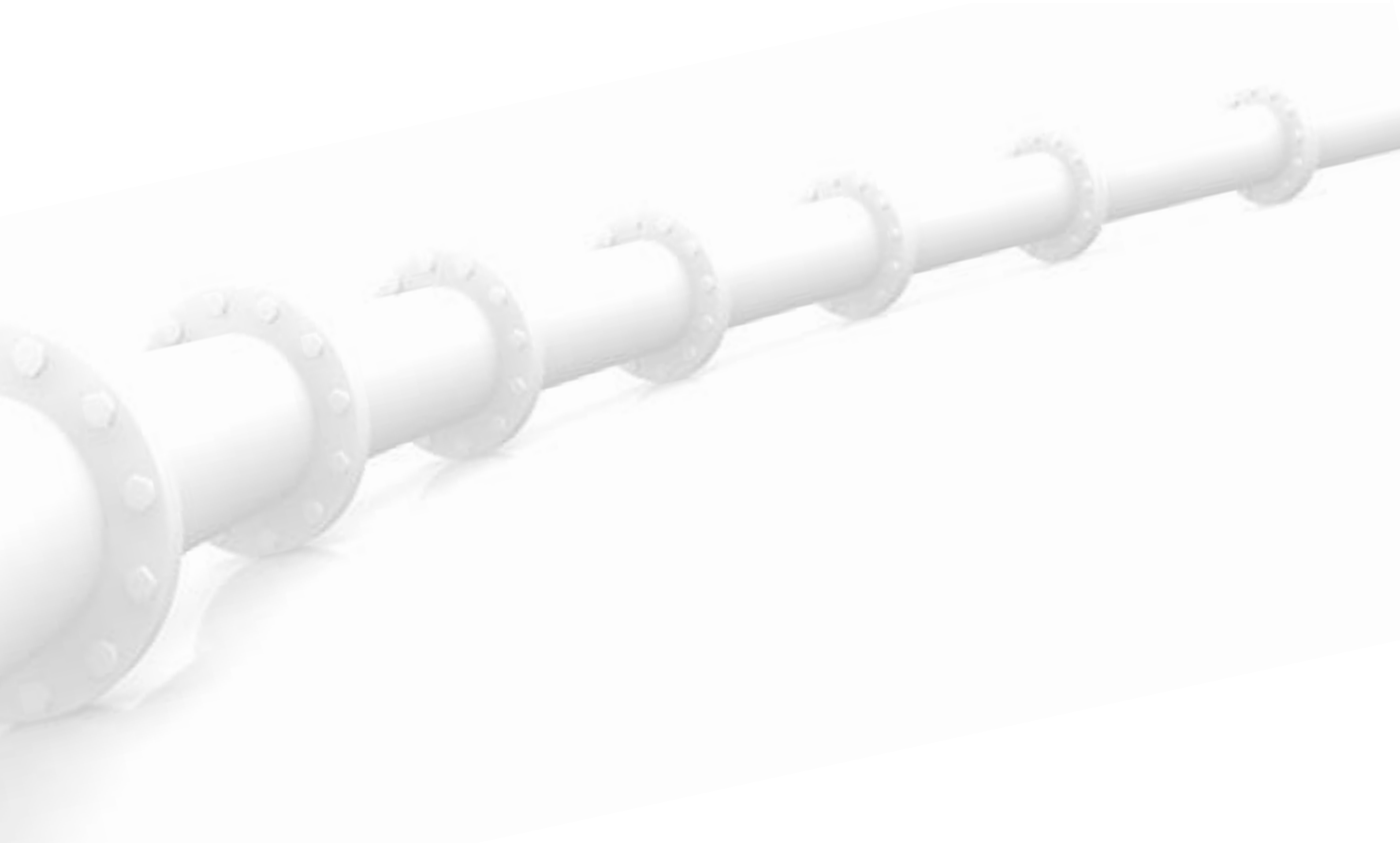
FUSIONS IN THE DANISH DISTRICT HEATING SECTOR



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Synopsis

Title: Fusions in the Danish district heating sector

Theme: Sustainable Energy Planning MSc Thesis

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This study analyses the company fusions in the Danish district heating sector, in the context of district heating consumer prices.

The Danish district heating prices are discussed based on the statistics and the heating districts of the country are organized into categories based on price ranges.

Fusions in the timeframe are presented with special regards to the prices in those districts which have been participating in fusions.

The fusions are evaluated by investigating whether the prices changed in the merged districts and if so, how.

Four specific cases are further analyzed from the perspective of consumer prices and company costs.

The analysis shows, that several company fusions have been carried out in the past couple of years. The most common motivation behind them was the will to find a solution for decreasing the consumer prices, which have been successful in most of the cases. However, the connection between fusions and consumer prices show a rather complex pattern.

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Preface

This report is written by Mark Benedek Almasi through the 4th semester of the master program Sustainable Energy Planning and Management at Aalborg University as the final thesis during the period from the 1st of February until the 17th of August 2016.

Acknowledgments

I would like to express my gratitude and thank the following people for helping my work:

- Kasper Nagel, Dansk Fjernvarme for helping with his ideas about the problem formulation;
- Jan Clement, Aars Fjernvarme for helping with information and ideas;
- and last but not least, Peter Sorknæs for helping my work with his advices as my supervisor at Aalborg University.

Reading guide

Number format

The report is written in English language and the English number format is used. Therefore commas mean thousands and dots mean decimals, such as:

- 2,500 is two thousand and five hundred and
- 2.500 is two and a half.

Referencing

References are indicated in Harvard-Anglia style. Sources are presented with the name of author and year of publication in the study with full reference in the reference list. When referring to a source within a sentence, it is indicated right after the referred text, before the full stop: (name, year). When the reference is made to more than one sentences, it is indicated after the full stop of the last sentence where the reference was used: . (name, year)

Units

When needed, the units of measurement are indicated within square brackets: 50 [MW].

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1. Introduction

Heating homes is a basic need in Europe and in countries with colder climate, such as Denmark, it has even higher importance. Heating of a household can be achieved through individual heating which can be considered to be traditional, but in the last couple of decades, another form, district heating has also become an option and as such, it has become quite popular.

