using 18,1 MWh/year. Fixed cost includes subscription and effect charge. The cost depicted in figure 4.12 is ranked according to total cost and there is a slight but not general tendency that high total cost includes both high fixed and variable costs.

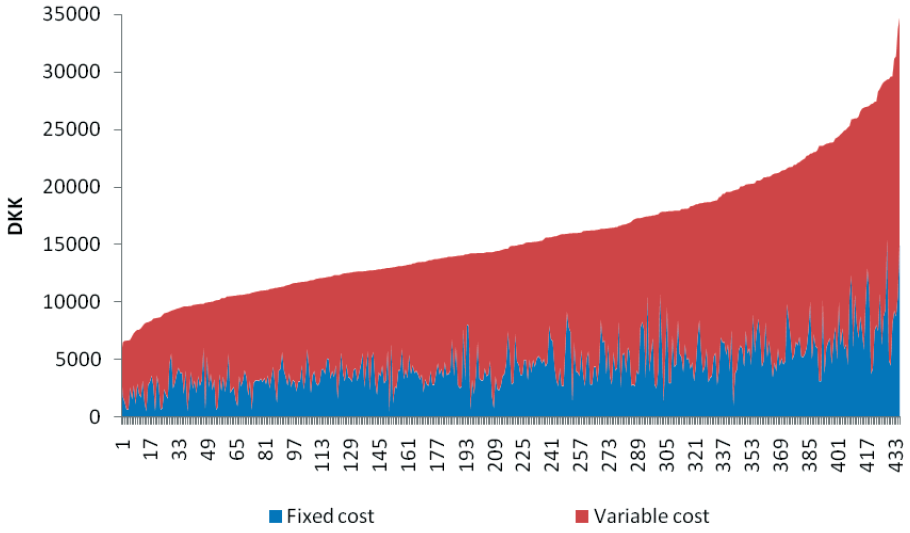

Figure 4.12 Price distribution on fixed and variable costs ranked by total costs, 2007
Source: Danish District Heating Association

Figure 4.13 shows the development of the average price for some different types of producers. The open field plants are the most expensive ones and they have also raised their prices most. These plants are usually relatively small de-centralized plants placed close to small communities without earlier collective heat supply.

Many of these plants faced some financial problems in the late 1990s due to increasing gas prices and in spite of financial aids of DKK 370 million in 2000 and DKK 85 million in 2003 many plants still charge significantly higher prices compared to the larger centralized plants. As pointed out by the Danish District Heating Association in the latest of its price investigations[14] there has been substantial price increases for district heating from smaller open field plants and smaller CHP-operations (less than 5 MW) using natural gas.

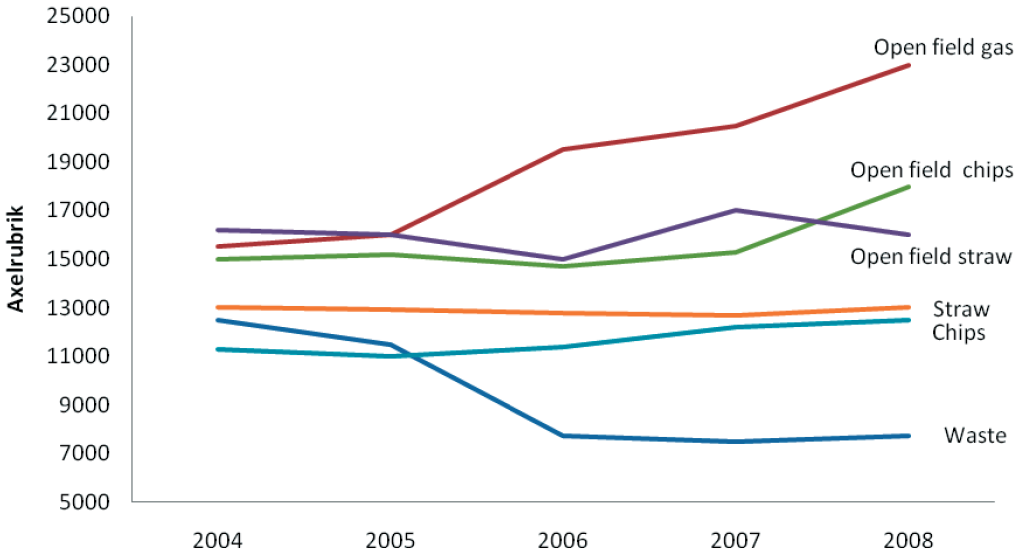

Figure 4.13 Average price development on type of producer 2004-2008
Source: Danish District Heating Association

Summary

District heating has a dominant position in the Danish heat market with a market share in 2007 around 60%, a share that has constantly increased the last 30 years. As for most countries the total production and consumption of district heating shows an upward trend and in 2007 Denmark consumed around 25 000 GWh of heat of which more than half was consumed in residential buildings. The Danish district heating market is regulated in terms of both an obligation to connect to a network and in terms of a non-profit price regulation. This regulation is enforced by the Danish Energy Regulation Authority (DERA) with eventual disputes handled by the Energy Supplies Complaint Board. The major fuels being used in Danish district heating plants are natural gas and bio-fuels and a majority, around 80%, of the heat being produced is produced

14 "Fjervarmepriser i Danmark 2008" available at www.danskfjervarme.dk

in CHP-plants. The CHP-plants stand thus for 80% of the electricity supply in Denmark. There are many, relatively small however, district heating plants in Denmark and a majority of the plants are owned by consumer cooperatives. In delivered heat, however, the market is dominated by the Danish state owned company DONG and the Swedish company Vattenfall that together stands for approximately 60% of the heat delivered. In greater Copenhagen, and some other urban areas, there exist some special market solutions involving a well developed wholesale market where the municipalities own the transmission and distribution network for which they buy the heat from nearby plants such as CHP-plants, waste incineration plants and industrial waste heat. Due to the fact that the Danish market consist of many relatively small plants using a variety of fuels having a non-profit price regulation the prices varies relatively much across the country. In January 2009, for example, Denmark had a lowest price at 200 DKK/MWh and a highest price at 1388 DKK/MWh, a total range of almost 1200 DKK/MWh.

5. FINLAND

District heating is the significant source of heat for space heating and the provider of hot tap water in Finland. District heating is dominating especially in dense populated areas and was introduced in Finland in the early 1950s. Table 5.1 summarizes some facts about the Finnish district heating production and consumption for 2005.

Table 5.1 Basic facts for the Finish District Heating Sector, 2005

Number of DH companies	150
Number of CHP plants	75
Maximum heat output capacity (exclusive industrial contribution)	19 890 MW
With combined heat and power production	6 230 MW
Without power production	13 850 MW
Fuels used for DH	
coal	25 %
oil	4 %
natural gas	38,3 %
renewable	14,1 %
waste (peat)	16,8 %
other	1,2 %
Total heat delivered to the pipeline system	32 780 GWh
Heat delivered with electricity production	23 590 GWh
Heat delivered for industrial use	2 930 GWh
Heat delivered to consumers	26 370 GWh
Total route length of DH pipeline system	10 020 km

Source: Country-by-country report 2007, Finland

In 2007 the district heating companies in Finland produced 33 600 GWh of heat of which 30 500 GWh was consumed and delivered through 312 separate heat distribution systems with a total length of 11 000 km. This heat was produced by 572 stationary heating plants and 81 cogeneration plants whose total capacity was 11 910 MW + 7 250 MW. In addition, the access to 380 transportable heating plants generates a total capacity at 20 390 MW.

Market Development

District heating is the most common used way of providing heat to different kinds of buildings in Finland. District heating is available in almost all cities and towns and in 2007 approximately 2.6 million Finns lived in a building heated by district heating. Its market share is almost 50% and almost 95% of all residential buildings and a majority of the official and business buildings use district heating. For one-family houses the share using district heating is 6%. In the larger cities district heating has a market share of over 90% (Energiateollisuus). Figure 5.1 shows the overall market share for district heating and the alternative heating sources.

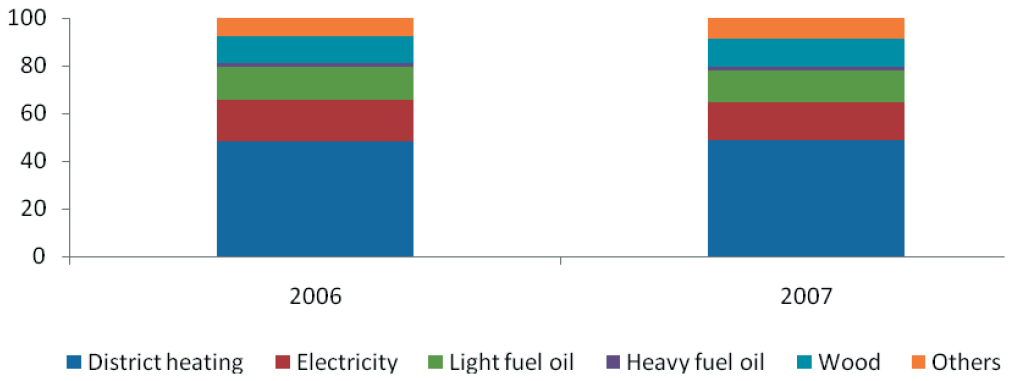

Figure 5.1 Market shares of heating sources for space heating in Finland 2006 and 2007
Source: Energiateollisuus 2007 and 2008

Figure 5.2 shows the development of district heating production and consumption in Finland from 1990 to 2007 divided on user, residential buildings, industrial buildings and other.

Close to 33 600 GWh of district heating was produced in 2007and slightly more than 30 500 GWh was consumed. More than half of that, around 17 000 GWh was consumed for residential heating and the provider of hot tap water.

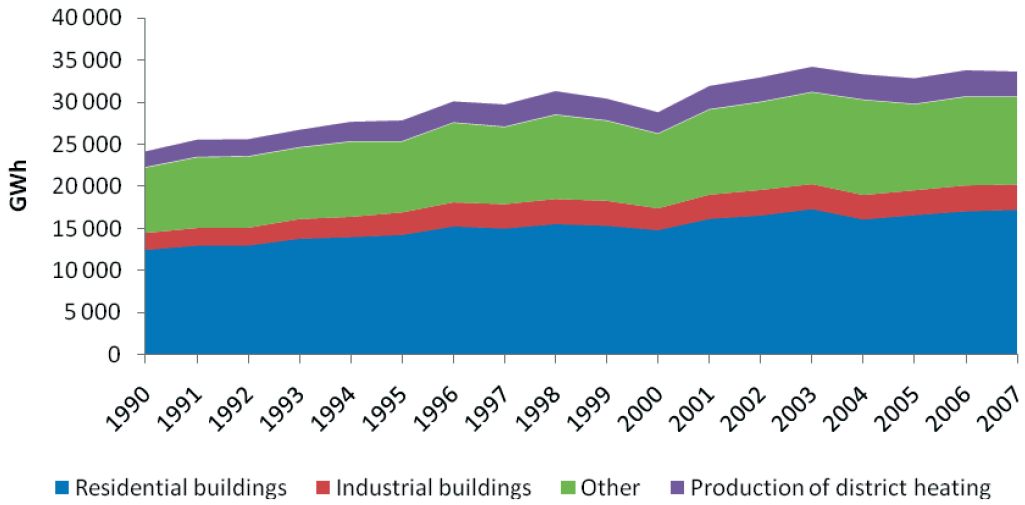

Figure 5.2 Production and consumption of district heating in Finland, 1990-2007, in GWh
Source: Statistics Finland

Public Policy and Legal Framework

The authorities' surveillance of the district heating market is primarily based on both the competition law and the law regarding the electricity market. The position of the consumers is also protected through the consumer protection law. According to the Finnish competition authority a district heating company has a dominant position with respect to its customers. According to Energiateollisuus, taxes on energy and the effects caused by the system with tradable permits has to be incorporated in the price formation.

According to a report by Juha Vanhanen et.al (2003)[15] one conclusion is that there seems not to be any obvious reason to open the district heating markets similar to the opening of the electricity markets in the 1990s. It is claimed in the report that external suppliers of hot water to the network cannot compete with the local heat producer over deliveries in the same network. Instead it is claimed that the price of district heating can be kept at a fairly low level thanks to the completion from alternative techniques. An increased transparency of the district heating activities can also contribute to a downward pressure on future district heating prices according to the report.

Basic Conditions and Market Structure

Fuel and Technology

The fuel used in the Finnish plants in 2007 is primarily natural gas followed by coal and peat. Figure 5.3 summarize the picture for 2007 and Figure 5.4 provides a picture over the changes in the fuel use over time between 1976 and 2007.

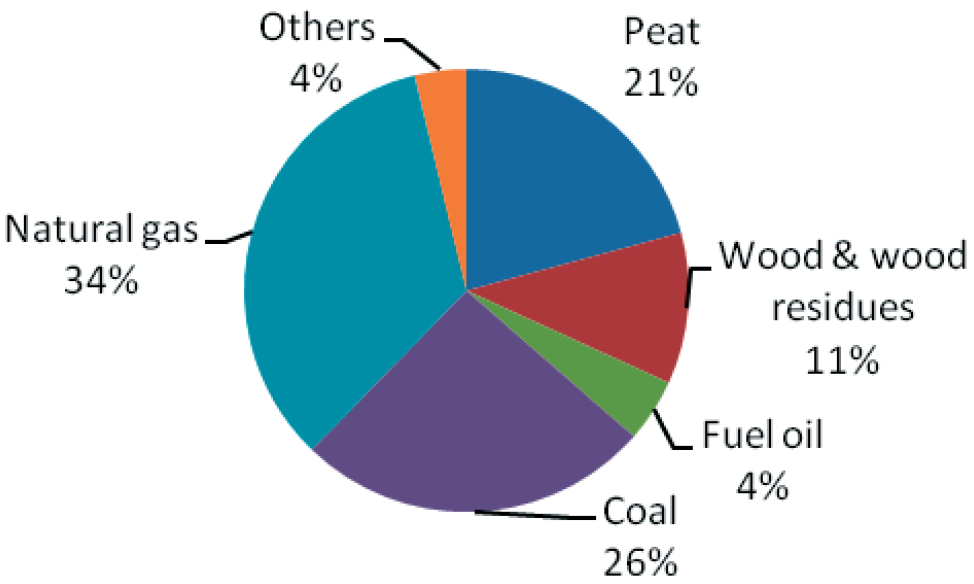

Figure 5.3 Fuel usage 2007

Source: Energiateollisuus, 2008

The trend from 1976 to 2007 shows clearly a reduced use of oil and also coal. The relative share of peat has been more or less unchanged since the beginning of the 1980s while the share of both natural gas usage and wood has been increasing. In comparison with some other countries such as Sweden and Denmark, Finland's usages of renewable fuels are lower.

15 "The developments of surveillance activities over the district heating markets" (Kaukolämpötoiminnan virano-maisvalvonnan kehittäminen). Available in Finnish at www.tem.fi.

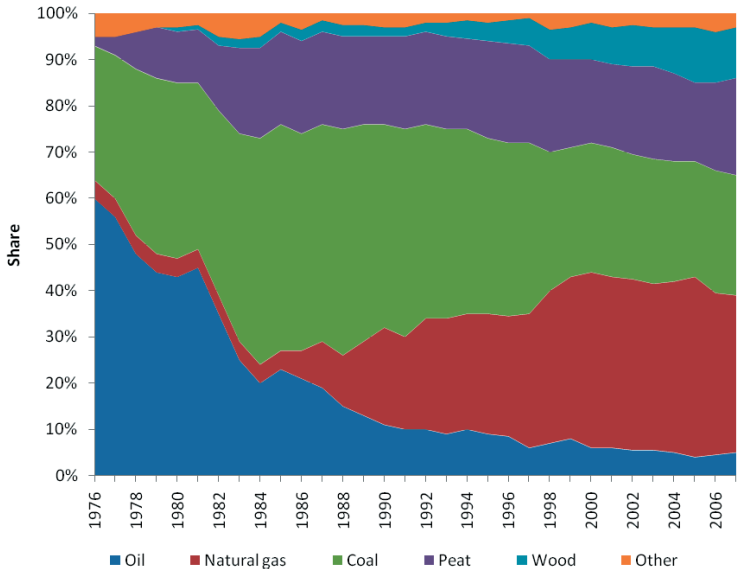

Figure 5.4 Share of different fuels over time in Finland

Source: Energiateollisuus, 2008

District heat production in Finland has been relatively stable over the last decades; however, the share of heat produced in combined heat and power plants (CHP-plants) has increased from 56% in 1985 to around 75% in 2007, see Figure 5.5.

The relatively high share of heat delivered from CHP-plants means also that Finland's share of electricity production generated in CHP-plants is high compared to Sweden but relatively modest compared to Denmark. Of a total electricity production of almost 78 000 GWh in 2007, over 26 000 GWh came from CHP-plants, i.e. over 30% compared to 5% in Sweden and 80% in Denmark.