District heating is a heating solution widely spread in Denmark, providing heating and warm water service to 64% of the Danish households (Dansk Fjernvarme, 2015). When a technology reaches such a large share of the population, it puts a lot of pressure and responsibility on experts and decision makers to offer a high level of service for reasonable prices. On the other hand, district heating is a local service in a way, because heat cannot be transferred to high distances without high losses (Gróf, 1999), therefore the place of production and use of heat need to be within reasonable distance. However, in the last couple of years, district heating companies have been merging with each other, therefore growing over the borders of their formal local service territories on an increasing scale in the near past. (Nielsen, 2016).

All this has raised many questions. Which districts decide to merge with others and why? Is there any pattern to be found? What does a fusion do to a district, what consequences does it have? Can a district benefit from a fusion, and if so, how? What expectations does the district heating company have before merging and do these expectations fulfill?

Finally, these questions has led to formulating the problem and the research question of present study.

1.1. Research question

How do fusions affect the district heating consumer prices in Denmark?

To answer this question, first, a general overview on district heating and specifically the Danish district heating is needed. Then, a detailed analysis is necessary on the Danish district heating consumer prices, followed by a research on the fusions in Denmark. After this, these fusions need to be evaluated and analyzed from the perspective of their effect on the district heating consumer prices. Finally, specific cases need to be investigated, where a more detailed research is possible in order to find out, what exact effect did the fusions have. These are explained into details with the used methods in the next chapter.

2. Methodology

In this chapter, the methods used in present report are described by the structure of the report, followed by subchapters regarding quantitative and qualitative methods.

2.1. Methods in the structure of the report

In the following, the methods are explained which were used to be able to answer the research question following the order of the report, as shown on Figure 2.1.

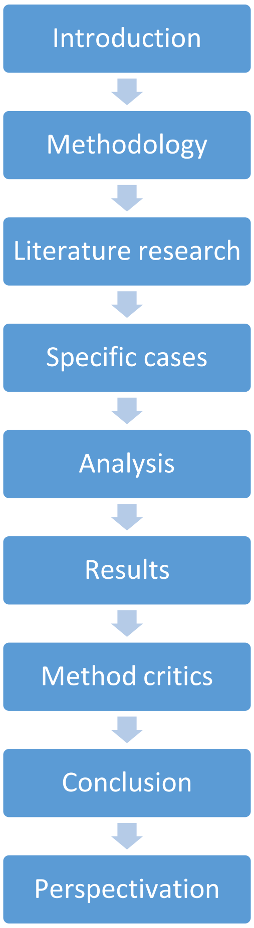

Figure 2.1 Structure of the report

First, a literature research was needed in the field of district heating with special attention to district heating in Denmark. To do this, District Heating and Cooling by Sven Werner was used as well as relevant scientific articles and official publications from Danish authorities such as Dansk Fjernvarme, Danish Energy Agency (Energistyrelsen) or Danish Energy Regulatory Agency (Energitilsynet).

This literature research is then followed by the presentation of specific district heating cases. The purpose for this was to investigate and test the findings of the project on specific cases and also to be able to do detailed investigation which is not possibly executable on a large scale. The main goal when selecting the cases was to follow the method of stratified sampling. This means, that when selecting specific cases for further investigation, and there is a quality by which they can be categorized, then those selected cases should be in equal amount from all the categories (Bryman, 2008). The reason for doing so was to have as diverse examples as possible, which helps to increase the validity of the results. In this case, categories were set by the effect of fusions on the consumer prices in the heating districts. However, it was also a preference to be able to fetch reliable data from the cases and also, that it should be one of the latest fusions. The reason behind this was the assumption that the older the fusion the more difficult it is to have data on it. This assumption was later confirmed.

The next part of the project is the analysis within the timeframe 2010-2015. The reason for choosing these limits in time is because this period of time is assumed to provide enough information to make a representative study, but also because, according to Kasper Nagel from Dansk Fjernvarme, Energitilsynet started to collect data from district heating companies in this form in 2007 and before 2010 they did not receive all the data, but after 2010 they have begun to collect it more consistently (See Appendix 4). The analysis chapter has two main parts, the first of which is regarding analysis of those data which are related to the whole country. This means the detailed analysis of the consumer price and fusions throughout Denmark based on the price statistics published by Energitilsynet. The second part of the analysis is of the specific cases. It includes analysis of price elements and cost analyses of each of the four selected district heating companies throughout the time frame. Regarding case study methodology, the work of Bent Flyvbjerg was studied. According to Flyvbjerg, such an analysis of specific cases can be a useful tool to test theoretical results and even to form theories, however, it can be difficult to form a general conclusion based on case studies. Even though, he points out that generalization can often be done on the basis of case studies. (Flyvbjerg, 2006)

The analysis is followed by summary of the results. The purpose of this is to give a brief overview of the results of the analysis, which is easier to evaluate.

In the following chapter, critics towards the methods used are presented. This is to take a critical view on the methods and the project itself and to acknowledge the possible weak points.

The method critics are followed by the conclusion of the project.

2.2. Quantitative methods

Quantitative methods are methods of research which produce numerical results, which can be measured or calculated and then used for further calculations. Reliability of the results is high but their validity is low. Main purpose of them is to measure quantity in a given task. (Kaspersen, 2016) Such methods were used widely in the analysis part of the project, where district heating price data were collected from the sources, then analyzed, compared and categorized, which data then were used for evaluating the fusions. Quantitative methods were also used in the second part of the analysis, where price elements of districts and costs of the companies are analyzed.

2.3. Qualitative methods

Qualitative methods are used for deeper analysis and do not produce measurable results. The main task is to create description of quality of the subject. Results have high validity but low reliability and there is a high risk of subjectivity. A typical example for a qualitative method is interviewing. (Kaspersen, 2016) Qualitative methods were used in the project to collect information which could not be seen from the pure numbers. This typically meant interviews of different kinds. The form of interviews most often used in researches are semi-constructed interviews. This means getting prepared in advance on the subject of the interview so it is possible to thematize the questions of the interview in the form of a semi-constructed interview-guide, as attached to the report as Appendix 1. (Brinkmann & Tanggaard, 2015) The interview-guide was made after a first research has been performed and the purpose of it was to gain information that was not available online. An e-mail and a personal interview was conducted with Jan Clement at Aars Fjernvarme with this method, of which summaries can be found in Appendix 2 and Appendix 3 while an e-mail consultation was performed with Kasper Nagel (See Appendix 4) and other interviews were done via e-mail when it was necessary.

3. Literature research

To clarify the context of the project and to collect preliminary knowledge about the field, a literature research was performed, the result of which is presented in the following.