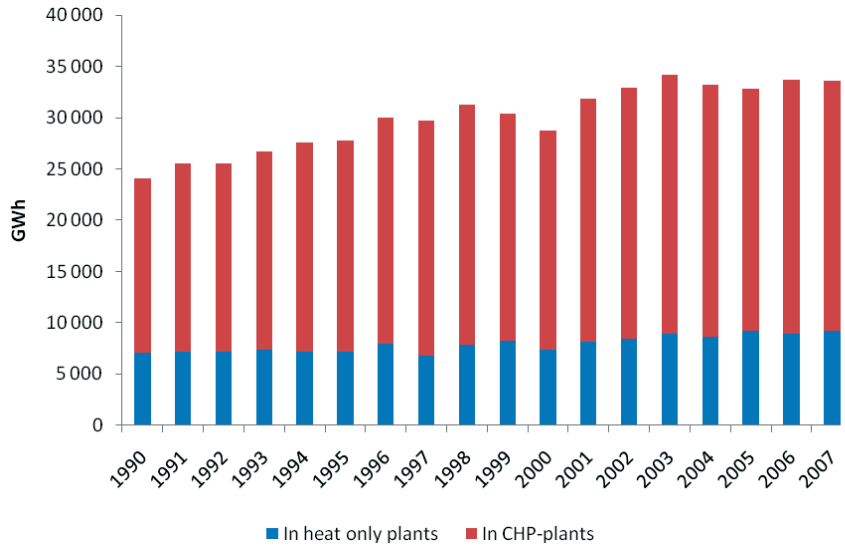

Figure 5.5 District heat production in Finland 1985-2007

Source: Energiateollisuus 2008

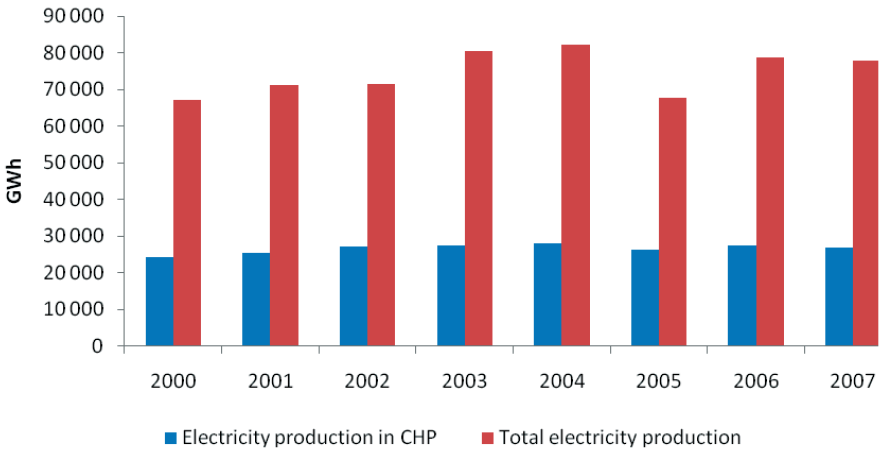

Figure 5.6 Electricity production in Finland 2000-2007

Source: Statistics Finland

Market Structure

At the end of 2007 there were 43 district heating companies which sold district heat mostly produced in combined heat and power (CHP-plants) and 51 district heating companies sold heat produced in heat boilers. Table 5.2 provides information on ownership and production in 2007.

Table 5.2 Number of companies and production on ownership 2007

Ownership	Number of companies	Production in GWh
Municipality owned companies	17	11 750
Municipality owned joint stock companies	78	14 067
Private companies	4	4 197
Total	**99**	**30 014**

Source: Energiateollisuus 2008

A relatively significant part of the district heat that is fed into the Finnish network is managed through a wholesale market. A large part of the hot water produced either in an electricity producing activity or comes in a form of waste hot water from some other industry such as a steel mill or paper mill is sold on to district heating companies. In 2007 over 9 000 GWh of hot water was managed in the wholesale market. The ten largest, ranked by amount of traded energy, in that wholesale market in 2007 are presented in table 5.3. The table has two parts; the upper ten companies on the buyer side represent companies that buy hot water (most often from power companies) for distribution and sales to the final consumer. The lower three rows represents the "pure" wholesale market.

Table 5.3 Traded energy in 2007

Buyer of district heat	Amount of energy in GWh	Seller of district heat
Turku Energy, Turku	1212	Fortum Power and Heat, Naantali
Jyväskylän Energy	1011	Jyväskylän Energy production
Vaasan Sähkö	610	Vaskiluodon Power, Vaasa
Lappeenrannan Energy	429	Lappeenrannan CHP
Seinäjoen Energy	348	Vaskiluodon Power, Seinäjoki
Kajaanin Heat	282	Kainuun Power, Kajaani
Kokkulan Energy	276	Kokkulan Power
Rauman Energy	271	Rauman Power
Vari, Kouvola	238	KSS Energy
Varkauden Heat	196	Varenso, Varkaus
Total	4873	
Others	3847	
Total DH companieas	**8720**	
Kokkolan Power	10	Fortum Power and Heat
Kokkolan Power	46	Kemira Chemicals, Kokkola
KSS Energy	272	Kymin Power
Total wholesale companies	**328**	
Total	**9048**	

Source: Energiateollisuus

By the end of 2007, the number of costumers was almost 119 000. In total the building volume heated was slightly over 800 million cubic meters of which almost 50% was residential buildings. Almost 2,7 million people lived in buildings heated by district heating in the end of 2007. The share of population using district heating varies across the country and area. In the capital city, Helsinki, over half a million people, 93% use district heating provided in a network from 1957 run by Helsingin Energy. The highest market share, 98%, has however the cities of Jyväskylä (population around 85 000) and Oulu (population around 150 000).

Market Conduct and Performance

The gross average price in 2007 was 4.56 cent/kWh, with the taxes constituting 24% of the price. The price varies substantially between different towns. According to the Energiateollisuus is usually the size of the network that has the most influence on the price level. In addition, in the cases when the heat is produced in CHP-plants the prices are generally lower. Also the kind of fuel, the age of plant and network, the town's structure, the efficiency, the maintenance and the owner's return requirements influence the price. Figures 5.7 and 5.8 shows the price path with price spread from 1977 to 2007 and the price spread for 2007 respectively.

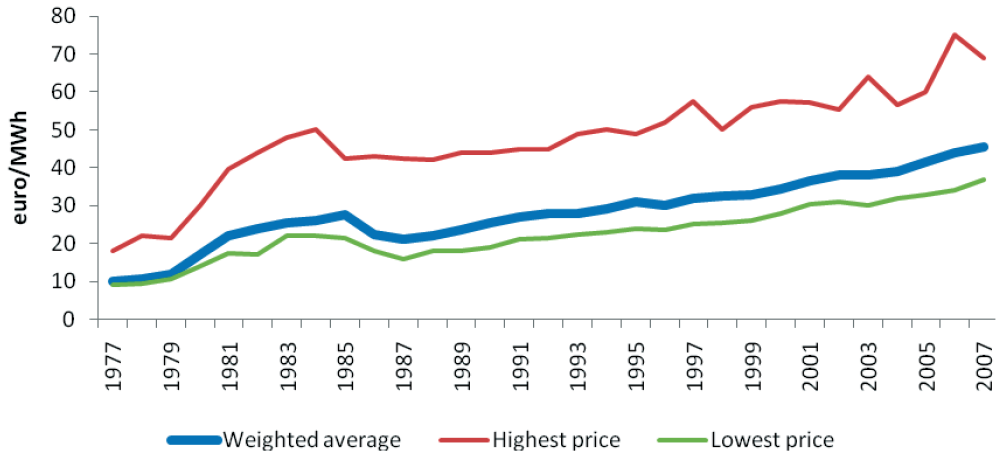

Figure 5.7 Price path and price spread in Finland in EUR/MWh, 1977-2007

Source: Energiateollisuus 2008

Table 5.4 summarize some price data for the years 2003-2007 including extreme values, range and weighted average in Euro/MWh. The range fluctuates but shows no upward or downward trend. The fluctuations are mainly the result of fluctuations in the upper extreme price as seen in figure 5.8.

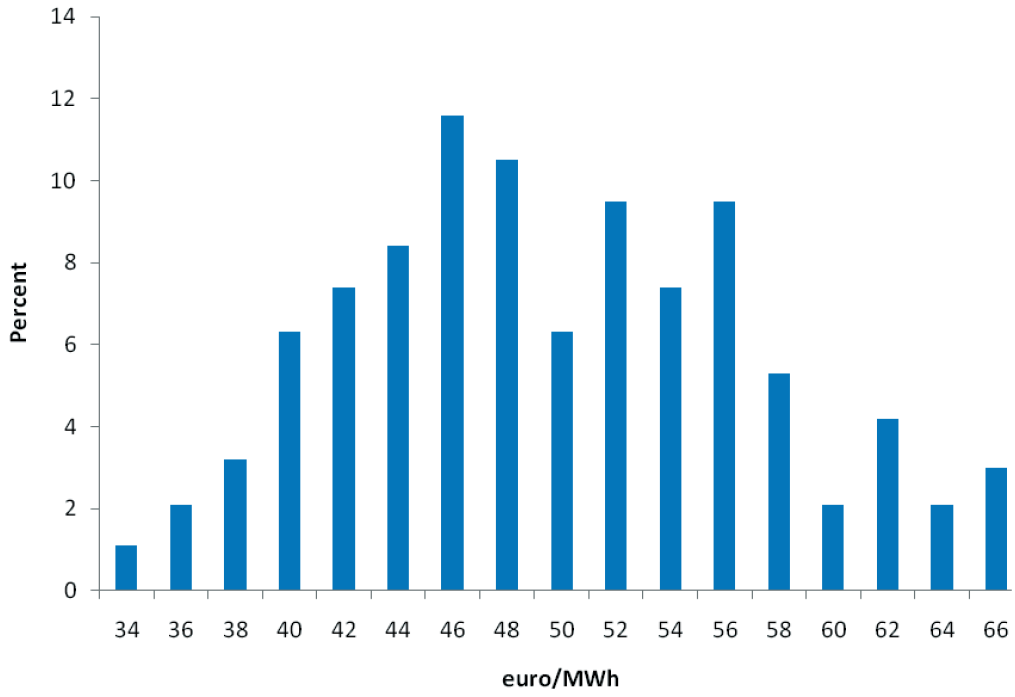

Figure 5.8 Price spread in Finland 2007, euro/MWh
Arithmetic average = 50,7 and weighted average = 45,6 euro/MWh

Source: Energiateollisuus 2008

Table 5.4 Highest and lowest price together with range and weighted average price

Euro/MWh	2003	2004	2005	2006	2007
Highest	64	56,5	60	75	69
Lowest	30	32	33	34	37
Range	34	24,5	27	41	32
Weighted average	38	39	41,5	44	45,6

Source: Energiateollisuus

In Finland it is the owner of the entire residence building, either the tenants as a group or any other owner, which is seen as the costumer to the district heating company. The used amount of heat is metered for every costumer and the cost of heating is distributed among the tenants usually according to the area. The tariff is based on:

- Connecting fee
- Basic fee
- Usage fee

The customer pays a connection fee when district heating is connected to the building. The level of this fee depends on the size of the building. The basic fee is covering the fixed cost for the heat while the usage fee covers the variable costs and depends on, for example, on the fuel being used in the particular network.

The share of basic fee and usage fee on total cost varies among the companies but the basic fee is usually around 20% (the highest around 35% and lowest around 12%) of the total cost giving a usage fee share of around 80%.

Vanhanen et.al (2006) presented some calculations regarding investment cost (fixed cost) and energy cost (variable cost) in Euro/year for district heating and some close substitutes. Figure 5.9 presents these results for a single detached house using 20MWh/year.

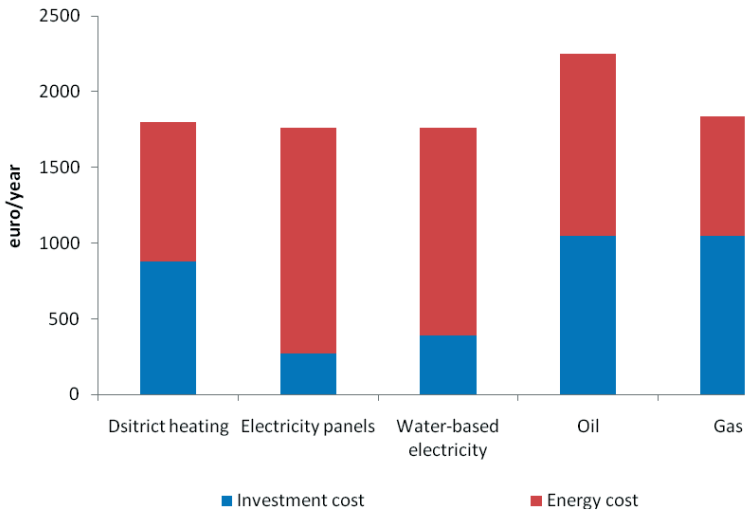

Figure 5.9 Distribution of yearly investment (fixed) cost and energy (variable) cost for a detached house using 20 MWh/year

Source: Vanhanen, Syrjänen and Vartianen, 2006

District heating, Electricity panels and water based electricity heating comes out approximately the same in total cost, but with a higher investment cost for district heating. Consequently the variable cost, the energy cost is higher for the electrical heating alternatives.

Figure 5.10 shows a more detailed picture of the energy cost in Euro/MWh for different sources in some different buildings comprising detached house assumed to use 20 MWh/year, terrace house assumed to use 100 MWh/year, low-rise buildings assumed to use 225 MWh/year and high-rise building assumed to use 450 MWh/year. In this comparison, using prices from 2005, electricity based heating and oil based heating comes out as the most expensive alternatives.

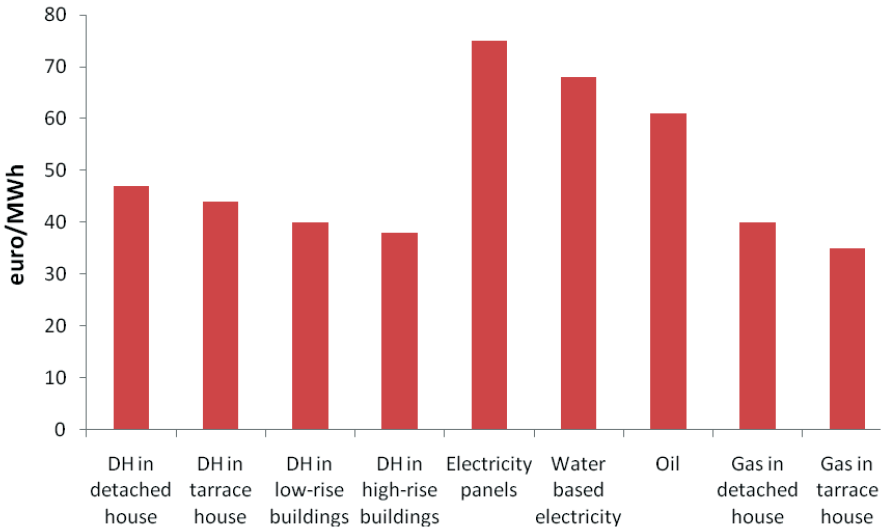

Figure 5.10 Cost of different heating sources in Finland 2005 in euro/MWh

Source: Vanhanen, Syrjänen and Vartianen, 2006

The energy cost for district heating is, as expected, falling with the size of the building as more users "share" the investment cost which doesn't increase proportionally with the number of users. Gas in single detached houses and in terrace houses are on an energy cost basis close competitors to district heating. However, in low-rise and high-rise apartment buildings district heating comes out as the alternative with the lowest energy cost.

As Sweden has the "REKO-system" Finland have introduced "The Fair District Heating" quality mark ("Reilu Kaukolämpö") for energy and district heating suppliers with open and customer-oriented operations. The quality mark requires constant development of district heating as a high-standard product, open and comparable pricing, customer safety, and open communications and co-operation between various customer groups and other partners. According to the quality mark requirements of the Finnish Energy Industries, a company applying for the quality mark should also utilize the technical and economic recommendations of the Finnish Energy Industries, for example, connection and sales terms of district heating. A company with the quality mark ensures high reliability of district heating supply.

The quality mark requirements of Fair District Heating have been developed in co-operation with the customers. A total of 36 companies have, by 2008, been awarded with the Fair District Heating quality mark. The total sales of these companies amount to more than 73% of district heating sales. The customers of the companies with a quality mark account for almost 63% of all customers (Energiateollisuus).

Summary

Of the total heat consumption in Finland in 2007, almost 50% came from district heating. Also, of all consumed district heating in 2007, around 30000 GWh, 50% was consumed in residential buildings, especially in larger urban areas such as the capital city Helsinki. The seemingly limited surveillance over the Finnish district heating market is pursued by the Finnish competition Authority in accordance to the competition law. Natural gas, coal and peat are the dominating fuels and almost 50% of the heat is generated in CHP-plants. Most of the district heating companies in Finland are municipality owned joint stock companies and a relatively large part of the heat is managed through a wholesale market. Prices have been increasing in nominal terms and was in 2007 45,6 Euro/MWh, and the observed price range between the highest and lowest price is fairly constant ,slightly above 30 Euro/MWh. The obvious competitors in Finland are Electricity based heating and the use of gas, but the strength of the competition depends on the available relevant market.

6. LITHUANIA

As in most other former Eastern European country, Lithuania had a well developed district heating system. Every town and larger settlement had a district heating network. District heating tariffs were very low, there were no need to save heat, therefore control valves or other equipment enabling to measure and control the heat consumption were non-existent. After collapse of the Soviet regime fuel prices increased to international levels causing substantial increases in, for example, district heating prices. The following transition process in Lithuania is still an ongoing process which, as will be described below, has lead to fundamental changes for how the district heating market in Lithuania is functioning. Table 6.1 shows some basic facts for the Lithuanian district heating sector 2005/06.

Table 6.1 Basic facts for Lithuanian District Heating Sector, 2005/06

Number of DH companies (production >5 GWh)	58
Number of CHP plants	36
Number of CHP DH plants	18
Maximum heat output capacity (exclusive industrial contribution)	9789 MW
With combined heat and power production	2231 MW
Without power production	7558 MW
Fuels used for DH	
coal	0.14 %
oil	4.25 %
natural gas	81.70 %
renewable	12.05 %
other fuels	1.86 %
Fuels used for CHP electricity (units connected to DH)	
oil	1.00 %
natural gas	99.00 %
Total heat delivered to the pipeline system	10110 GWh
Heat delivered with electricity production	5030 GWh
Electricity delivered from CHP plants connected to DH	1764 GWh
Heat delivered for industrial use	984,0 GWh
Heat delivered by industry to the pipeline systems	2200 GWh
Heat delivered to consumers	8126 GWh
Total route length of DH pipeline system	2507 km

Source: Country-by-country report 2007, Lithuania

Market Development

District heating has a dominant position in Lithuania's total heat production. As depicted in figure 6.1, around 70% of all heat produced in Lithuania is produced in district heating plants.