3.1. District heating

District heating is one of the widespread energy services of our times. This solution is providing space heating and domestic hot water for a growing number of customers worldwide. According to Werner, the definition of district heating can be captured as:

“Energy service based on moving heat from available heat sources to immediate use directly by customers.” (Frederiksen & Werner, 2013)

District heating appeared first in the late 19th century in the USA and in the early 20th century in Europe. It has come a long way in technological development from first generation district heating, where steam was used as the heat carrier, running in pipes in ducts, through the second generation where the heat carrier medium was changed to hot water, to the third generation where the pipes are mostly directly buried and bonded underground. (Frederiksen & Werner, 2013) The fourth generation of district heating has started to spread at this point in time. The top-feature of this technology is low-temperature heat carrier, which allows higher efficiency, due to lower losses which have basic thermodynamic reasons. However, this generation is still to spread widely.

The main idea behind district heating is to fulfill the customer demands for heating by using local fuels or heat sources that otherwise would be wasted. Werner describes the obligatory elements of a district heating system as follows:

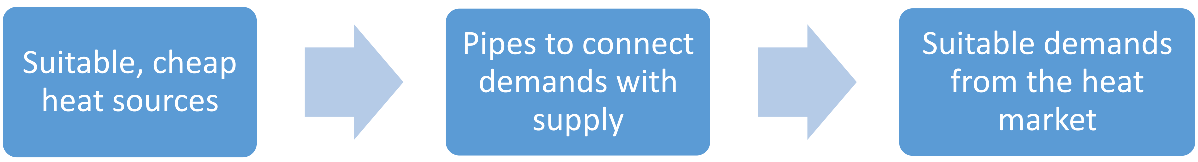

Figure 3.1 Elements of the district heating system, according to Werner

He states that all these components have to be local in order to minimize capital investment in the distribution network, which means that in the case of a local system, it is an advantage that the distances (and hence the pipes) are short, therefore costs can be reduced when investing into building the system. He defines suitable demands as space heating and preparation of domestic hot water for use in residential, public and commercial buildings, as well as low temperature industrial heating purposes. All in all, district heating basically means supplying local demands from local heat resources. (Frederiksen & Werner, 2013)

Currently, the most commonly used heat sources are co-generation heat and power plants (CHP), waste-to-energy plants (WtE), excess heat from local industry, combustible renewable sources, natural geothermal, solar heating panels and large heat pumps. CHP, WtE and industrial excess heat are considered to be secondary energy supply, while combustible renewables, geothermal and solar panels are considered to be primary energy supply. According to Werner, the amount of heat coming from secondary supply is significantly larger than the one coming from primary supply. This leads to a conflict, because secondary energy supplies are based on fossils while all the renewables are primary, and when replacing a secondary energy supply with a primary one (e.g. fossil with renewable), it has a low impact because the replacement only decreases the fossil demand to a quite small extent and thus the policy making intention of increasing the renewable energy share is hard to meet. (Frederiksen & Werner, 2013)

It is important to mention the general pros and cons of district heating. Werner does this comparison from the customers' perspective, as presented in the following.

Among customer benefits, the comfortable, simple and continuous being of district heating service is mentioned, as well as the fact that less space and lower investment is needed from the customer, compared to individual heating. District heating means that no fuel combustion happens in the households which reduces the risk of fire or explosions. Payments of customers are based on the current consumption which means reduction of costs for them. Also, no major customer investment is needed due to local availability of a non-fossil heat supply.

On the other hand, customers have no possibility to negotiate between different prices and delivery conditions due to the natural monopolies. The monopoly situation also means that no internal competition is present, therefore bad decisions regarding for example development, can cause the loss of the gains achieved due to the monopoly. It is also important to mention, that high switching costs and practical difficulties occur if the customer wishes to switch to individual heating, which means they might be trapped in the district heating systems. Moreover, if accidents or system failures should happen, whole cities are affected instantly. Partially due to reasons mentioned earlier, customers of district heating have no influence on their own heat supply situation. (Frederiksen & Werner, 2013)

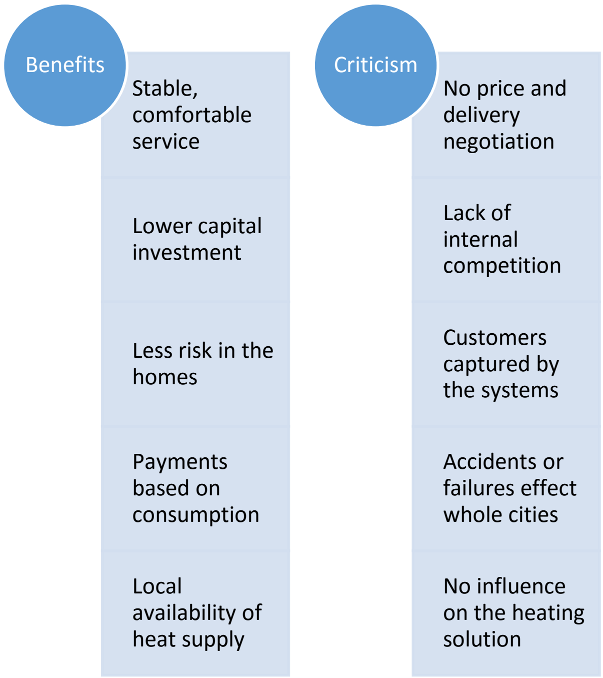

Figure 3.2 Benefits and criticism of district heating according to Werner

In connection to Werner's thoughts, it might be worth considering that the payments are indeed based on consumption but it is largely dependent on the price structure of the specific area. Therefore how much are the payments connected to the heat consumption highly varies between towns. In addition to this, in the case of individual heating with solutions that burn a fuel, the same connection is valid, because the amount of necessary fuel is dependent on the heat demand of the household that varies throughout the year. It also has to be mentioned that in the case of Denmark, investments are mostly made on a communal level, which means that the customers are involved and they are the ones who pay for the investment after all. This is also the reason why the last critical argument is not entirely true, since the customers have a word in the local planning process therefore they might be able to make an influence. As of the failures and accidents question, it is certainly a risk that in the case of such an event, the security of supply is at risk and it is a task for local planning to build such a district heating system where this event can be prevented with for example the use of back up plants or heat storages. However, due to precautions and back-up facilities, it might also be considered as a benefit of district heating, because consumers supply is significantly more secure compared to individual heating, where a back-up system is normally not installed.

3.2. District heating in Denmark

The first district heating unit started production in September 1903 in Frederiksberg. The unit was producing heat by burning waste and the main purpose was to provide heating for Frederiksberg Hospital and other communal buildings. It was owned by the public and could provide heat to most of the public buildings nearby. After the Second World War, district heating expanded significantly, mainly due to the generation shift from steam to hot water based technology. Comprehensive design of heating appeared first as a result of the oil crisis in the 1970s, basically to promote heating solutions that used ducted pipes and natural gas as a source, in district heating plants, most preferably CHP units and to create boundaries between areas with natural gas-based and district heating. This resulted in a constantly growing market share of district heating compared to other heating solutions from 10% in 1960 to reaching 50% in the 1990s and growing above 60% in the 2010s (Frederiksen & Werner, 2013). The outcome of this growing was large integrated district heating systems in Hovedstadsområdet, Århus and Trekantsområdet (Kolding, Fredericia, Middlefart and Vejle), among many others. As a result of the technological advance and heat planning, the number of districts increased by 200 in this period of time and reached 450 by 2004. (Dietrich & Mortensen, 2009)

As of 2015, 64% of the Danish households receive district heating service and 55% of the heat is coming from green energy sources. Due to further advancement and optimization throughout the years, net loss in the district heating system has been falling since 2006, as well as the administration costs. (Dansk Fjernvarme, 2015)

Apart from the past and present, the future challenges of district heating in Denmark is also a question of importance. According to governance theory, different levels of governance need to be taken into consideration (Lissandrello, 2015). This means that not only national but also the EU goals need to be taken into account. As a member of the EU, Denmark has to fulfill the 2020 goals. These are:

- 20% reduction of CO2 emission compared to 1990
- 20% renewable share (In Denmark it's already 30%)
- 20% increase in energy efficiency

Apart from these, in 2020, wind turbines are expected to produce 50% of the electricity consumption. According to the new Energy Agreement, more than 35% of the energy shall come from renewable source and a 7.6 % reduction in gross energy consumption is to be achieved, in relation to 2010. By 2050, the energy system should be free of fossil fuels. (Danish Energy Agency, 2015); (Danish Energy Agency, 2012)

According to the Danish Energy Agency, the efforts to meet these goals will consequently mean that the significance of wind power will increase which means that balancing the increase of this intermittent and fluctuating energy needs to be balanced in the electricity system. This predicts challenges in the electricity sector but district heating can offer help here.

The problem with huge amounts of heat is, that it is very difficult to store it, therefore the produced energy needs to be used immediately. However, a heat storage in the system can help this problem, making it possible for the district heating plant to optimize its operation in time. These flexible district heating systems can have a balancing role and therefore integrate wind energy. (Danish Energy Agency, 2015)

The expectations towards the Danish district heating system were summarized by director of Dansk Fjernvarme Kim Mortensen:

“There is an increasing political pressure on the [district heating] sector, to deliver cost-effective and environmental-friendly heat.” (Nielsen, 2016)

The district heating companies in Denmark can have various ownership structures. Vast majority of the companies, 83.3% are owned by the customers, 12% are owned by the local Kommune, 3.6% owned by a private company and 0.7% owned by residents’ association. However, when considering the share of produced heat in total, the shares change significantly. 59% of the delivered heat is from company owned by the Kommune, 37% is delivered by customer-owned companies, less than 4% is coming from private companies and less than 1% is from companies owned by residents’ association. This difference tells that in most cases, those district heating companies which deliver large amounts of heat, meaning an extensive district heating network therefore a large town, are typically owned by the Kommune, while the majority of the companies, which are consumer-owned, are typically small. This statistic is strongly connected with the district heating prices, which shows a pattern where the most expensive areas are typically small districts. (Energitilsynet, 2015)

It has become quite popular for these districts to merge with others, which can mean benefits for them by helping to reduce their costs and therefore the consumer prices as well. Present study is investigating this phenomenon through the district heating price statistics, starting from a definition for fusion as when a company stopped being published independently in the statistics and further research confirmed that the service area belongs to another company, latest from the date the next price statistic was published. For further detailed studying, specific cases are selected by the method described in Chapter 2. These cases are presented in the following.

4. Description of the cases

The following cases are used to investigate the effect of fusions on specific examples in order to see, what exactly happened and how fusions affected the district heating prices. The method for selecting the cases has already been described in Chapter 2, the results of that selection method (Aars, Gauerslund, Odsherred and Hammel) are presented in the following.

4.1. Aars Fjernvarme

Aars is a town in Nordjylland, with approximately 8,000 people which makes it a middle-size town in the Danish context. It is the largest town of Vesthimmerland Kommune with a slightly increasing population, according to Danmarks Statistik. (Danmarks Statistik, 2014)

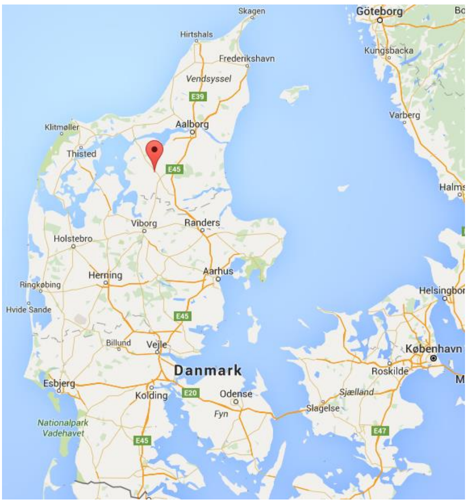

Figure 4.1 Position of Aars in Denmark

The district heating service in Aars is supplied by a waste-to-energy plant, which has two incineration units, built in 1986 and 1995. They have a capacity of 8.5 and 10 [MW] heat, with an additional wood boiler for backup purposes, a smaller heat storage tank and a heat recovery system to capture heat from the flue gas. The overall maximum capacity of the plant is around 30 [MW] (See the summaries of interviews with director Jan Clement in Appendix 2 and Appendix 3).

There has been three fusions with the Aars district heating network in the time period 2010-2015. The geographical location of these districts are presented on Figure 4.2. The pipe connection to Suldrup is approximately 12 [km], to Haverslev 8 [km] and Hornum about 10 [km] from Aars Fjernvarme.