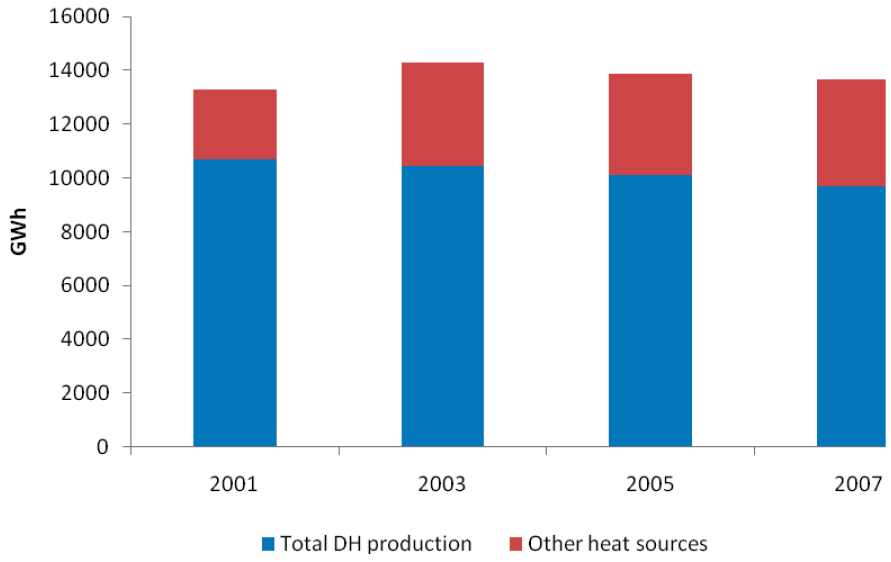

Figure 6.1 The heat market 2001, 2003, 2005 and 2007 in Lithuania (GWh)
Source: Lithuanian District Heating Association (2008) and Lithuanian Department of Statistics

As seen in the figure, both total heat production and especially the production of district heating have declined over the observed years. The reduction in district heating have been relatively larger than the reduction in total heat production resulting in a decreasing share of district heating from 80% in 2001 to 70% in 2007.

District heat production and district heat consumption in Lithuania experienced even greater reductions prior to 2001. Figure 6.2 shows the significant reduction in both the production and consumption of district heating since 1997. This is explained by the economical situation in Lithuania including bankruptcies and disconnections of industrial companies, decline in living standards, and switch over individual natural gas – based heating (Lithuanian District Heating Association) . Figure 6.2 shows the development from 1997 to 2006 and it is clear that the production and consumption stabilized in 2002 with a production slightly above 10 TWh and consumption between 8 and 9 TWh. Also, the heat losses (the difference between the lines in Figure 6.2) have decreased from above 30% in 1997 to below 18% in 2006.

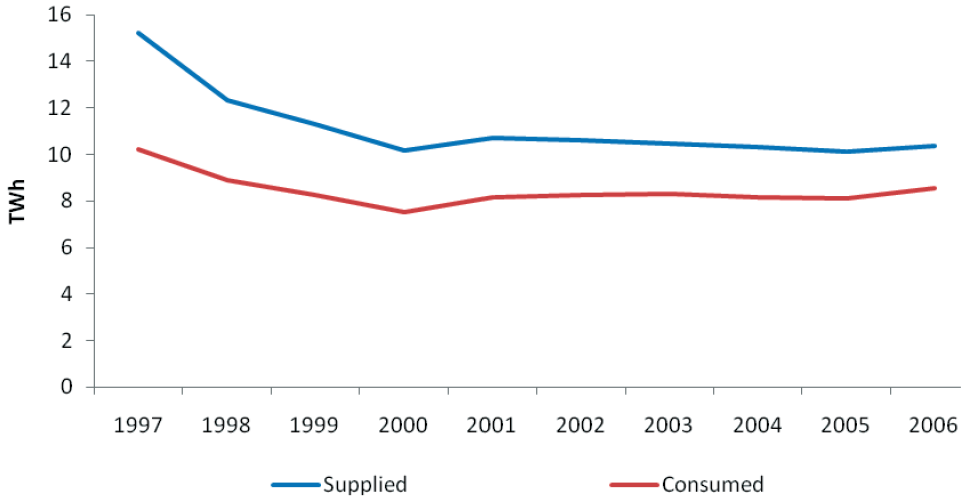

Figure 6.2 District heat production and heat consumption 1997-2006 in Lithuania (TWh)
Source: Lithuanian District Heating Association (2008)

Public Policy and Legal Framework

Taxes and Price Regulation

The heat prices in Lithuania are set by National Control Commission for Prices and Energy (NCC). District heating suppliers, generating more than 5 GWh of heat, prepare and submit for approval of the NCC, the base prices. The base prices that are approved by the NCC are publicly announced and is set for 3-5 years and subject to re-evaluation every year and adjusted if the market changes, a version of price-cap regulation. These market changes might be, for example, a change in fuel prices, inflation changes, and if the traded volume change significantly.

Energy taxes consist of taxes for State natural resources, environmental pollution taxes, land taxes, property taxes and road taxes. The value added tax (VAT) in Lithuania is 18%. According to commitments for the Lithuanian entrance into the EU, VAT for heat and hot water was 18% from May, 2004. However, the Government of Lithuania decided to compensate 13% of this VAT to residents from September 2004 leading to a present VAT level for heat and hot water supplied to residents at 5 %. For industrial consumers the VAT for DH is still 18%. Also for gas and electricity VAT is 18%.

In accordance with the base prices, the Municipalities' Councils set the heat prices to be charged by every controlled heat company with a production over 5 GWh of heat per year. Municipalities also set the heat prices for heat producers selling less than 5 GWh of heat per year. The maximum tariffs for maintenance of the systems in apartment buildings are also set by the municipalities.

Legal and Institutional Framework

Competition between district heating and decentralized heating, primarily individual natural gas fired boilers, still exists. As the Heat Law came into force in 2003 the former uncontrolled disconnections from DH networks decreased correspondingly.

In implementing the Heat Law, several DH companies purchase large amounts of heat from independent heat producers. A somewhat competitive market is thus established at the heat production stage. During 2005, district heating companies purchased about 2200 GWh heat from industrial companies, approximately 22 % of the total heat delivered to DH network. In accordance to the Heat Law, competition is also slowly promoted in these areas of hot water preparation and supply and in the field of maintenance of heating and hot water systems inside the apartment houses.

The Energy Law (adopted in October, 2002) is the main legal act on Lithuanian energy system regulation. Under this law there are 6 other laws, regulating the main energy sectors:

- Heat Law
- Natural Gas Law
- Law on Electricity
- Law on Biofuel, Biofuels for transport and Bio-oils
- Law on State Stocks of Petroleum Products and Crude Oil
- Law on Nuclear energy

The Energy Law regulates the activities in the heat sector, their relationship with heat consumers, their interrelationship and responsibilities. The general objectives are;

- to guarantee the reliable and high quality least-cost heat supply to consumers,
- to establish the reasonable competition in the heat sector,
- to defend the rights and legitimate interests of heat consumers,
- to improve the efficiency of heat production, transmission and consumption,
- to increase the utilization of local fuel, biomass and renewable energy resources in heat production
- and to reduce the negative impact of heat energy industry on the environment.

Relevant Institutions

The main authorities regulating Lithuanian energy sector are the Government, the Ministry of Finance, the Ministry of the Environment, the National Control Commission for Prices and Energy (NCC), the State Energy Inspectorate and Boards of the 60 Municipalities in Lithuania.

The Ministry of Finance implements the State policy in the energy sector, drafts and approve legal acts regulating the issues of security of supply, installation, operation, technical safety, efficiency of energy facilities, drafts the National Energy Strategy implementation plan and programmes, coordinates respective implementation; approves the rules for transmission, distribution, supply and consumption of energy and energy resources; establishes the procedure for building up maintenance, accumulation and use of stocks of energy resources; lay down quality requirements for energy consumed in the country; establish the procedure and terms for the connection of energy facilities (networks, equipment, systems) of the customers and producers to the operating facilities of energy enterprises (networks, equipment, systems); establish the procedure of state control of the energy sector and control of the customers' energy equipment; establish the procedure, volume and terms of furnishing of the information relating to

the energy activities to state institutions, agencies and third parties, e. t. c. The Ministry of Finance also develops international cooperation within the energy sector.

The Ministry of the Environment decide on issues relating to environmental protection, construction and fulfil functions, organise and carry out monitoring of environmental effects in increased pollution areas of energy sector activities. In conjunction with the Ministry of Finance it lays down quality requirements for the energy resources used and intended to be used in the country and submit recommendations for the use thereof. The Ministry of the Environment also take part in setting up of renewable energy resources programmes.

The National Control Commission for Prices and Energy (NCC) approve the methodologies and procedures for setting state regulated prices; set state regulated price caps; control the application of state regulated prices and tariffs; approve charges for connection of energy facilities; approve the purchase price for electricity generated from renewable energy; grant a licence for transmission, distribution, public supply and independent supply of energy, and control over the licensed activities of energy undertakings.

The State Energy Inspectorate exercises the State control of energy facilities and equipment and finally; the Management of the energy sector at municipal level are allocated to the individual Municipalities Within their respective territory, municipalities shall regulate the supply of heat to customers.

There are many other bodies involved in the management of National energy sector. The Ministry of Social Security and Labour is, for example, authorised to provide heating, hot and cold water subsidies to low-income families. In addition the Ministry of Finance is also directly involved because of budgetary considerations.

Long term prospects

According to the Lithuanian District Heating Association, district heat supply will not increase by 2025. By implementing residential and public buildings renovation programs the energy demand can be reduced, it is thus assumed that the total DH demand in 2025 will be even less than in 2004

In 2005 public district heating CHP plants produced 1764 GWh electricity, i.e. 16.5% of total electricity (10754 GWh) delivered to Lithuanian National Power Grid. The possible annual power production with total installed power capacity (593 MW) can be 2866 GWh. The forecast for new CHP production potential is 4203 GWh per year. According to the Lithuanian District Heating Association the Lithuanian CHP plants could in the future generate 7,1 TWh electricity per year.

The main trends for CHP development by 2020 states that the share of CHP electricity would make up at least 35% (in 2005 around 16,5%) and that the share of CHP heat would make up at least 75% (in 2005 around 50%)

Further challenges for the future, involving for example the Ignalina closure, is described in the Country-by-Country report 2007 pages 260-261 made by the Lithuanian District Heating Association.

Basic Conditions and Market Structure

Fuel and Technology

The fuel used in Lithuanian district heating plants is primarily, around 80%, natural gas imported from Russia. The use of renewable fuel is however increasing and was in 2006 standing for almost 15% see Figure 6.3.

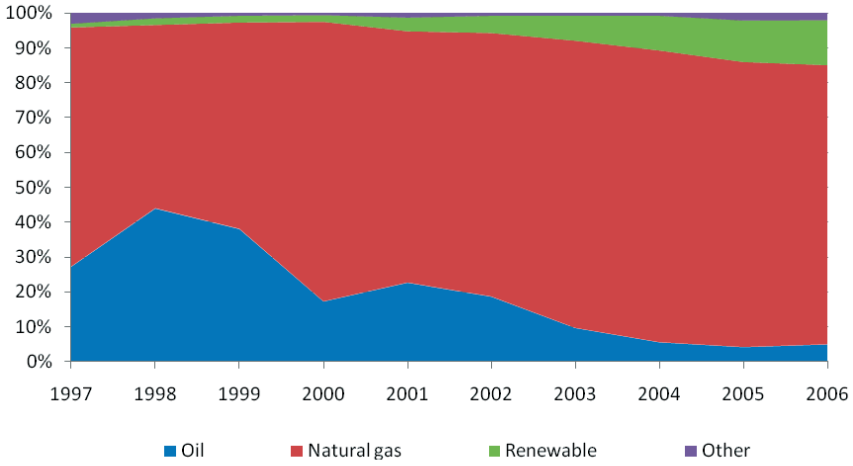

Figure 6.3 Fuel usages for heat production 1997-2006

Source: Country-by-country report 2007, Lithuania

The renewable fuels are dominated by wood based fuels (90%) followed by geothermal and biogas and straw.

A little less than half of the heat production is produced in CHP-plants of which almost all is produced using natural gas. However, all new CHP-plants use renewable fuels. Figure 6.4 shows the distribution of the heat produced in CHP-plants and heat only plants respectively for the years 2001, 2003, 2005 and 2007.

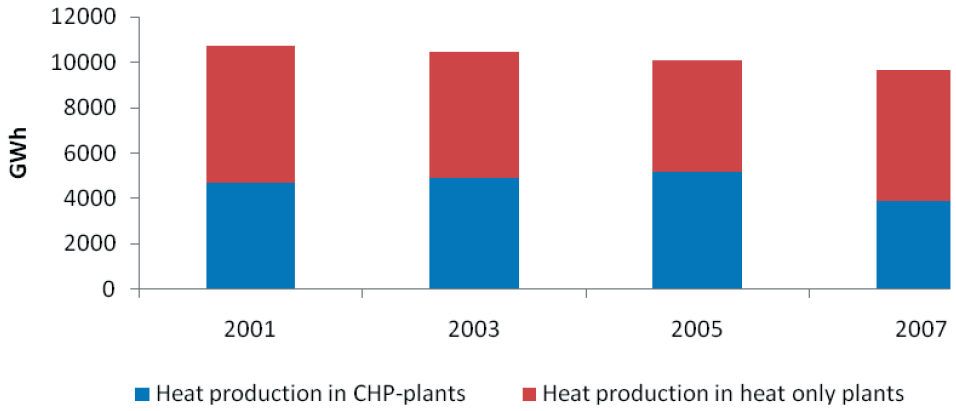

Figure 6.4 Production of heat in CHP-plants and heat only plants in Lithuania 2001, 2003, 2005 and 2007.

Source: Lithuanian District Heating Association (2008), and Country-by-country report 2007, Lithuania

Figure 6.5 shows that the electricity production in CHP-plants that produces electricity that is feed into the national grid is slowly increasing, but is still marginal compared to total electricity production.

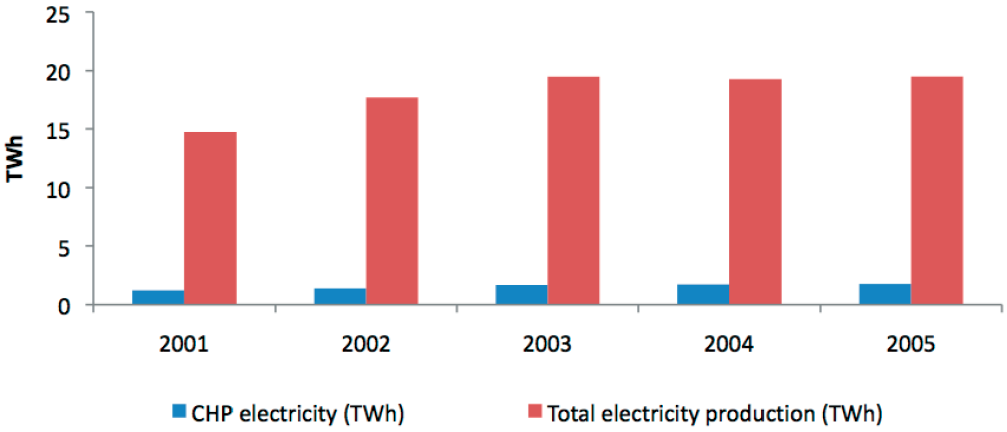

Figure 6.5 Production of heat in CHP-plants and heat only plants in Lithuania 2001, 2003 and 2005.

Source: Lithuanian District Heating Association (2008), and Country-by-country report 2007, Lithuania

Market Structure

In 2007 there were about 58 companies in Lithuania operating 94 district heating systems (where the annual heat generation is not less than 5 GWh). Connected to these systems are 27000 buildings of which 17000 are apartment houses with 660000 individual flats including about 2 million residents in total. Figure 6.6 shows the development for the number of costumers (flats).

Figure 6.6 Number of costumers (flats) connected to the DH-system.

Source: Country-by-country report 2007, Lithuania

The total length of integrated DH network was 2507 km in 2005. Most of this, 1980 km, is from before 1991. More modern pipelines constructed and put into place after 1990, make only 21 % (520 km). According to the Lithuanian District Heating Association, around €910 million investments are required for the reconstruction of outdated pi-

pelines. €72 million are planned to be allocated from EU Structural funds 2007-2013, (Country-by-country report 2007). Table 6.3 depicts the data for the three largest district heating networks in Lithuania in 2007.

Table 6.3 The three largest networks in Lithuania

DH company	Number of connected customers	Length	Capacity
Vilniaus energija	163437	558 km	2212 MW
Kauno energija	119009	417 km	757 MW
Klaipedos energija	47230	214 km	1025 MW

Source: Country-by-country report 2007

Ownership and re-regulation

In 1997 the former state monopoly, Lithuanian Power Company (LPC), was split into six regional and thirteen municipality companies. Prior to the de-regulation, the Lithuanian district heating network was well developed with very low prices. However, after collapse of the Soviet regime, fuel prices increased to international levels causing significant increases in district heating prices and state subsidies was initially used to soften the burden on LPC. After several years, LPC still made serious losses. Therefore, the Government of Lithuania decided to restructure LPC, separating its district heating businesses turning it to regional and municipal ownership. The regional companies were owned by several (from 4 to 9) municipalities and were operating in broader regions, surrounding some bigger city.

Keeping the single price policy meant however that smaller towns, with higher cost of providing heat, were being subsidized from dense populated and industrial areas. During 1998 to 2001 the process of further dividing the district heating companies continued and all but one regional company was split into single municipality owned companies. As a consequence, district heating tariffs increased in all regional towns while the five largest cities maintained low, and even reduced tariffs. Figure 6.7 shows the ownership conditions in 2005. Municipalities own slightly less than 60% of DH companies, the rest being leased. The lease of heat utilities to foreign and domestic investors started in 2000. Dalkia Group (France) manage 9 utilities; “E energija” UAB (local investor) - 3 utilities and “Fortum Heat Lietuva” UAB (Finland) – 2 utilities.

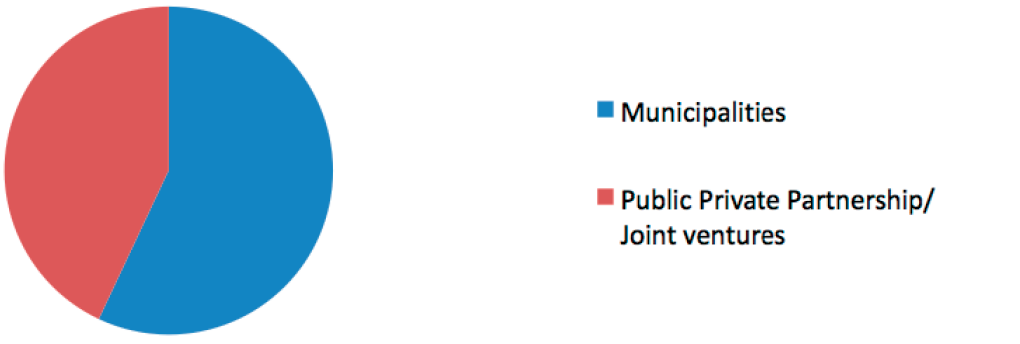

Figure 6.7 Ownership Lithuanian District Heating 2007

Source: Lithuanian District Heating Association

With the presently used individual or heterogeneous pricing, the cost of district heating in rural areas is higher compared to the urban areas. Heavy burden of district heating prices is thus reduced by the state for low-income customers. In 1999, the Parliament passed a law on compensations for low income customers if and when the district heating bill exceeds one quarter of the households income, all the rest is compensated by the state budget.

In 2007, 8005 GWh of district heat was consumed out of which 5796 GWh (over 70%) was delivered to households for heating and hot water preparation purposes. The rest was delivered to other users (industry/business companies (552 GWh), budgetary organisations (1017 GWh) and other consumers (640 GWh)). Figure 6.8 depict the small variations between different consumer groups for 2001, 2003, 2005 and 2007.

Figure 6.8 Heat usages on consumer groups 2001, 2003, 2005 and 2007

Source: Country-by-country report 2007, Lithuania

The competition between district heating and decentralized heating mostly based on individual natural gas fired boilers still exists. As the Heat Law came into force in 2003 the previously almost uncontrolled disconnections from DH networks decreased correspondingly. The main competitors to district heating companies are the natural gas distribution companies as they are seen to have, for example, superior marketing capabilities. There is no general state policy aiming at restricting competition, but larger municipalities and cities have already issued regulations restricting to what is called "easy cherry picking". Issuing licenses to district heating companies, according to the heat law from 2002, is claimed to further solve this problem (National Control Commission for Prices and Energy, Lithuania).

The heat prices are based on the supplier's necessary (rated by the state) costs for heat preparation, transmission, installation, inspection and verification of commercial heat and/or hot water meters, customer billing for heat, and accounting. The cost of maintenance of heating systems in the buildings is not included in the heat prices.

The average cost structure for the district heating industry in Lithuania is shown in Figure 6.9. Fuel constitute by far the highest share of total cost followed by the cost of labor, the total share of these to costs is almost 55%. Purchased own heat, material

and depreciation is also of significant size. Key financial indicators for 2001-2005 are shown in Table 6.4.

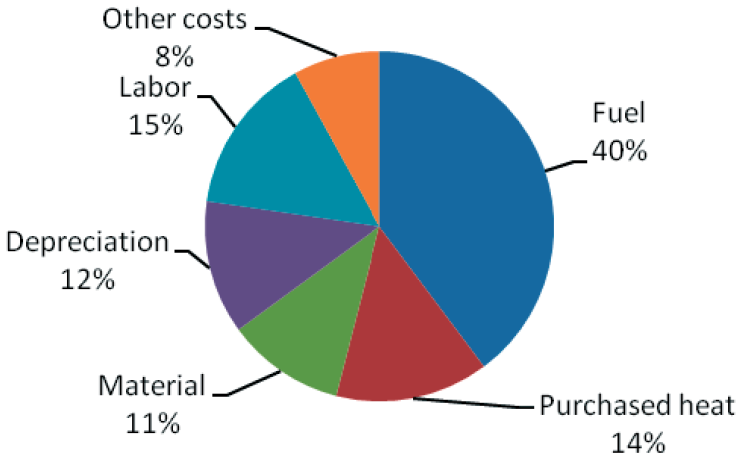

Figure 6.9 Cost structure in Lithuanian district heating plants

Source: Country-by-country report 2005, Lithuania

Table 6.4 Key indicators for 2001-2005

	Unit	2001	2002	2003	2004	2005
Average cost of fuel	EUR/toe	135	131	131	126	126
Turn over for heating	million EUR	272	278	277	268	265

Source: Country-by-country report 2007, Lithuania

As for most countries, the district heating operations in Lithuania are fully vertically integrated but with an existing wholesale market between the district heating plants and producers of hot waste water sold to the district heating operations. In 2007 this wholesale market constituted around 20% of the total heat consumed. Table 6.5 shows the district heating operations and their respective supplier of waste heat water.

Table 6.5: Buyers and sellers of waste hot water in Lithuania 2007

Buyer	Amount of energy in GWh	Seller	Type of operation
Vilnius energy	43,4	Grigiskes	Paper mill
Kauno energy	1 483,7	Kauno termofikacijos elektrine	Electricity producer
Klaipedos energy	31,6	Geoterma	
	38,4	Pramones energy	Electricity producer
	22,5	Ukmerges energy	Electricity producer
	14,0	Klaipedos baldai	Furniture industry
	7,6	Izobara	
Litesko	2,3	Axis Industries	
	3,9	Klaipedos ugne	
Panevezio energy	87,5	Lifosa	Chemistry industry
	36,3	Simega	
	5,2	Panevezio stiklas	Glass industry
E energy	1,1	Izobara	
	16,5	Eniras	Electricity producer
Plunges silumos tinklai	45,8	Plunges bioenergija	
Varenos siluma	4,4	Matulzu plytine	Brick industry
Elektreny komunalinis Ukis	69,6	Leituvos elektrine	Electricity producer
Total wholesale	1 913,9		

Source: Lithuanian District Heating Association, 2008

Market Conduct and Performance

The heat price is divided according to different technological stages: production, transmission and sale. The production price accounts for about 63%, transmission 34% and sales 3% of base price. The main share of the production price comprises fuel costs. Therefore, the structure of fuel and the price of the different types of fuel also influence the amount of the bases price which is the key factor implementing competition in production. The bulk of cost in the transmission price comprises heat transmission losses in the pipeline the fluctuation of which considerably affects the base price level. Figure 6.10 shows the average price development from 1996 to 2007 in EURO/MWh.

The price path is relatively stable from 1997 (year of market deregulation) to 2005. After that, in 2006 and 2007, the prices have increased as a consequence from the higher gas prices. However, since the district heating market in Lithuania was de-regulated in 1997 when the former state monopoly Lithuanian Power Company was reconstructed into regional and municipal companies[16], there no longer exists one single national price. In 2005 the heat tariff varied from 25.11 to 46.34 EUR/MWh. See figure 6.11.

16 The de-regulation process will be described in more detail in later sections in this chapter

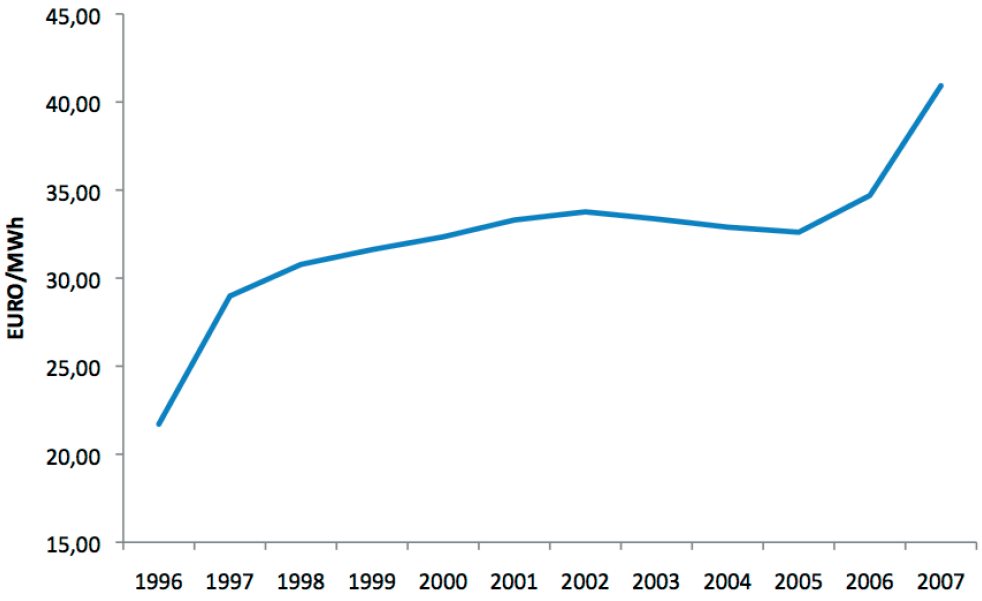

Figure 6.10 Price development of average district heating price in Lithuania 1996-2007, EURO/MWh

Source: Lithuanian District Heating Association

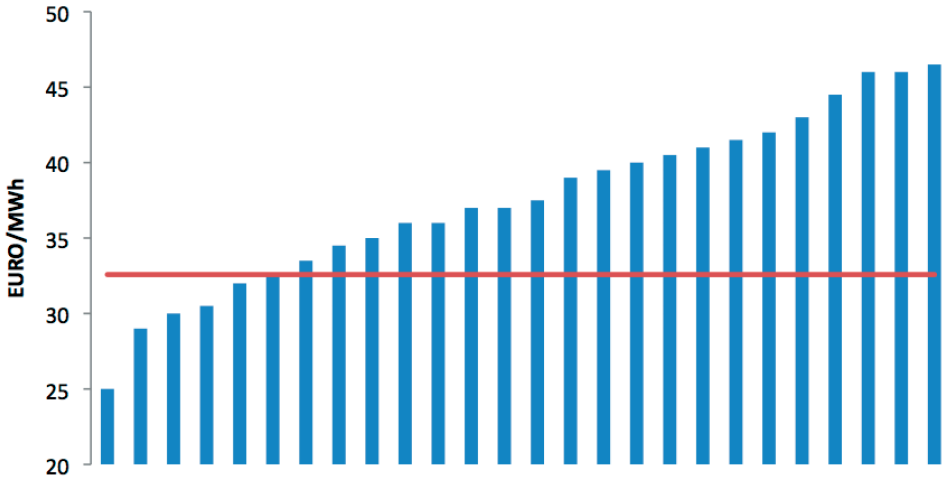

Figure 6.11 DH heat price distribution among companies in 2005 with the simple average 32,58 EURO/MWh

Source: Country-by-country report 2005, Lithuania

The impact of the transition process on prices, from originally having one single uniform price for all consumers to a more cost based pricing, is visible in the increased price spread over the latest years. Table 6.6 depicts some descriptive values for the prices (in Lt/MWh) for the years 2002, 2004, 2007 and 2008.

Table 6.6 Descriptive measures for district heating prices in Lithuania in Lt/MWh

Lt/MWh	2002	2004	2007	2008
Min value	105	102	107	113
Max value	162	170	210	234
Range	*57*	*68*	*103*	*121*
Ordinary average	133	132	152	171
Standard deviation	*17*	*19*	*24*	*26*
Median	134	129	150	169
First quartile	116	120	134	149
Third quartile	145	145	167	186
Interquartile range	*29*	*25*	*33*	*37*

Source: Lithuanian District Heating Association

All measures for price spread used in table 6.6, range, standard deviation and interquartile range, show an increasing trend. The range, i.e. the distance between the highest and lowest value have more than doubled between 2002 and 2008. This development of the prices is graphically presented in figure 6.12.

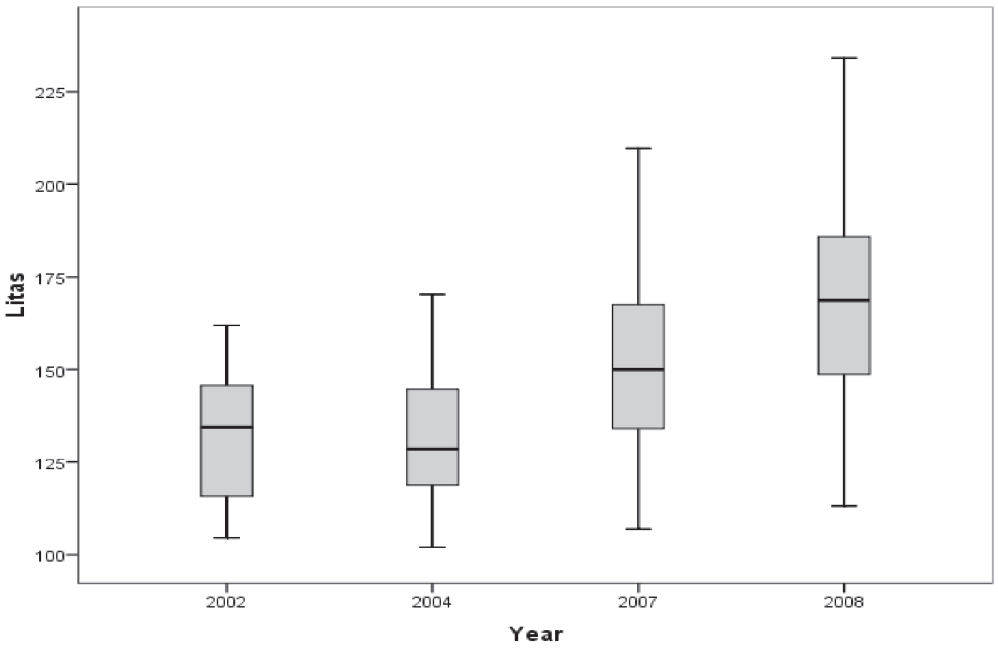

Figure 6.12 Median, interquartile range and range in Litas for 2002, 2004, 2007 and 2008

Source: Lithuanian District Heating Association

Regarding the structure of the tariffs, prices can for example be differentiated depending on the heat supply system, customer groups, volume of heat, reliability of supply, season of consumption, periodicity and method of metering. Although the costumers have, according to the Lithuanian District Heating Association, a choice between a two-part and

a one-part tariff system they have so far (2007) preferred the one-part tariff system.

Part of the heat customers buy the heat into the feeding point of the building where the meter is placed. In this agreement, a supply and consumption limit is established. These costumers pay only for heat production and transmission. These costumers are usually various official buildings, business companies and some are apartment buildings.

Consumers can also have the heat delivered passed the feeding point and into each apartment. In this case a service charge is added to the heat production and transmission price including subscription services cost for heat distribution, taxes and administration cost.

Summary

Since the collapse of the Soviet regime is the district heating market, as any another market in Lithuania, a market in transition. In spite of continuous fall in production and consumption of district heat in Lithuania from 1997 to 2005, district heating has kept its market share at around 70% in the heat market. There are however tendencies that the production and consumption of district heat is beginning to increase since 2005 and onwards. The district heating market in Lithuania is regulated in that the heat prices are, after negotiations, set by the National Control Commission for Prices and Energy (NCC). Natural gas is the clearly dominating fuel used in Lithuania and almost 40% of the district heat is generated in CHP-plants, which in turn only contributes marginally to the electricity supply. Almost 60% of the district heating companies are owned by the municipalities the remaining being leased by primarily Dalcia. Over 70% of the district heating consumption comes from residential buildings and around 20% of the total district heat deliveries goes through some kind of wholesale market including electricity producers, paper mills, chemistry industry etc. The prices in Lithuania were relatively stable up to 2005 when they started to increase. In addition to the increasing prices, the transition process has lead to increased price spread in Lithuania. The price range has more than doubled from 2002 to 2008.

7. AUSTRIA

The first CHP-plant in Austria was built in 1949 in the city of Klagenfurt and was built on the initiative of the municipality. Between 1950 and 1957 an additional five municipalities built both heat-only and CHP-plants. Since then, district heating has grown steadily and is constantly increasing its importance in Austria that, in 2007, had close to 400 district heating plants. District heating demand is covered mainly by municipal utilities and exists mainly in the metropolitan areas of Vienna, Graz, Linz, Salzburg, Klagenfurt, St. Pölten and Wels ((Austrian Energy Agency, 2004). Table 7.1 summarizes some basic facts for 2006/07.

Table 7.1 Basic facts for the Austrian District Heating Sector, 2006/07

Number of DH companies	392
Maximum heat output capacity (exclusive industrial contribution)	7 500 MW
Combined heat and power production	12 300 GWh
Without power production	5 300 GWh
Fuels used for DH	
coal	*21 %*
oil	*9 %*
natural gas	*57 %*
renewable	*5 %*
waste	*8 %*
Fuels used for CHP	
oil and coal	20 %
natural gas	60 %
renewable	16 %
waste	4 %
Electricity delivered from CHP plants connected to DH	17 847 GWh
Heat delivered to consumers	16 910 GWh
Total route length of DH pipeline system	3 968 km

Source: Country-by-country survey 2009, Austria

Market Development

The production of district heating in Austria has more than quadrupled from above 4 000 GWh in 1980 to almost 18 000 GWh in 2007. Figure 7.1 illustrate the development.

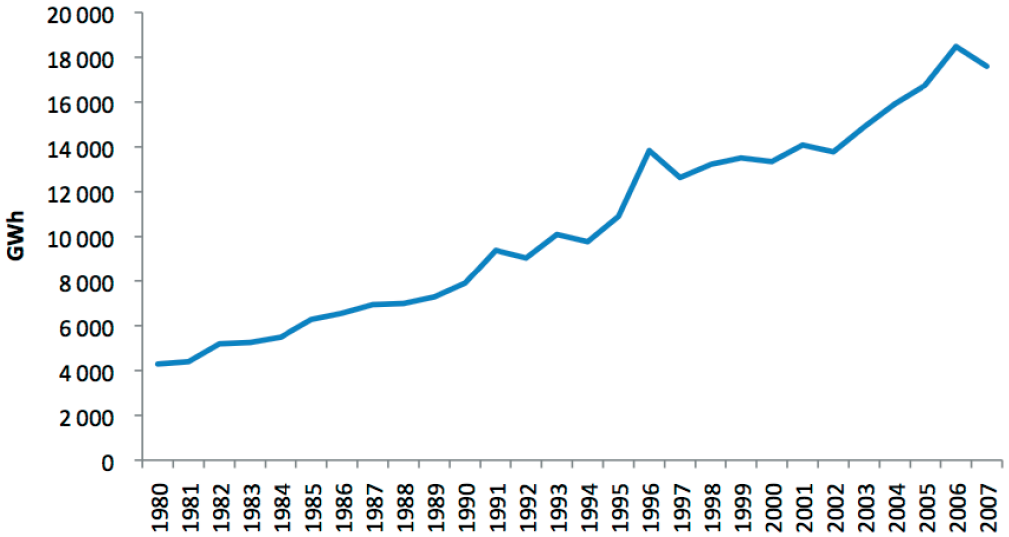

Figure 7.1 Development of district heating production in Austria, 1980-2007 in GWh
Source: Statistik Austria

Even if the development of district heat production has increased substantially its share of total heat demand in Austria is still marginal. Figure 7.2 shows that district heating constituted around 20% of the total heat demand in Austria in 2007.