Figure 4.2 Aars and the merged towns on map

According to Jan Clement, the main motivation behind the fusions was the economical reason. The Aars waste to energy plant with the back-up biomass boiler was too big for the heating demand in Aars, but since waste cannot be stored and waste incineration plants can only be regulated down to around 75% (Energistyrelsen, 2012), it always needs to be in operation, and therefore large amount of heat was wasted. In the surrounding towns which had decided to merge, gas engines were in operation, which have become uneconomical and caused the district heating prices to increase significantly. Therefore they have decided to merge with the Aars district heating company and got connected by pipes. This also means that Aars Fjernvarme took over the production units and the gas engines in the merged towns have only been operating in a marginal time of the year ever since. (See Appendix 2 and Appendix 3.)

4.2. Gauerslund Fjernvarme

Operating in the Trekantensområdet in Vejle Kommune, Gauerslund Fjernvarme is a company slightly different from Aars Fjernvarme. It could be considered as a regional district heating company, because its service area includes the towns of Børkop, Brejning and Gauerslund technically since it was founded in 1964. Today, these towns have a

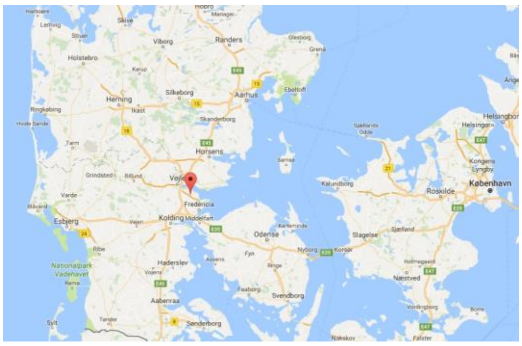

Figure 4.3 Position of Gauerslund in Denmark

summed population of approximately 8,500 which is quite similar in size as Aars. (Danmarks Statistik, 2014)

The district heating system originally was intended to be of the town of Børkop, but when founding the district heating company, the neighbor town of Brejning was also taken in and the district heating company was founded in co-operation. At the time of founding in the 1960s, the area which includes the towns of Børkop, Brejning and Gauerslund was called Gauerslund Kommune and that is where the name of the district heating company came from, as it has been providing district heating service in the region, not limited to a town alone. Since 1985, when TVIS (Trekantens Varme Interessent Selskab) has been founded, similarly to the whole region, heat has been supplied by them from typically excess heat from the oil refinery in Fredericia, Skærbækværket and a waste incineration plant in Kolding. Two heat centrals have remained from the old system, one in Børkop and one in Brejning, which include oil boilers and nowadays are kept as back-up units. (Møller, 2015)

There has been two fusions with Gauerslund Fjernvarme within the timeframe, in 2010 and in 2014 as can also be seen on the table in the Appendix. These fusions were with Kellers Park, which is about 1 [km] to the north-east from Brejning and Gårslev which is about 2.5 [km] to south-east from Gauerslund. The location of these towns are shown on Figure 4.4.

Figure 4.4 Gauerslund and the merged towns on map

Gauerslund Fjernvarme has been running Gårslev Fjernvarme since 1991 so a fusion has been on the way since then. It happened in 2014 only because of the financial situation of Gårslev

Fjernvarme. The main motivation was to reduce costs that was hoped to achieve by having common board, financials and billing. (Trekantområdets Varmetransmissionsselskab I/S, 2014)

4.3. Grevinge/Herrestrup (Odsherred Forsyning)

Grevinge and Herrestrup are two neighbor towns in Odsherred Kommune on the north of Sjælland with their summed population of around 900 which makes them significantly smaller than the other cases. (Danmarks Statistik, 2014)

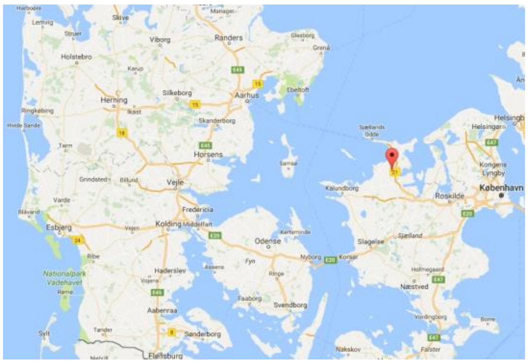

Figure 4.5 Position of Grevinge/Herrestrup in Denmark

The district heating plant in Grevinge has a gas boiler of 1 [MW]. It was built in 1995 and is providing heat to 378 households. Grevinge has been one of the most expensive heating districts in the country and as such, it has received a permission of building a 1 [MW] biomass-boiler in 2012 in order to help decreasing the district heating prices. This boiler is to be ready for operation in 2017. (Christensen, 2015)

District heating service in Grevinge/Herrestrup has had belonged to Odsherred Kommune, until, in January 2012 it was attached to Odsherred Forsyning A/S. (Christensen, 2015).

4.4. Hammel Fjernvarme

Hammel is a town in the east of Jylland of approximately 7000 people, which makes it similar in size to Aars and the Gauerslund region. (Danmarks Statistik, 2014)

Figure 4.6 Position of Hammel in Denmark

The district heating system of Hammel delivers heat to approximately 2000 households. The heat is mainly produced in the waste incineration plant which has 10.2 [MW] capacity, with an eventual help of oil boilers in the winter period. (Hammel Fjernvarme, 2015)

There has been three fusions with Hammel as can be seen on the detailed table in the Appendix. The first one was with Voldby in 2010, which is 2 [km] to the south. The second and third were in 2014, with Gjern, approximately 8 [km] to south-west and Lading-Fajstrup which is around 6 [km] to the south-east, as shown on Figure 4.7. (Hammel Fjernvarme, 2015)

Figure 4.7 Hammel and the merged towns on map

The main motivation behind the fusions with Gjern and Lading-Fajstrup was that with the 700 new consumers, the costs per person would be decreased thereby reducing the consumer district heating prices. (Hammel Fjernvarme, 2013)

4.5. Summary

As it has been shown, in most of the cases the motivation behind merging was economical, namely, because it was assumed to help reducing the consumer district heating prices. In the second part of the following chapter, this issue is analyzed.

5. Analysis

The analysis of present study is of two main parts. The first part was done on a country level, meaning that the used data and sources are relevant for the whole country. In the first part of the analysis, the district heating consumer prices are investigated throughout Denmark within the timeframe of the project, followed by the analysis of changing number of heating districts and fusions between 2010 and 2015.