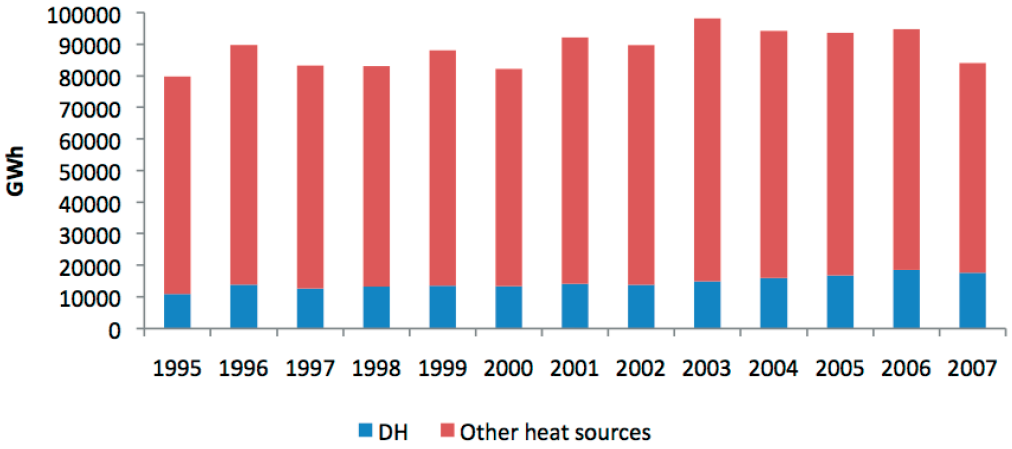

Figure 7.2 District heating and total heat market in Austria, 1995-2007 in GWh
Source: Statistik Austria and Fachverband der Gas- und Wärmeversorgungsunternehmungen

The demand for district heating is almost equally shared between households and industry including service sector. In 2007 the households represented 47% of the demand, public and private sector represented 40% of the demand and the manufacturing sector 13%. See figures 7.3 and 7.4.

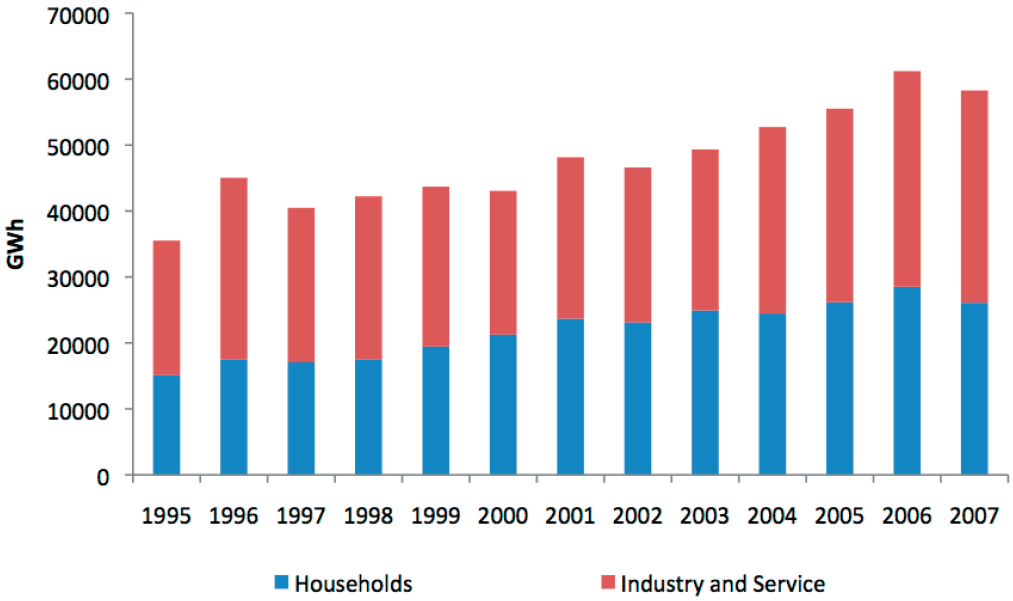

Figure 7.3 District heating usage in GWh divided on households and industry etc., in Austria 1995-2007

Source: Statistik Austria

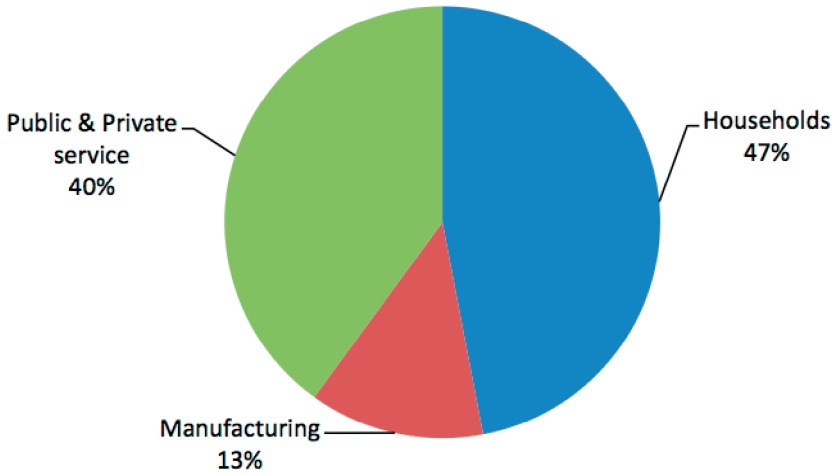

Figure 7.4 Detailed distribution of district heating demand in Austria 2007.

Source: Fachverband der Gas- und Wärmeversorgungsunternehmungen

Public Policy and Legal Framework

The district heating market in Austria is not subject to any direct legislation or federal regulation. The regulator in Austria, E-Control, do not in any way regulate, investigate or have any surveillance duties over the district heating market. Instead, with respect to

legislation, the district heating market is indirectly affected through legislation on the electricity market thereby affecting the conditions for the CHP-plants.

In 2003 Austria introduced its Eco-Power Act aiming to support the use of renewable energy sources and includes an uniform, subsidized, purchasing obligation from suppliers supplying power from wind, sun, geothermal, hydroelectric, biomass, landfill gas, sewer gas and bio gas (Country-by-country survey 2007). This activity is funded by an extra charge on the electricity price. The National council has since 2003 adopted some new amendments to the Eco-Power Act mainly aiming at some special targets regarding the use of renewable.

There is a special governmental subsidy for investments in heat extraction equipment in biomass CHP covering bewteen15% and 30% of the investment cost (Country-by-country survey 2007). In addition to the federal legislations and support schemes Austria also has some legislations on länder[17] level. One example is the legislation or regulations regarding buildings. Every länder has its own scheme regarding the subsidization of investment costs of heating systems mainly for renewable but some länder also provide subsidies direct for district heating.

Industrial buildings are not always covered by the länder specific regulation and can therefore get governmental subsidies for different investments. There is for example a 30% subsidy on investments for district heating systems using only renewable fuels and a 15% subsidy for district heating systems using fossil fuels. In 2008 the National Council amended a new law for expansion of district heating and district cooling networks providing a state aid of 50 million Euros per year for building new district heating and cooling infrastructure (Country-by-country survey 2007 and 2009).

Basic Conditions and Market Structure

Fuel and Technology

As for the other countries in this study also Austria shows a decreased use of oil and coal for district heating generation. See figure 7.5. The use of natural gas is fairly constant and it is primarily the increased use of biomass that has replaced the oil and coal usage.

17 Austria is a federal parliamentary democracy divided into nine provinces or länder (Burgenland, Carinthia, Lower Austria, Upper Austria, Salzburg, Styria, Tirol, Vorarlberg and Vienna).

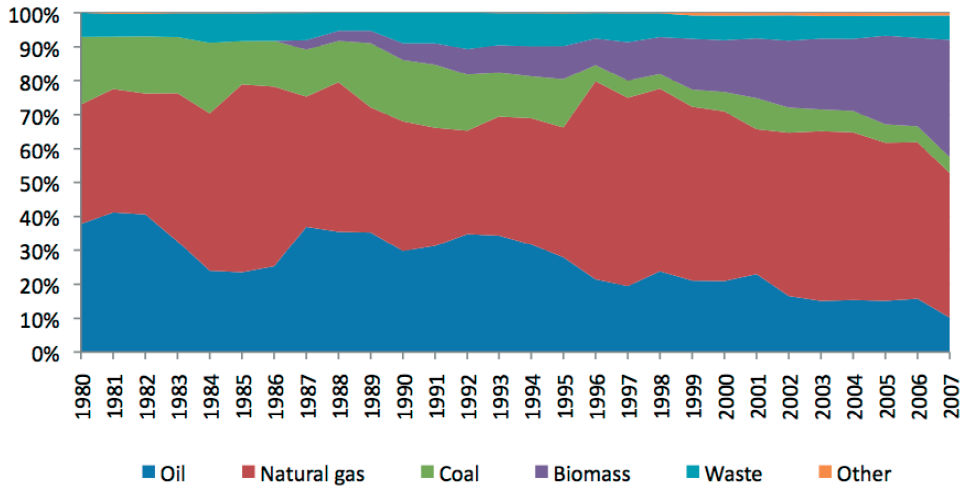

Figure 7.5 Share of different fuels for district heating generation in Austria 1980-2007.
Source: Statistik Austria

Around 60% of the produced district heat in Austria is derived in combined heat and power plants (CHP). These CHP plants are an important factor for both the heat and electricity supply in Austria. See figure 7.6. The electricity supply in Austria has primarily two sources, hydro power (70%) and thermal power (30%) and 85% of the electricity generated by thermal power plants comes from CHP-plants. This thermal power is used to balance the seasonal variations of demand.

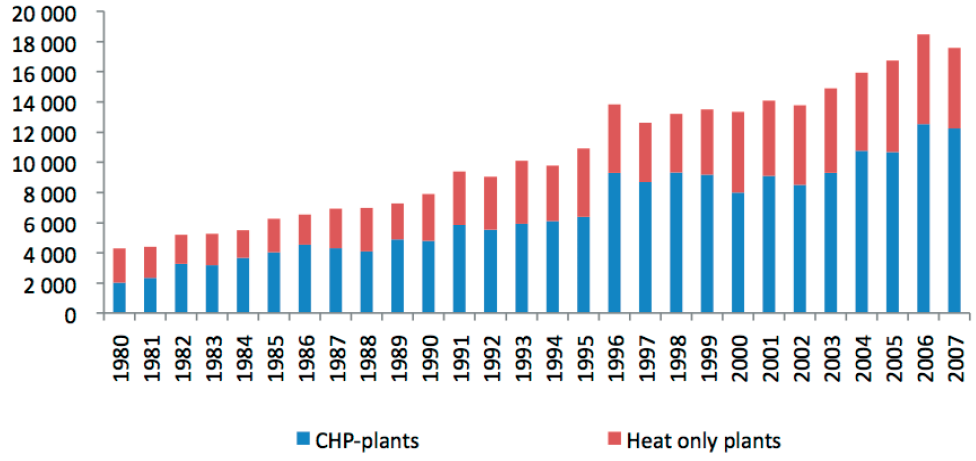

Figure 7.6 Total district heating production in GWh divided on production in CHP-plants and heat only plants in Austria 1980-2007.
Source: Statistik Austria

Figure 7.9 shows the contribution to total electricity production that comes from the CHP-plants in Austria for the years 2000 to 2007. The share of CHP-plant's contribution to the

electricity production has been increasing and was in 2007 slightly below 20%. Hydropower dominates as the source of electricity generation in Austria with a share of 60% in 2007.

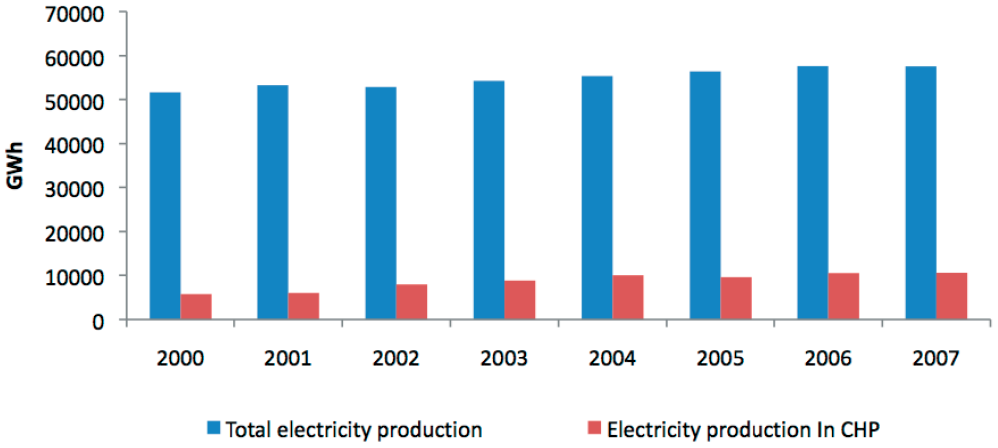

Figure 7.7 Total electricity production and electricity production in CHP-plants 2000-2007 in GWh

Source: Statistik Austria

Market Structure

Out of all apartments in Austria, 18% use district heating as their source of heat while the rest use central heating (61%) or some kind of individual heat source (21%). These are national figures which change substantially when analyzing the share of apartments using district heating in different municipalities. In for example Linz the share is almost 60%, in Vienna 36%, in Klagenfurt 30% etc. The total number of apartments connected to district heating was in 2007 approximately 626 000, see figure 7.8.

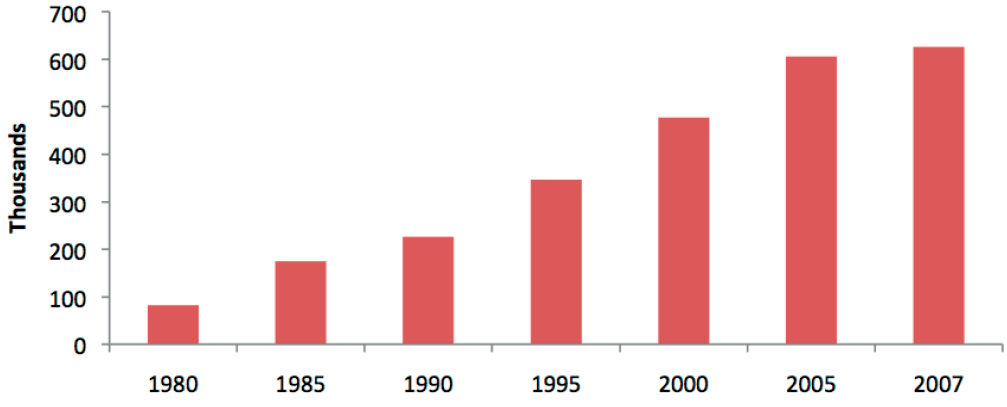

Figure 7.8 Number of apartments (in thousands) connected to district heating in Austria, selected years

Source: Fachverband der Gas- und Wärmeversorgungsunternehmungen

The number of member companies in Fachverband der Gas- und Wärmeversorgungsunternehmungen (FGW) is increasing slowly and was in 2006, 392 companies producing district heating. Figure 7.9 depicts the development.

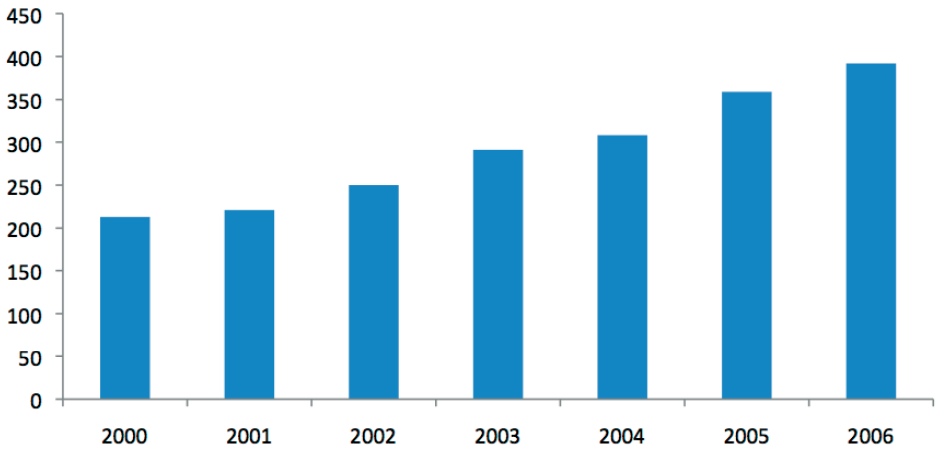

Figure 7.9 Number of district heating (member) companies in Austria selected years
Source: Fachverband der Gas- und Wärmeversorgungsunternehmungen

However, this is the number of companies, not the number of plants. According to Euroheat & Power's country-by-country survey 2009, Austria had 588 DH-utilities in 2006. To get more specific data on the number of plants in Austria has been proven difficult as no plant date has been made available and different numbers and definitions must exist. For example, according to the Austrian Energy Agency (2004), the number of rural biomass-fired district heating plants with a capacity between 100kW and 5MW was close to 700 in 2001. These small plants are usually run by farmers using wood chips and sawmill residues as fuel. The building of these plants was subsidized by both the Federal Government and by the individual länder[18] and the plants usually operates only wintertime as a substitute to the solar energy used in the summertime

An absolute majority, almost 90%, of the district heating plants are publicly owned either CHP-plants or heat-only plants. Figure 7.10 shows the development of ownership between 1980 and 2007.

18 Austria is a federal parliamentary democracy divided into nine provinces or länder (Burgenland, Carinthia, Lower Austria, Upper Austria, Salzburg, Styria, Tirol, Vorarlberg and Vienna).

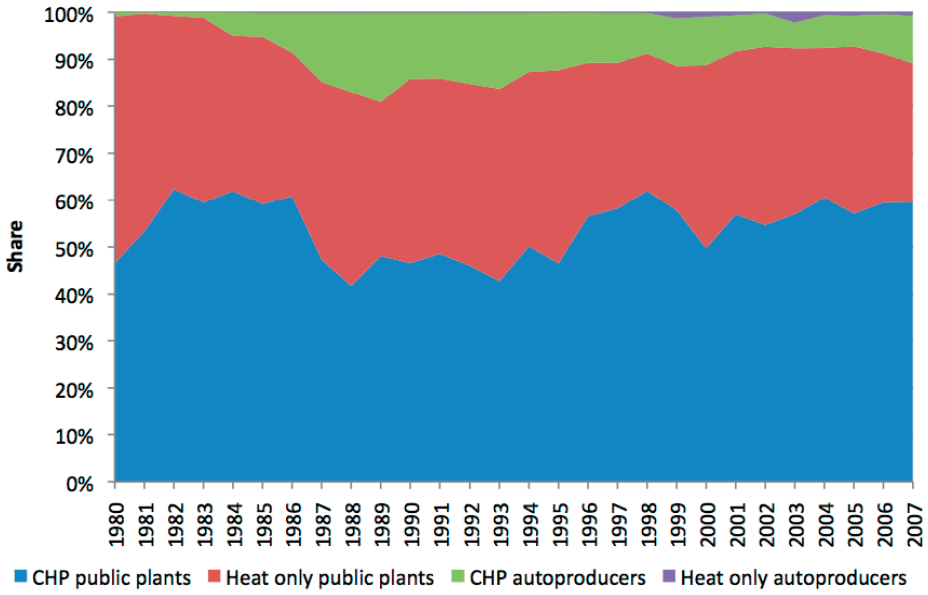

Figure 7.10 Share of total district heating production divided on public plants and autoproducers in Austria 1980-2007.

Source: Statistik Austria

According to available statistics all plants dedicated at producing either heat directly for district heating indirectly in CHP-plants are owned publicly by municipalities. The other providers of heat to the network are called autoproducers and we adopt here the definition of an autoproducer used by the International Energy Agency: "Autoproducer undertakings generate electricity and/or heat, wholly or partly for their own use as an activity which supports their primary activity".[19] According to the Austrian Energy Agency almost 90% of the heat provided for by autoproducers originates from three main sectors:

- Production and processing of ferrous metals
- Pulp and paper industry
- Chemical industry

19 Energy Statistics Working Group Meeting: Special Issue Paper 2, Public vs. autoproducers: a never ending statistical issue. Downloadable at http://www.iea.org/Textbase/work/2004/eswg/SIP2.pdf

Market Conduct and Performance

The availability of plant level data concerning both production and monetary information is to our knowledge highly limited. This holds also for aggregated data concerning price level for district heating and the eventual price spread between different markets for district heating in Austria. Figure 7.11 provides an estimate for the price development in Austria between 1986 and 2008. The estimation is done using official price information from Ecoheatcool (2006) regarding the years 1999 to 2003 in combination with official statistics regarding energy price index development in Austria for the years 1986-1998 and 2004-2008.

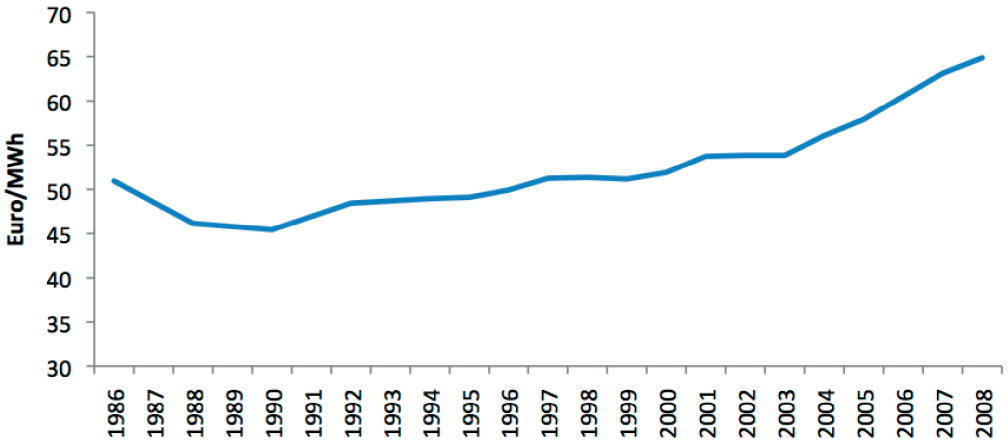

Figure 7.11 Estimated price development in Austria, 1986-2008, Euro/MWh

Source: Statistik Austria, Energy Agency Austria and Ecoheatcool.

In addition to the price development estimation provided in figure 7.10, the Austrian Fachverband Gas Wärme (FGW) inform in the Country-by-country survey (2007) that the price spread in 2005 was from 51,24 to 71,52 Euro/MWh, i.e. a price range of 20,28 Euro/MWh with an average price being 57,90 Euro/MWh. All these prices include the Austrian VAT of 20%.

Summary

Even if the production of district heat has increased dramatically in Austria, from around 4000 GWh in 1980 to almost 18000 GWh in 2007, it has just around 15% of the heat market. Central heating is still the dominating source of heat in Austria. Natural gas and bio mass are the most used fuels for district heating generation and almost 70% of the heat generated in district heating plants is generated in CHP-plants. The nominal prices have steadily been increasing from 1990 and the average price in 2005 was 57,90 Euro/MWh with a lowest price at 51,24 and a highest at 71,52 Euro/MWh.

8. ANALYSIS

Market Development

In general, the market share for district heating has continuously increased in Sweden, Denmark, Finland and Austria. In Lithuania the market share for district heating is relatively stable in spite of continuous fall in production and consumption. This is due to emerged economical situation in Lithuania (bankruptcies and disconnections of industrial companies), decline in living standards and a switch to individual natural gas based heating[20].

Public Policy

To describe the national public policy it is possible to divide it in

- competition-based approach including direct competition between district heating and other heat sources and competition between heat producers at the wholesale level, and
- regulatory approach including district heating zones, tariff regulation and energy plans.

All countries in this study are members of the European Union and are accordingly covered by the European legislation. All countries have some kind of energy and/or electricity law. In all countries legislation and/or taxation supporting environmental-friendly production of heat is in force. At least Sweden, Denmark and Lithuania have regulation or norms concerning maximum heat consumption in buildings.

In Lithuania one key strategic provision in the National Energy Strategy is to provide conditions for competition among heat producers and to establish a procedure to purchasing heat form the independent producers for the heat supply systems.

Denmark has the most extensive legislation concerning district heating including an obligation to connect new and existing buildings to public supply, a ban on installing electrical heating in new buildings and in existing buildings with water based central heating and tariff regulation. In Lithuania the heat prices are set by National Control Commission for Prices and Energy (NCC). The Swedish district heating law aims at maintaining the unregulated heat market at the same time as the consumer's position is strengthened. The district heating market in Austria is not subject to any direct legislation or federal regulation. However, Austria has some legislation at länder level but this legislation differs between länder. In Finland the regulatory supervision is based mainly on competition legislation and partly on the Electricity Act.

In addition to the regulation, each country has an energy agency with different tasks, usually including the responsibility for collecting and publishing statistics but also supporting the market with technological issues and even research. Sweden, Denmark and Lithuania also have an authority for surveillance of the district heating markets.

20 EuroHeat & Power Country-by-country-survey 2005

Basic conditions and market structure

Fuel and technology

The mix of fuel for the district heat production varies. Renewable energy sources such as wood chips and waste dominate in Sweden. But the market share for renewables is growing in all the countries included in this study. In Denmark, Finland, Lithuania and Austria fossil fuels like coal and especially natural gas dominate, se figure 8.1.

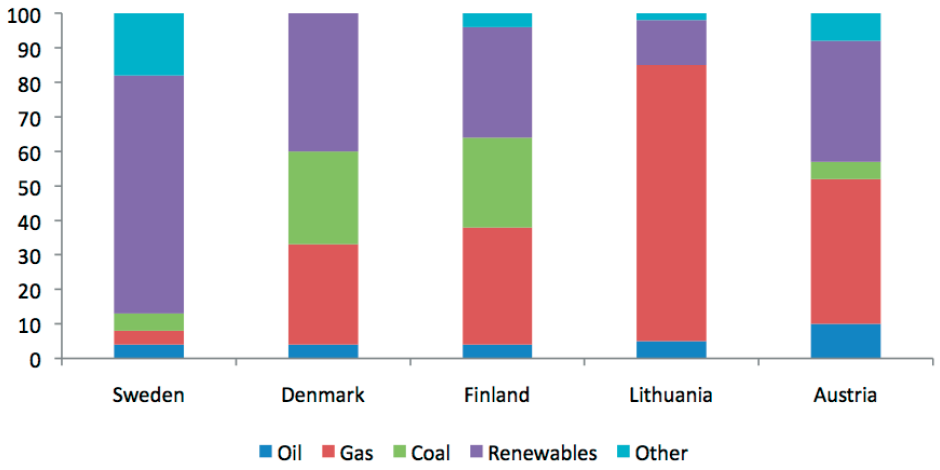

Figure 8.1 Share of different fuel usage for district heating in 2007

Source: Figures 3.3, 4.4, 5.5, 6.3 and 7.5

Denmark and Finland have the most extensive use of CHP for district heat production, with a share of approximately of 75-80%. In Sweden and Lithuania the corresponding share is less than 50%, se figure 8.2. Also in Austria CHP is used for the majority of the district heat production, but the district heat stands only for 20% of the total heat production.

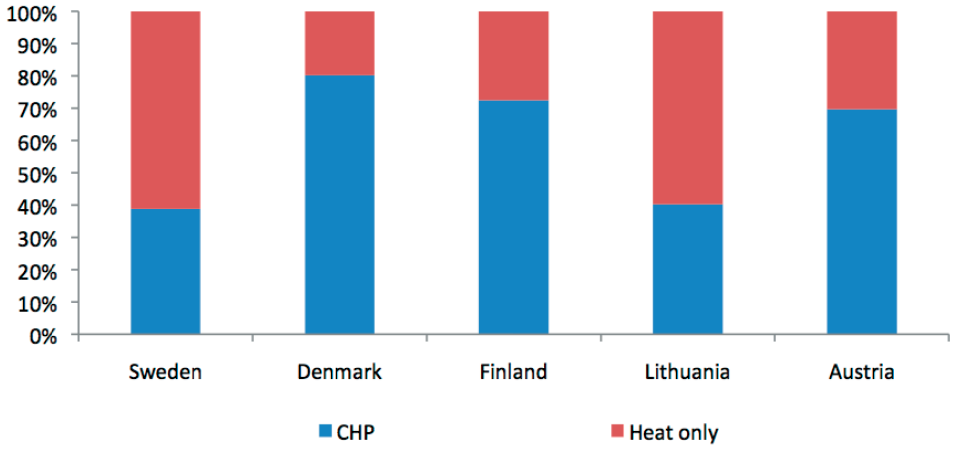

Figure 8.2 Share of heat from CHP and heat only plants in 2006

Source: Figures 3.4, 4.5, 5.6, 6.4, and 7.6

Market structure

Heat market

District heating is a part of the heat market. The market share for district heating varies between 20% and 70% in this study. Alternatives to district heating are for instance central heating with oil or gas, electricity, pellets and heat pumps, figure 8.3 describes the situation in 2006.

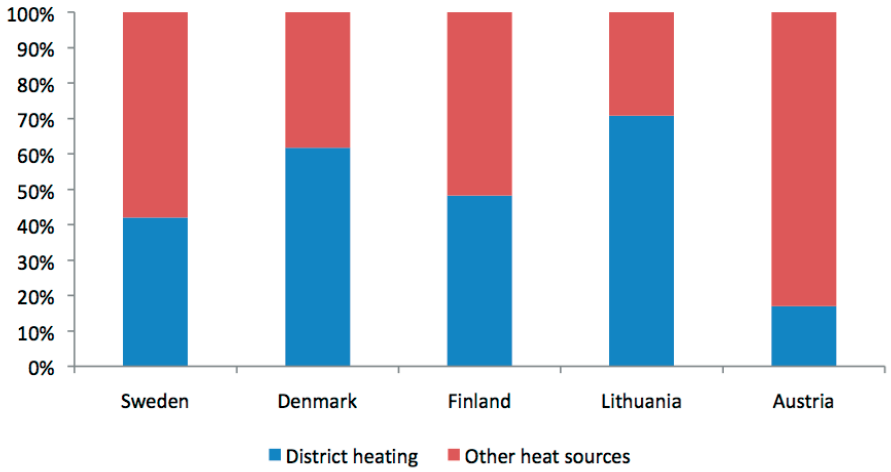

Figure 8.3 Heating sources share of total heat market in Denmark, Finland, Sweden and Austria, 2006

Source: Figures 3.1, 4.1, 5.1, 6.1 and 7.2

In many cases it is possible for consumers to choose heating system for their homes, except in Denmark. Due to legislation it is hardly possible for a household in Denmark to choose heating system. But district heating doesn't cover every residential houses, other premises and industrial premises and is therefore not always an alternative. On the other hand district heating could be the only option, see figure 8.4.

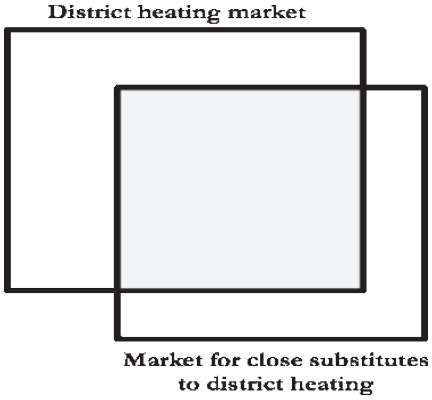

Figure 8.4 Different relevant markets

Source: Swedish Energy Markets Inspectorate

In Lithuania larger municipalities and cities have issued regulations restricting to what is called “cherry-picking”. To further solve the problem the National Control Commission for Prices and Energy issues licenses to district heating companies in accordance with the heat law from 2002.

District heating markets

Most of the district heat is provided by a municipality or a municipality owned joint-stock company. District heat delivered by a private company is most common in Sweden. In Denmark nearly 40% of the district heat is delivered by consumer cooperatives and in Lithuania more than 40% is delivered by joint-ventures and Public-Private-Partnerships.

The district heating operation consists of production (P), transmission (T), distribution (D) and finally consumption (C). Some district heating companies are vertical integrated from production to distribution (first column in figure 9.5). Many district heating companies buy all or a part of the heat from other companies, for instance waste heat from an industry (column two and three). This trade at the wholesale level is a single-buyer system and should not be mixed up with full three party access, TPA, since full TPA means that the customers (households etc.) choose producer of their district heating. In Denmark trade exists at a second wholesale level, since the market is divided into one more level, transmission, (column four).

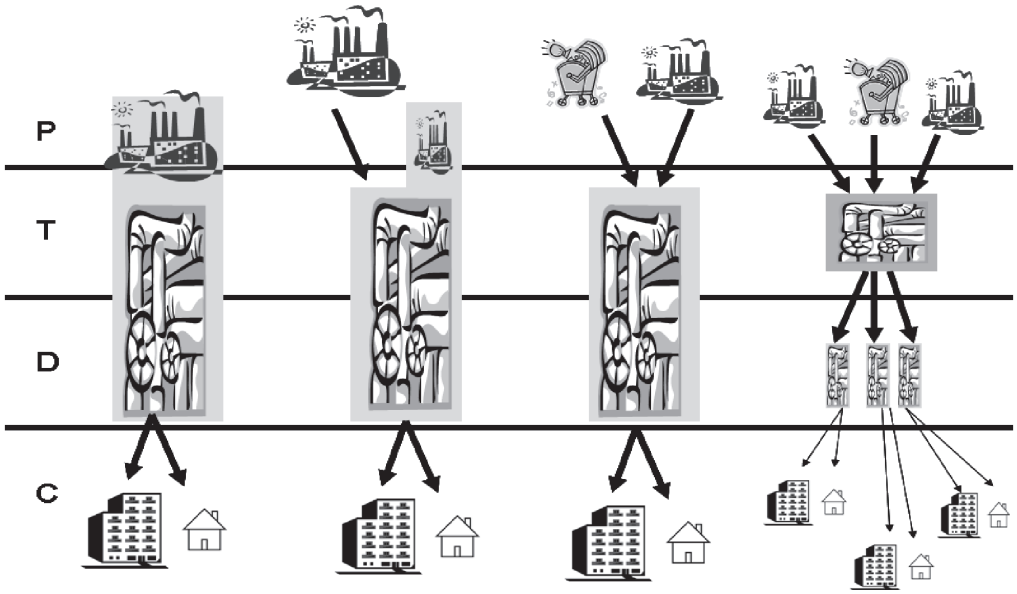

Figure 8.5 District heating markets

Table 8.1 shows the amount of wholesale between heat producers and district heating companies/transmission companies and table 8.2 shows the number of district heating companies and the amount of production.

Table 8.1 Wholesale

	Number of wholesale companies	Heat production in TWh	Percent of total DH production
Sweden	>55	6[1]	10
Denmark	n/a	18[2]	>60
Finland	>75	9[3]	30
Lithuania[4]	>15	2	20
Austria	n/a	n/a	n/a

At least three transmission companies act in Denmark. Their heat sales exceed 8 TWh.

Table 8.2 Retail – District heating companies

	Number of DH companies	Heat production in TWh	Percent of total heat production
Sweden	131	43	55
Denmark	600	34	55
Finland	100	32	50
Lithuania	58	10	70
Austria	392	18	20

As can been seen from previous figures a lot of companies are involved in district heating production and distribution. District heating is a local product and the district heating companies don't compete for the same customers but some district heating companies in Denmark and Finland sell heat to other district heating companies. Still the consumers can't choose their supplier of district heat. In most countries the consumers may choose heat system, but once they have chosen district heating they can't choose or change supplier. This is a very important difference compared to nearly every other heating system. In Sweden the consumer may choose supplier of electricity to their heat pumps, pellets supplier to their pellets burner and so on. But once you have chosen district heating you are stuck with one supplier.

Conduct and performance

The price development varies among the countries. Figure 9.6 depicts the real price indexes from 1997 to 2007 (data for Denmark from 2001). The fuel is of crucial importance for the price. Lithuania, with the largest price increase, uses natural gas for more than 80 % of the district heat production. Corresponding amount for Denmark and Finland is one third and for Sweden only 3 per cent. In Finland the energy rate depends on the fuels used and the variable costs in heat procurement. In Sweden the pricing is based on alternative heating methods. In Denmark, with a strict cost-based pricing, the real price has decreased. In Austria natural gas make up for 60 % of the fuel used for district heating, but the market share for district heating is only 20 %.