In the second part, the specific cases are analyzed from the perspective of elements of the consumer heating prices and company costs, meaning that the second part of the analysis is done on a case level. These analyses are always done regarding the districts to which others have merged (main districts), meaning that these are those districts which have been present through the timeframe. This is done because detailed data was unable to be found regarding those districts which have merged to another (merging districts) and therefore formally have not been recorded as individual districts for a time.

5.1. District heating prices in Denmark

This research uses consumer district heating prices as a basis. The factor that is the most significant from the perspective of the consumers, is the price for district heating. It cannot be assumed that consumers have an extended knowledge about their own district heating network, but the price they pay for the service is of importance. Therefore, in order to assure the public relevance of this study, the district heating prices were chosen. This part gives an overview of the Danish district heating prices in general, followed by the analysis of the latest statistics available and finally, extending the research to the timeframe 2010-2015.

5.1.1. About the heating prices

In Denmark, the district heating companies are not allowed to make profit of their operation, which means that the price the consumers pay need to precisely cover the company's costs connected to production, distribution and administration in an average share of 72%, 23% and 5%, respectively (Danish Energy Agency, 2015). This means that the consumer prices are composed of fuel costs, heating production facility, district heating network, buildings, operation and maintenance and administration costs. It also means, that the consumer prices are affected by investments, changes in the fuel prices, heat loss and efficiency of the production unit, taxes, financial supports and the electricity prices regarding both production (in case of CHP's) and use (as in electric boilers or heat pumps). These factors make the consumer price, by a price structure that varies between heating districts. According to Danish Energy Agency, prices are usually lower in large scale networks than in smaller scale networks, because of economies of scale and higher heating density, meaning that in a large network, the costs and heating losses per unit of heating is lower than in a small system. (Danish Energy Agency, 2015) A comparative analysis including 41 towns in Denmark, conducted by Alexander Kousgaard Sejbjerg at Aalborg University shows, that the price structure varies greatly between towns, which makes the detailed comparison of prices complicated (Sejbjerg, 2015). However, the general elements of the district heating prices are set by the same concept, as presented in the following, which makes it possible to execute a general comparison.

The consumer price is summary of fixed and variable parts in general. Fixed parts are specific amounts that are not dependent on the amount of heat used. This means annual subscription fee and specific fee to be payed based on the area of the household. The variable part is the amount that is connected to the consumption of the household. This includes a price per MWh of heat delivered and, in some cases, also a fee connected to the amount of hot water delivered. An example is presented on Table 5.1, including the current heating prices of NORFORS, a regional district heating company located on the north of Sjælland.

Fixed annual fee [DKK/year]	Fixed areal fee [DKK/m^2]	Variable heat fee [DKK/MWh]	Variable flow fee [DKK/m^3]
725	41.88	626.25	5.63

Table 5.1 District heating price elements of NORFORS in 2016

These elements explained above compose the district heating price in the individual districts. Due to the reasons mentioned above, namely the non-profit principle, the transparency of price components and the fact that similar components form the consumer prices everywhere in Denmark, make the district heating prices fairly comparable throughout the country. In order, to be able to conduct such a comparison, a basis is necessary which represents the consumer prices according to similar conditions, regarding household area and heat consumption. This is explained further in the following.

5.1.2. Latest district heating prices in Denmark

The analysis was started with the latest data available, which was from August 2015 (Energitilsynet, 2015). Even though, another data sheet was expected to be published by April 2016, it has not been released up to this point in time.

When looking at this data, first a basis of comparison needs to be chosen. The price of one MWh of heat may be a good basis but it only includes the variable part of the consumer costs, therefore it does not give a representative image of the price the consumers have to pay in the individual districts. This is because different towns use different price structures meaning that the fixed part of the consumer prices may vary greatly. One of the standard household prices with their standard annual heat consumption was a more reasonable choice and since some of the data for the 75 [m^2] households were missing, in order to minimize data loss, the price for the 130 [m^2] with a yearly heat consumption of 18.1 [MWh] was chosen. The individual districts are not weighted by their population, meaning all districts are represented equally. Based on this, the prices of the districts are comparable and they can be presented in decreasing order, as shown on Figure 5.1.

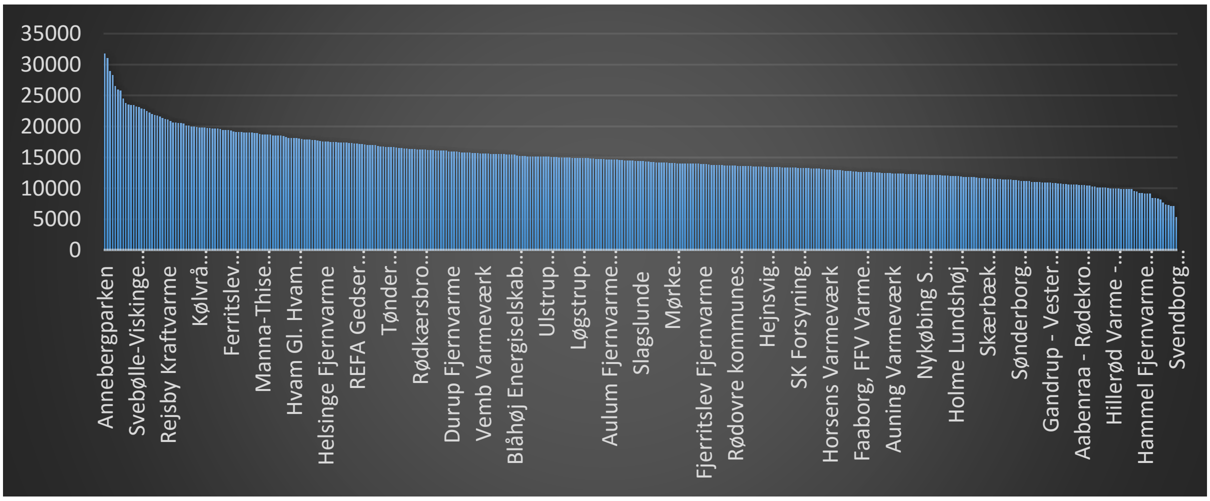

Figure 5.1 District heating prices in DKK/household/year as of August 2015

The average price for this household size is 14,860 [DKK/year] and 419 districts are registered. Further analysis of the data showed that in 249 cases the prices differed from the average with less than 20% and in 387 cases the difference from the average is below 50%. This means, that even though the prices have a relatively wide range, in most of the districts they a fairly close to the average.