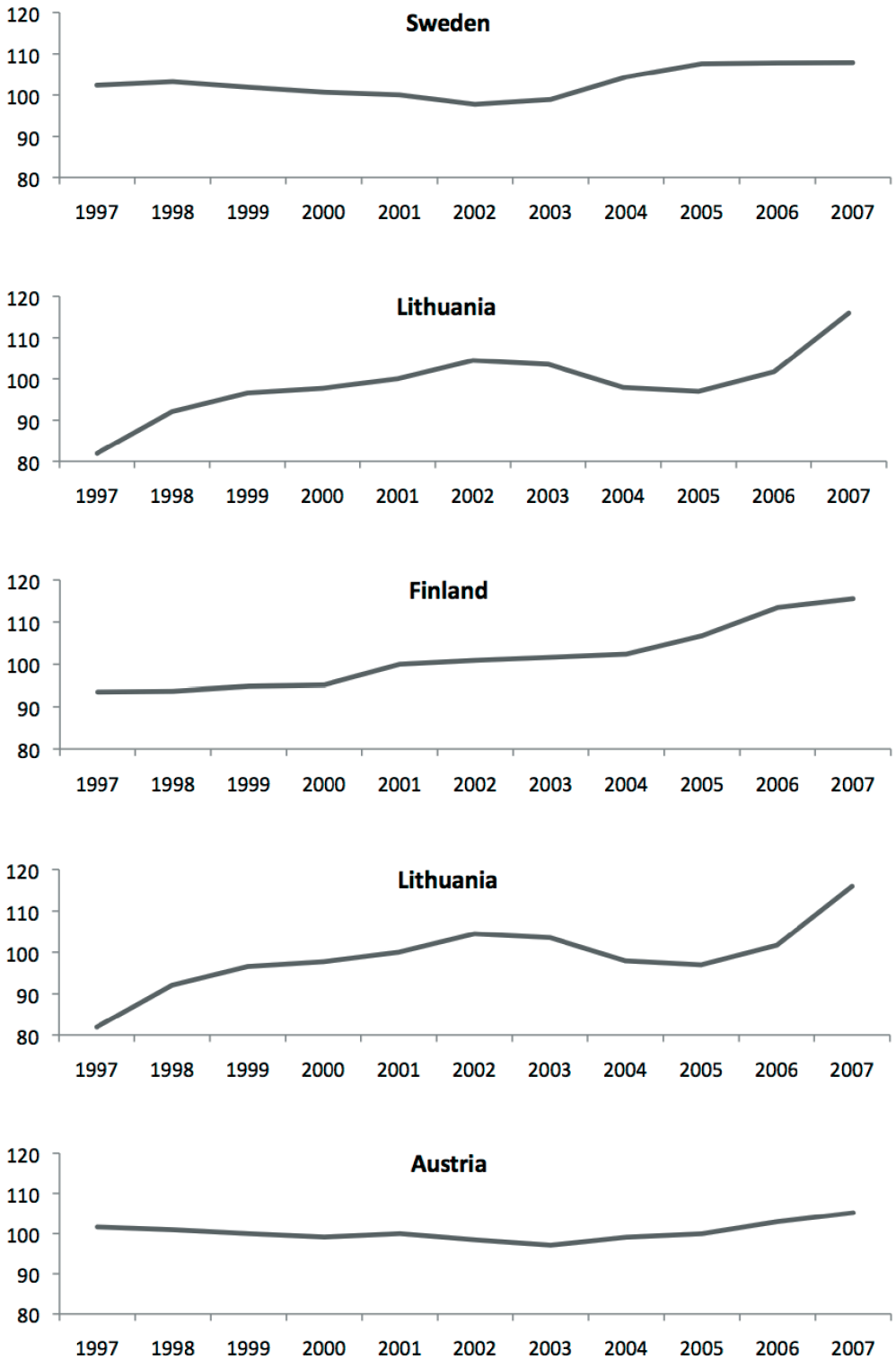

Figure 8.6 Real price indexes (2001=100) from 1997-2007

Source: Each country's respective District Heating Association and each country's consumer price index

All countries in this study show a price spread. Figure 8.7 depicts the un-weighted (each plant is one observation) price spread in Euro/ MWh in 2007.

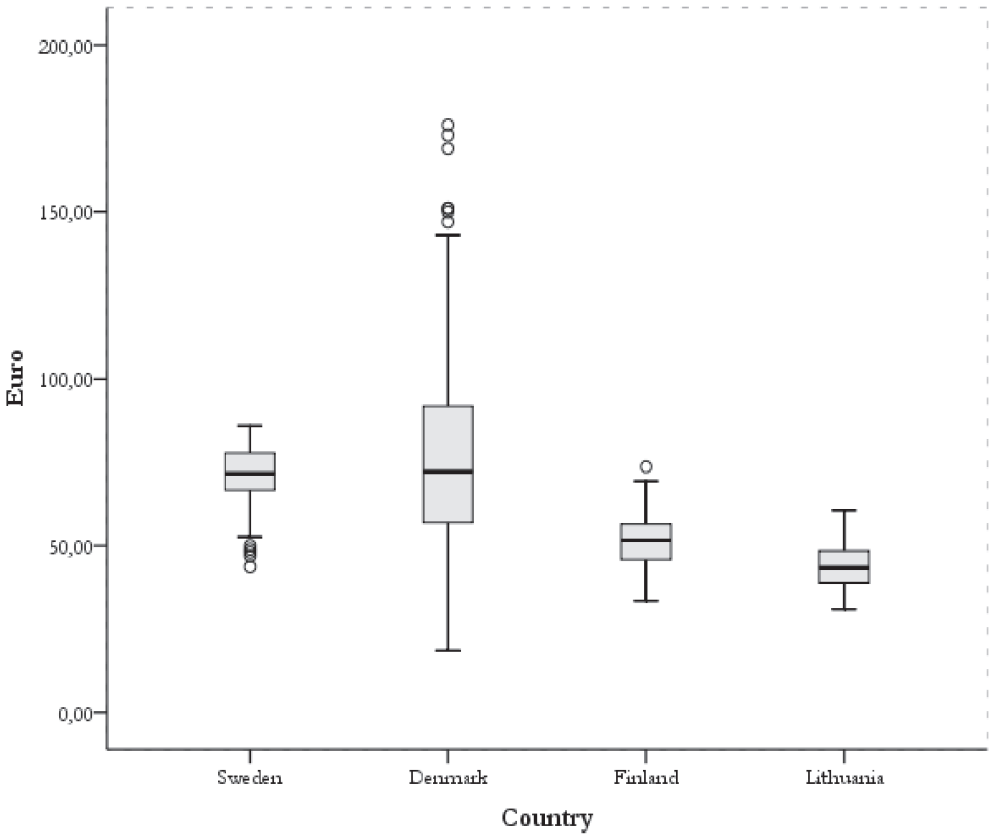

Figure 8.7 Boxplot[21] for 2007 prices in Sweden, Denmark, Finland and Lithuania in Euro/MWh
Source: Avgiftsgruppen in Sweden, the Danish District Heating Association, Finnish Energy Industries and the Lithuanian District Heating Association

Beyond fuel, the size of the district heating system and plant age has big impact on the price level. Denmark shows the largest price spread. This could partly be explained by the large number of small district heating companies, where some of them use natural gas. In Lithuania the price spread increased conspicuously when the district heating companies were divided into several minor companies,

Lithuania is in a transition period after the collapse of the Soviet regime. The heat consumption is very high. Of all apartment houses, 96 % were built before 1992 and nearly all of them are in desperate need of renovation. As the heat law came into force in 2003 the uncontrolled disconnections from district heating networks decreased.

21 The central "box" in a boxplot has its ends at the quartiles and spans therefore around half of the data. The line within the box marks the median and the length of the box is the inter quartile distance. The "whiskers" at either end extend to the smallest and largest observation. An observation is denoted by a circle if it is further away than 1,5 inter quartile distance from each respective quartile.

During 1996 to 2007 about 290 million Euro have been invested in the modernization of the DH sector. Another obstacle is that the recalculation of district heating prices is not related to increase of fossil fuel prices. The Lithuanian District Heating Association has presented an evaluation of district heating companies' losses. During 2006, 2007 and first half-year 2008 the losses amounted to nearly 88 million Euro. The Lithuanian District Heating Association has proposed the following actions to find the way out of the existing situation:

- use of biofuel and waste in the production of heat
- expansion of CHP and
- renovation of buildings.

In Denmark the Danish Energy Regulatory Authority in 2008 settled 11 cases in the heating sector. The corresponding number 2007 amounts to 8, while 291 cases were settled at secretariat level. One of the principal cases 2007 was a review of the budgets and financial statements of the district heating plants. The result of the review of 451 district heating plants revealed that, overall the plants did not have an adequate basis for their reported district heating prices. Just 14 district heating plants passed the review with a clean bill of health. In other words, 437 plants were selected for further processing. This review revealed inadequacies in the basis for transferring to reserves and the basis for depreciation. Further inadequacies were excessive funds and inadequate statements of changes in equity and reserves. According to DERA the review will be followed up and the ongoing cooperation with the Danish District Heating Association on disseminating knowledge about the price regulations in the Heat Supply Act has been intensified.

Finland and Sweden have a market-driven regulation. In these countries a quality mark can be awarded for district heating suppliers. The quality mark has been developed in co-operation with the customers.

According to the Finnish Energy Industries the reliability of district heat supply in Finland is 99.98 percent and a district heat customer is likely to have his heat supply disrupted for two hours a year on average. A clear majority of the outages are planned, i.e. the client is notified in advance. During the last years the authorities have got 3-4 complaints annually.

In Sweden the Independent District Heating Board has 15 open cases concerning renegotiation of tariffs in housing cooperatives. The Swedish Competition Authority has two ongoing investigations concerning occurrence of excessive pricing. A quality committee within "REKO fjärrvärme" handles complaints from customers. Up to now, only two cases have been reported. These cases concern dissatisfaction with the product and breach of contract. According to the Swedish District Heating Association many disputes are sorted out locally between the customer and the district heating company.

Price development, price spread and customers' complaint are not the only factors that describe the market performance. Different countries focus on different aspects of a market. But, regardless of public policy, price and pricing are important indicators of market performance. The following table summarizes some features for the included countries.

Nations / Variables	Sweden	Denmark	Finland	Lithuania	Austria
Public Policy	Competition-based approach, no price regulation	Regulatory approach energy planning, obligatory connection, ban on electric heat, price regulation	Competition-based approach no price regulation	Regulatory approach price regulation Municipal heat plans	No federal legislation
Legal Framework	-DH law -Electricity Act (Competition Act)	-Act on Heat Supply -Energy Conservation law	-Electricity Market Act (Competition Act)	-Energy law -Heat law -National Energy Strategy	-Energy Act -Legislation at "Länder" level (No federal legislation)
Government authorities	-Swedish Energy Markets Inspectorate -Swedish Energy Agency	-The Danish Energy Regulatory Authority -The Danish Energy Agency -Energy Board of Appeal -Local Authorities	-The Energy Market Authority	-National control commission for Prices and Energy -State Energy Inspectorate -Local Authorities	-Austrian Energy Agency -Länder
Ownership	-Municipalities 66 % -State (Vattenfall) 7 % -Private 27 %	-Municipalities 61 % -Consumer cooperatives 39 % (including a few private companies)	-Municipalities 86% -Private 14%	-Municipalities 57 % -PPP/Joint ventures 43 %	-Public 90 % -Private 10 %
Pricing	Market price	Cost based	Market price	Price control	

Municipalities, including municipality owned joint-stock companies

9. SUMMARY OF THE STUDY

The markets under scrutiny in this study show both similarities and large differences in a verity of respects. The district heating markets, being natural monopolies, are treated differently by the countries' respective authorities focusing on different aspects of the market with different market outcome. In for example Denmark it is seen as crucial that district heating plants also produce electricity, hence the large proportion CHP-plants. CHP-plants in Denmark stands for 80% of the electricity supply. Denmark's dependence on electricity imports means that the authorities via regulation makes it difficult to use electricity for heating, it is banned in new houses. This results in a strong position for the district heating plants in their natural monopoly position. The lack of substitute techniques for space heating reduce the relevant market to, in most cases just, district heating. The result is an obvious need of price regulation. However, this non-profit price regulation in place in Denmark means that the price risk is taken by the end costumers and the somewhat increased dependence on own gas supply as a fuel in often small plants has lead to large price spreads across Denmark as shown in figure 8.7. The price spread shown in this figure gives however not a fair overall picture of the Danish situation. The prices presented in the figure are not weighted against the size of the plants and it is in fact a limited number of small plants and thus consumers that actually meet these high prices, still they exists and must be considered to represent the downside of the Danish system.

In the urban areas in Denmark, especially in greater Copenhagen, there exists an interesting and relatively well developed wholesale market. Having vertically separated the plants (CHP, waste incineration and waste heat) from the transmission and distribution network we can here observe a wholesale market between the municipality owned networks and the heat producers and a retail market between the often municipality owned distribution network and the final costumer. The final costumer can however not choose between different suppliers so the system cannot be regarded as having third party access (TPA).

The district heating market in Sweden has no price regulation. The companies are assumed to work in a businesslike manner and are consequently free to set prices. The market is, however under the surveillance of both the Swedish Energy Market Inspectorate and the Swedish Competition Authority. Also, Sweden has introduced an independent district heating board that mediate in issues between companies and their customers in accordance to the district heating law.

The availability of alternative ways of heating varies across the country and foremost across the type of building. Small, detached houses have often more alternatives than residential buildings with many flats. Consequently, these smaller houses are seen to be less locked-in by earlier decisions on heating source compared to larger residential buildings. Having available substitutes means that the natural monopoly situation is weakened in Sweden compared to Denmark. Charging too high prices can trigger a substitution from district heating to another system such as heat pumps or pellet burners. The obvious effect of this is that many of the Swedish district heating companies openly set their prices for district heating, not in accordance to their respective costs, but in accordance to the nearest available alternative. The debate, and cases handled by the district heating board, reveals that there exists an opinion that district heating

companies in urban areas, such as Stockholm, might be taking some advantage of their dominant position. This is because they sell and distribute district heating in residential areas which in turn have less available alternatives and can thus not react to higher prices through substitution. The relatively high prices in these areas (the high end in figure 8.7) are by the Swedish authorities seen as "problematic".

Among the countries included in the study Sweden has the lowest share of heat produced in CHP-plants, below 40%. This is a natural consequence of historically having vast access to low cost hydro electric power and, in more recent history, nuclear power. Comparing the use of waste heat in DH-production puts Sweden in a not so favorable position. With its share of waste hot water usage of around 10%, Sweden has the lowest utilization ratio among the included countries.

The Finnish district heating market is similar to the Swedish in many respects with no price regulation and access to alternative systems especially for smaller, detached houses. In spite of a less favorable price trend during the last ten years, the Finnish prices are lower than the Swedish and show smaller price range compared to Sweden. This has no obvious explanation, but two features that differ between the countries can be mentioned. First, Finland has a much higher utilization rate of waste heat; around 30% of total DH production compared to the Swedish rate at 10%. Second, as pointed out in the earlier referred report by Vanhanen et.al. (2006) the Finnish district heating market show a high level of transparency in prices, production and trade of energy between companies. The report emphasize that it see no reason for the authorities to further intervene in the market as prices are transparent and no abuse of dominant position is seen yet.

The Lithuanian district heating market is a market under transition. It has a cost-based price regulation and although the Lithuanian prices still are among the lowest in comparison, the price trend and the increasing price range is less favorable. The transition process involves many issues including leaving a previous one-price system to introduce businesslike behavior, new ownership conditions etc. Even if the prices comes out low in an international comparison they are still high with respect to living standard as a relatively high share of the income goes to living expenses including heating. The new ownership conditions and, foremost business issues for each plant, are probably the factors behind the substantial increase of the price range as depicted in figure 6.12. The price range has more than doubled in Litas between 2002 and 2008. In addition the, by the Lithuanian District Heating Association, proposed price increases for the future are substantial.

It has been difficult to dig deep into the district heating market in Austria, mainly because of the limited data available. District heating in Austria is, by comparison, a small sector of the total heat market, around 20%. Still, Austria has lots of small, bio-fueled plants serving limited areas especially during the winters. There is no obvious legislation, or special authorities involved in the district heating market, at least not at national level. At the länder level there do exist some legislations and subsidy systems promoting district heating in certain areas. The price path in Austria shows no particular trend and the lack of plant data makes it impossible to do a deeper price analysis.

There is no evidence of the prices on average being lower or higher as a response to price regulation, but one obvious conclusion from this study is that price regulation, of the forms presented, shifts the price risk down to the final consumer. This might not be a major problem in that it is the authorities in each country have presumably the consumer interest at hand. It must be pointed out that a price regulation can be in place for other welfare reasons than keeping the district heating prices under control.

Questions that need further investigation concern the eventual connection between the price level and price range and different regulatory models as well as other variables such as the choice of fuel and business model. Other issues for further investigations are market systems influence on market performance.

APPENDIX: USA, DISTRICT ENERGY ST. PAUL, MINNESOTA

Introduction

This chapter provides some general information about the status of district heating in the USA as a whole and provides more specific information about one of the largest hot water based district heating system in that country, the one in St. Paul, Minnesota. The information regarding the United States builds on information provided from the International District Energy Association (IDEA) and The District Energy Report from 2005.

The United Sates

IDEA represents close to 700 members from 12 countries. Association members operate district energy systems owned by utilities, municipalities, hospitals, military bases and airports in 38 of the 50 United States. District energy systems operated by IDEA members are in 38 of the United States. The US Department of Energy estimates that there are over 2500 district energy systems operating in United States.

A clear majority of these systems are steam based as apart to the hot water based systems used in Europe. The special case, District Energy St. Paul described and analyzed in sub-sequent sections, is however one of the largest hot water based system in the US.