In order to have a representative image of the prices, seven categories were established, based on price ranges, as follows. The highest price range is made of those cases where the annual price reaches or extends 1.6 times the average price. The next range is down to 20,000 [DKK/year], while the third, fourth and fifth are made with 3,000 [DKK] steps, therefore they include districts with prices down to 17,000, 14,000 and 11,000 [DKK], respectively. The next range is between 11,000 and above 9,500, while at the low end of prices, the lowest ones are recognized including and under 9,500 [DKK/year]. In order to ease the use of these categories, they are named I.-VII. This categorization helps to make the extremely large amount of data, including more than 400 districts, analyzable regarding the prices. Even though considering the districts one by one would make a more precise analysis, this was not possible due to limits in time and extent, moreover, such a detailed analysis is not part of present study.

The number of districts falling into the individual categories are presented on Figure 5.2. These categories remain defined by the same borders throughout the entire analysis.

It can be seen, that in most of the cases, prices fall in Category IV. or V., which means annual heating prices between 11,000 and 17,000 [DKK], with leaving only a small number of districts in the extremely high and extremely low price categories.

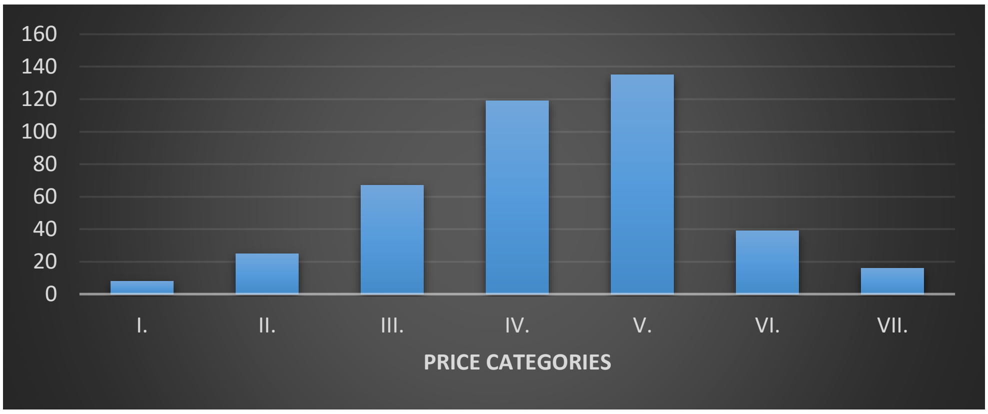

Figure 5.2 Numbers of districts in individual price categories as of 08/2015

5.1.3. Prices in the timeframe of the study

In order to be able to investigate the price changes in the Danish district heating sector, a timeframe of 5 years was used. The reason for this choice is that this period of time provides enough information to make a representative study, as mentioned earlier, but also due to the fact that Energitilsynet started to collect data from the district heating companies in this form in 2007, and, according to Kasper Nagel from Dansk Fjernvarme, they did not receive all the data before 2010, but after that they have begun to be more consistent about requesting data from the companies. The data sheets are as of August 2015 (Energitilsynet, 2015), March 2015 (Energitilsynet, 2015), August 2014 (Energitilsynet, 2014), March 2014 (Energitilsynet, 2014), August 2013 (Energitilsynet, 2013), March 2013 (Energitilsynet, 2013), December 2012 (Energitilsynet, 2012), August 2012 (Energitilsynet, 2012), March 2012 (Energitilsynet, 2012), July 2011 (Energitilsynet, 2011), February 2011 (Energitilsynet, 2011), December 2010 (Energitilsynet, 2010), July 2010 (Energitilsynet, 2010) and February 2010 (Energitilsynet, 2010).

Change of average price

As a first approach, the change of average district heating price is analyzed during the stated timeframe. In this data, the districts were not weighted by size, all of them were considered equally.

If we take a look at the change of the average price between 2010 and 2015, as shown on Figure 5.3, it can be seen that after a slight increase from July 2010 until the maximum in March 2014, the prices started to fall and reached a minimum in August 2015 which is the latest data included in this research. Even though the price difference between the highest and the lowest value at this point in time is only about 11%, the prices can be expected to decrease further.

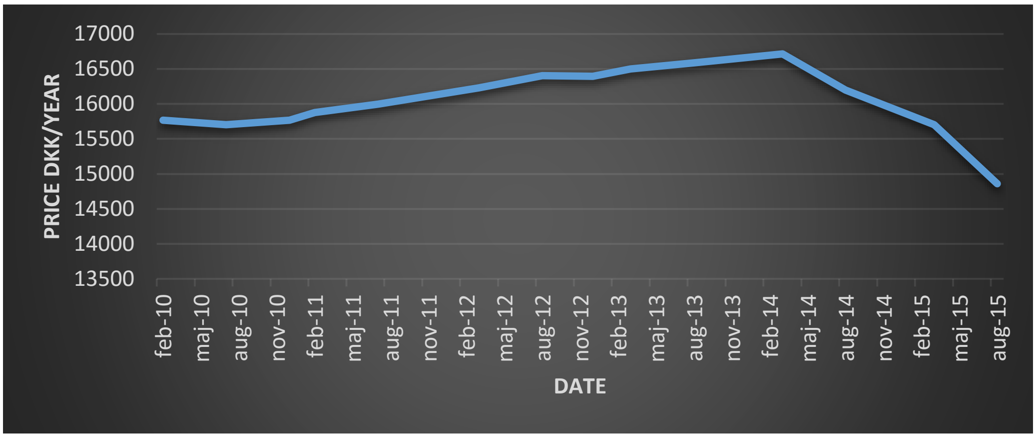

Figure 5.3 Average price within the timeframe

Reflection to Dansk Fjernvarme Benchmarking 2015

In the benchmarking report published by Dansk Fjernvarme, the net losses in the Danish district heating network have been constant or slightly decreasing in the framework period, while the administration costs per sold MWh have been falling significantly since 2012. Based on these two facts, the prices should be decreasing since 2012, which means that another component in the heating prices had to increase. This can be explained by the Danish Heating Act, Varmeloven. It states, that if a district heating company has higher income than expense (in this case, because of the decreasing administration costs and heat loss), then this difference can be realized as a price change the year after (Energi-, Forsynings- og Klimaministeriet, 2015).

Price range analysis

The price range analysis was used by the same method as at the latest data and the price categories were set up the same way. The results are presented on Table 5.2 including the latest data presented earlier.