In North America, district energy systems are typically located in dense urban settings in the center of central business districts of larger cities; on university or college campuses; and on hospital or research campuses; military bases and airports. District energy systems in North America typically serve "clusters" of buildings, which are sometimes commonly owned, as in the case of private or public university campus or hospital. Frequently, however, in downtown systems, the customer buildings have distinct and separate owners; are generally located near each other in a central business district or segment of the city, and are interconnected individually to the distribution piping network. The number of customer buildings served by a typical district energy system may range from as few as 3 or 4 in the early stages of new system development to as many as above 1 800 customer buildings served by Con Edison Steam Business Unit in Manhattan, the largest district steam system in the world.

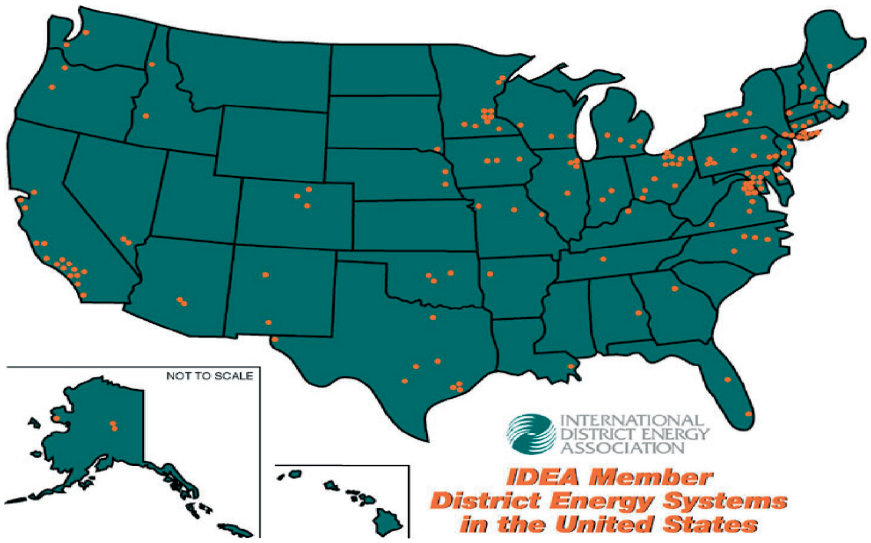

Figure A.1 IDEA member system map

Mature steam systems in U.S. cities like Philadelphia, Indianapolis, Boston or Denver serve between 200 and 400 customer buildings. Larger and established combination district heating and district cooling systems such as those in Hartford, Minneapolis, and Omaha generally serve between 65 and 150 customer buildings with heating and between 50 and 125 customer buildings with cooling. In most cases, the urban district energy system typically serves over 50% of the commercial office space in the central business district and in many cases, market share exceeds 85%

District energy systems are the preferred method of heating and cooling most major college and university campuses. In the U.S. hundreds of campus energy systems provide highly reliable and scalable energy supply. Many U.S. universities are adding or increasing their ability to generate electricity on campus and are recycling heat from power generation to heat buildings and drive steam chillers for campus air conditioning.

The downtown district energy system in Minneapolis also demonstrated significant growth throughout the 1980's and 1990's. The district heating system grew to serve over 120 customer buildings and the district cooling network expanded to supply nearly 40 buildings downtown, as it became one of the largest combined systems in the United States. The Minneapolis Energy Center grew at pace with the expanding central business district in Minneapolis.

The Minneapolis market has the unique conditions of extreme weather in both summer and winter where design conditions can reach minus 25 C in winter and the summer time can exceed 35 C with high humidity. This leads to significant peak capacity for both steam and chilled water capacity and forms an excellent base business condition. Both Hartford and Minneapolis were operated as stand-alone district energy businesses with particular attention paid to operations, capacity planning, customer service and marketing and sales.

Market Conditions in the USA

As mentioned, district energy in North America exists primarily in the central business districts of large urban cities and on college and university campuses where there is common ownership of real estate and energy facilities. Likewise, district energy investments have historically occurred where there is either significant vertical density of floor space or common ownership under a contiguous real estate location like a campus. The market sectors typically served by district energy systems are commercial office space, large hotels, convention centers and sports arenas and increasingly, apartment buildings and condo conversions. In the US, residential building stock has historically grown in the suburbs and outside the central business district. As a result, residential space has historically not been constructed within the geographic area traditionally served by North American district energy systems.

Figure A.2 shows the yearly additions of area heated with district energy in the US between 1990 and 2004 in million square meters.

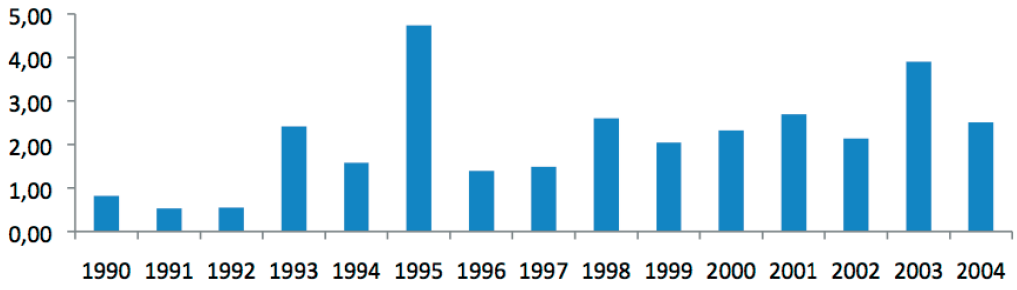

Figure A.2 Yearly additional million square meters of area with district energy

Unlike Europe and also Eurasia, where district energy services often are owned and managed principally by the municipal utility company (city or state-owned), the systems serve a high percentage of residential building stock which exists in central cities and in nearby sections. Therefore, when evaluating market share for district energy systems across a population of buildings in North America, it is important to assess penetration in the types of buildings likely to be located in an urban setting (i.e. building size greater than 5 000 square meters).

Figure A.3 shows how the yearly additions are distributed between different kinds of buildings between 2000 and 2004 in million square meters. Commercial buildings clearly dominate together with entertainment, cultural and sports and governmental buildings. Residential buildings have a very limited market of the above described reasons.

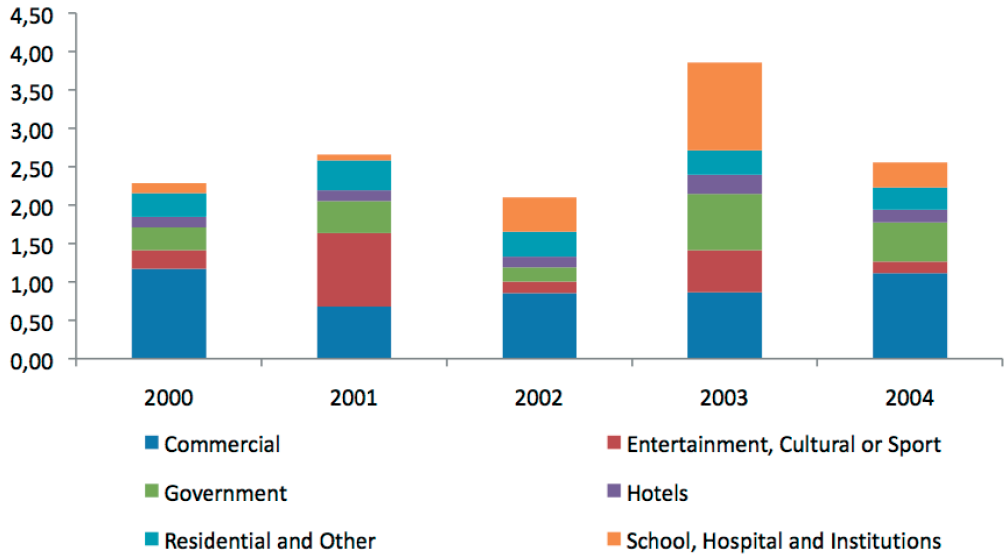

Figure A.3 Yearly additions of area on building type, million square meters

District Energy St. Paul Minnesota

General background and market growth

District Energy St. Paul is a district heating company serving customers in the down town area of St. Paul, Minnesota with hot water based district heating and cooling. The district heating operation started in 1983 as a consequence of the oil crisis during the 70's and 80's. District cooling was added to the company's operation in 1993. Since 2003 the company provides energy from a CHP-plant using primarily (80%) wood waste.

"The Twin Cities are a great place to discuss America's energy challenge... I had an early look at the future right here this morning, in St Paul. I toured a plant that harnesses the best of new technology to produce energy that is cleaner, and more efficient, and more affordable. The plant boils enough water to heat 146 major office buildings in downtown St. Paul. Not a bit of energy is wasted, not even the waste. The excess heat generated as the water boils is captured and used to create steam which is used to create still more electricity which is used to power pumps, and to deliver heat."
"The plant is a model of energy efficiency. It is also a model of energy diversity. It uses conventional fuels like oil, and natural gas, and coal... and renewable fuels, like wood chips. And the plant is a model of affordability. While other energy prices rise, District Energy has not raised its heating and cooling rates, in four years."
President George W. Bush, St. Paul, May 17, 2001

The district heating operation has in total connected 484 buildings and homes to their 32 km long network. The company has a total heat generation capacity of 289 MW primarily from the down town plant, the Kellogg Boulevard plant, but also additions and backups from Regions Hospital plant and a mobile boiler. The total energy sales in 2007 was 314 870 MWh.

The district cooling operation has a network with a total length of 17 km serving 96 buildings, 1.7 million square meters in total. The capacity is 32 900 tons and the total energy sales in 2007 was in excess of 35.5 million ton-hours. The development in the company's energy sales for the fiscal years (October – September) 2005 – 2007 is shown in Table A.1.

Table A.1 Energy Sales District Heating and Cooling, 2005-2007

	2005	2006	2007
District Energy (MWh)	294 882	303 289	314 870
District Cooling (ton-hours)	33 128 274	36 190 112	35 652 212

Source: District Energy, St. Paul

Organization and Financial Summary

District Energy St. Paul is a non-profit company. It has seven members on the board of directors, three of these are appointed by the city of St. Paul and three are elected by the costumer group. These six members then choose a seventh. The company is a so called

501c3 non-profit organization and is as such exempted from income tax and can receive tax-deductible contributions. It is possible to generate a surplus for future investments and maintenance but it cannot generate profits for distribution to owners or members. Table A.2 summarizes some financial facts for the three fiscal years, 2005-2007.

Table A.2: Total Revenues and Expenses for District Energy St. Paul, 2005-2007

District Energy	2005	2006	2007
Total Operating Revenues	$ 15 390 405	$ 17 513 644	$ 18 242 328
Total Operating Expenses	$ 10 881 306	$ 13 058 276	$ 13 971 380
Net from Operations	$ 4 509 099	$ 4 455 368	$ 4 270 948
District Cooling			
Total Operating Revenues	$ 8 299 550	$ 9 107 518	$ 9 539 466
Total Operating Expenses	$3 607 034	$4 803 096	$ 5 217 575
Net from Operations	$ 4 692 516	$ 4 304 422	$ 4 321 891

Source: District Energy, St. Paul

Pricing and price "regulation"

The prices that District Energy St. Paul has charged its costumers during the active years has in real terms been falling steadily up to the year 2004 after which the prices has been increasing pulled up with the help of gas prices. Figure A.4 shows the price development in $/kWh during these years both in nominal and real terms.

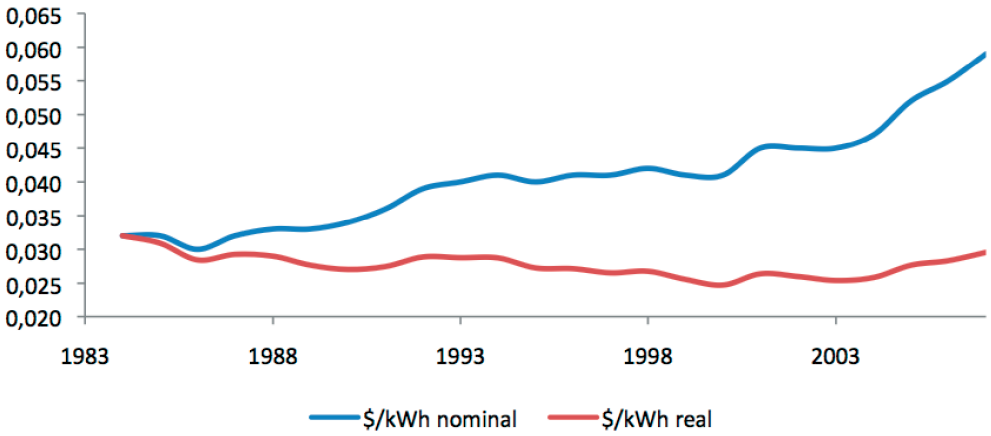

Figure A.4 Nominal and Real Prices (1984 price level) in $ per kWh, 1984-2007

The prices, or service rates, are set up for one year at a time and run from October to September. The total charges are made up by two parts: the *demand rate* and the *energy rate*. The first part, the demand rate, is in $ per kW and is based on the company's annual fixed cost divided by total consumer demand. This charge covers thus the fixed costs of providing the service.

The second part, the energy rate, is expressed in $ per MWh and is solely based on

the estimated fuel cost for the year. District Energy St. Paul uses no mark-up in this rate and every deviation the fuel price shows from the initial estimate is passed down to the costumers, this adjustment part is called the *fuel adjustment charge*. This means that the consumers are taking the entire fuel price risk, a consequence of the non-profit assessment.

The costumers are billed monthly and energy usage is measured monthly for each costumer. While the energy charge will vary from month to month, the demand charge is fixed and based on past consumption and is as such subject to re-evaluation every 12 months. If necessary there will show up a fuel adjustment cost post on the bill if the cost of fuel deviates from the initial estimate. A city fee, a so called franchise fee, of 8.7% is added together with the state sales tax. The rates for October, 2008 to September, 2009 is shown in Table A.3

Table A.3: Service Rates for District Energy St. Paul October 1, 2008 to September 30, 2009

	Demand Rate (per kW/month)	**Energy Rate (per MWh)**
District Energy	$ 4.71	$ 30.51
	Demand Rate (per ton; per month)	**Energy Rate (per ton-hr)**
District Cooling	$ 25.66	$ 0.079

Source: District Energy, St. Paul

These rates has been stable in recent years, the fuel adjustment charge has however been substantial both in 2006 and in 2007 which can be seen in the charges for the upcoming period.

Table A.4 Service Rates and Adjustment Charge 2005-2008

District Energy	**2005/06**	**2006/07**	**2007/08**	**2008/09**
Demand Rate ($/kW per month)	$ 4.35	$ 4.35	$ 4.35	$ 4.71
Energy Rate ($/MWh)	$ 14.15	$ 14.15	$ 14.15	$ 30.51
Fuel Adjustment ($/MWh)	$ 1.63	$ 9.13	$ 10.83	n.a
District Cooling				
Demand Rate ($/ton per month)	$ 23.28	$ 23.28	$ 23.28	$ 25.66
Energy Rate ($/ton-hour)	$ 0.061	$ 0.061	$ 0.061	$ 0.079
Fuel Adjustment ($/ton-hour)	$ 0.00	$ 0.007	$ 0.013	n.a

Source: District Energy, St. Paul

Apart from being a non-profit organisation the company are subject to some kind of price regulation. Every change in price for upcoming periods has to be announced to and approved of by the city council in St. Paul.

Ever-Green Energy

The company District Energy St. Paul is seen as a successful company in both the eyes of the city of St. Paul and its customers. Its success has also been spread outside of Minnesota and outside of the United States both for its technology and for its business

model. Since District Energy St. Paul is a non-profit organisation it has no possibilities to engage in revenue generating consultant work for other interested in these technologies or business models. For this reason the board of District Energy St. Paul formed the company Ever-Green Energy which is a "for-profit" organisation taking on consultants work in the field of district energy and district cooling.

In its work, Ever-Green Energy focus solely on renewable energy sources such as wood and wood chips, waste, surplus heat and bio-gas and is always aiming for the lowest prices achievable. One of the major projects that Ever-Green Energy is engaged in is a district cooling project in Hawaii. This district cooling project is estimated to replace at least 75% of the electricity use for cooling by bringing up 4 degree C water from a depth of 550 meters outside the coast of Hawaii.

The clear goal of Ever-Green Energy is to use the generated profit from the consultant work and subsidize the prices charged to the costumers in District Energy St. Paul. In 2008 it is claimed that the profit generated in Ever-Green Energy has subsidized the price charged by District Energy S. Paul with approximately 10%.

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Meetings

Fredäng, Julia, Dalkia, Sweden
Ingeman Koch, Heidi, Sekretariatet for Energitilsynet/Konkurrencestyrelsen, Denmark
Jakovljevic, Dusan, Euroheat&Power, Brussels
Lauersen, Birger, Dansk Fjernvarme, Denmark
Puchkarev, Nikolia, Euroheat&Power, Brussels
Rydåker, Anders, CEO, District Energy, St. Paul, Minnesota, USA
Werner, Sven, Professor, Högskolan Halmstad, Sweden

Other Communications

Energiateollisuus/Finnish Energy Industries, Finland
Energimarknadsinspektionen/Energy Market Inspectorate, Sweden
Energistyrelsen/Energy Agency, Denmark
Fachverband der Gas- und Wämeversorgungsunternehmungen/Association of Gas- and District Heating Supply Companies, Austria
Konkurrensverket/Competition Authority, Sweden
Lietuvos šilumos tiekéju asociacija/Lithuanian District Heating Association, Lithuania
Svensk Fjärrvärme/District Heating Association, Sweden

FJÄRRSYN

Fjärrsyn – research and development to increase the knowledge about district heating, district cooling and combined heat and power a growing part of an energy future that is ecologically sound and financially and socially sustainable. Fjärrsyn is managed by the Swedish District Heating Association and financed in collaboration with the Swedish Energy Agency.

AN INTERNATIONAL COMPARISON OF DISTRICT HEATING MARKETS

This study provides an understanding of the similarities and differences between the district heating markets in Sweden, Denmark, Finland, Lithuania and Austria. The report entails a promise to enlighten any discussion on regulatory or, more broadly, institutional change in district heating markets.

There is no evidence of prices on average being lower or higher as a response to price regulation. One obvious conclusion is that price regulation, as presented, shifts the price risk down to the consumer. This might not be a major problem as the authorities in every country presumably have the consumer interest at hand. But a price regulation can be in place for other welfare reasons than keeping the district heating prices under control.

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