Datasheet	I.	II.	III.	IV.	V.	VI.	VII.
02/2010	15	63	78	112	118	43	23
07/2010	17	61	67	120	128	41	21
12/2010	18	42	83	126	127	37	21
02/2011	18	55	74	127	128	31	19
07/2011	14	57	81	133	128	21	19
03/2012	15	58	78	135	117	21	12
08/2012	14	67	72	136	114	16	12
12/2012	13	67	75	135	112	18	10
03/2013	11	74	70	139	110	17	9
08/2013	11	67	88	135	107	17	3
03/2014	8	72	94	146	90	16	2
08/2014	7	50	100	149	99	18	5
03/2015	7	38	89	142	111	22	8
08/2015	8	25	67	119	135	39	16

Table 5.2 Number of districts in different price categories

When looking at these numbers, it can be seen that the number of districts in the high price range (Category I.) has been falling since 2010 and fell from 18 to 8. The number of districts in category II and III are nearly constant but in the close past, both have been decreasing. It can also be seen, that significantly more districts fall to those categories that are set around the average price (Categories IV. and V.), and that throughout the past years, the number of districts in these categories increased. This is true for category IV apart from the latest data which shows slight decrease but it is true for category V especially in the latest data. If we take a look at the remaining two categories, it can be seen that the number of districts with low heating prices has decreased for a while and started to increase again in 2014.

All of this means, that district heating customers receive this service for a slightly but constantly decreasing price (which could also be seen from the average prices), and also that prices in the Danish district heating sector are slowly equalizing, with more and more districts having prices around the average and less and less districts with prices at the high end of the price range.

5.1.4. Summary of price-analysis

After analyzing the change of district heating price in Denmark between 2010 and 2015, it can be stated that prices around the country are tending towards the average which has been decreasing itself in the latest times. The data presented on Table 5.2 is not including those districts, which were recognized in the statistics but were missing data, therefore there is a slight statistical uncertainty here. However, this means 0-6 cases per datasheet with an average of 4.1 district, which represents an insignificant amount of data. It can be seen clearly that the number of districts have been decreasing significantly within the time period of this research. Since this issue is of importance, it needs further investigation, which is presented in the following.

5.2. Fusions in the Danish district heating sector

In this chapter, the reduction in the number of district heating companies mentioned previously is in focus. First, the change in the number of districts is discussed, followed by the presentation of fusions, and, finally, the fusions from the perspective of the companies.

As mentioned earlier, within the limits of this study, a company was considered as participant in a fusion if it was not independently published in the statistics of Energitilsynet after a point in time and further research confirmed that the service area belongs to another company, latest from the date the next price statistic was published.

5.2.1. Change in the number of districts through the time period

As a start, the specific number of reduction needs to be investigated. After the price analysis described in the previous chapter was done, it could be seen that the number of companies has been descending. After more detailed research regarding the heating districts in the price statistic, it was found, that this number was actually constantly descending apart from a very few examples. From the 458 districts in February 2010 (and 459 in May 2010), it has been reduced to 419 as of August 2015. The change in the number of districts throughout the timeframe is presented on Figure 5.4.

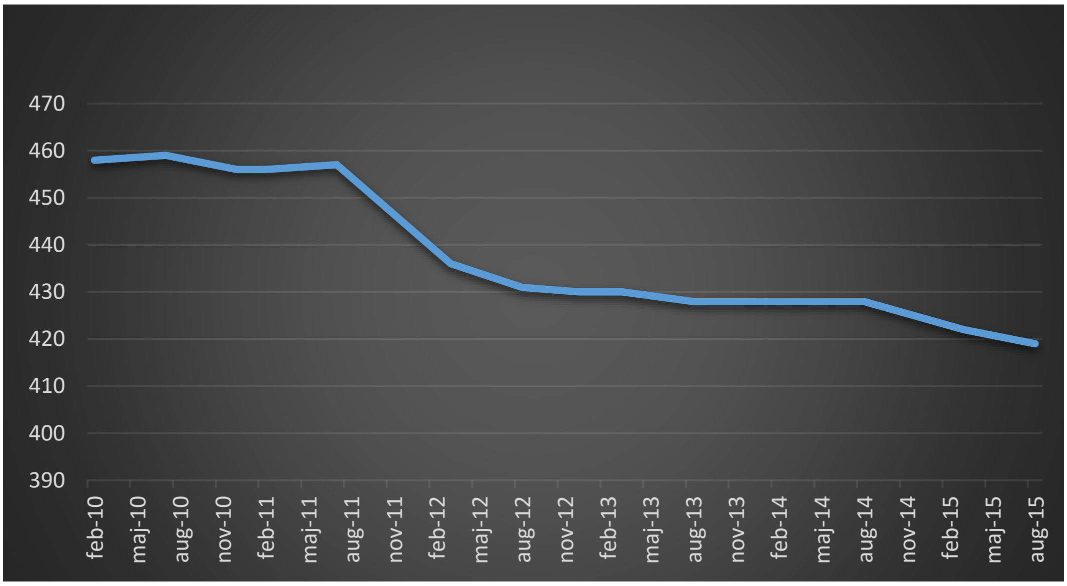

Figure 5.4 Number of heating districts throughout the timeframe

If we take a look at the statistics before this time period, it can be seen that the number of heating districts have been around 450-460, but only after a significant increase after 362 districts in July 2007. After this point in time, the number of districts started to increase rapidly and reached 443 by January 2009, meaning 81 new heating districts in the statistics in just 2 years. According to the opinion of Kasper Nagel from Dansk Fjernvarme, this increase is because before 2010, Energitilsynet did not receive data from all the plants around the country, but they have started to be more consistent about requesting data from them. Therefore it cannot be stated with complete certainty that the number of heating districts has risen or is this phenomenon only due to the lack of data in the years 2007-2010.

5.2.2. Fusions during the timeframe of the study

Further research done on the reduction of numbers of heating districts showed that in reality, new districts appeared on the datasheets while others were removed from them. This change through the time period 2010-2015 is mainly due to the company merges in the Danish district heating sector, however it needed further investigation. The numbers of districts on the individual datasheets with the changes compared to the previous ones are presented on Table 5.3.

Datasheet	New	Number of districts	Removed
02/2010	-	458	-
07/2010	+8	459	-7
12/2010	+0	455	-4
02/2011	+5	456	-4
07/2011	+8	457	-7
03/2012	+2	436	-23
08/2012	+1	431	-6
12/2012	+3	430	-4
03/2013	+3	430	-3
08/2013	+1	428	-3
03/2014	+1	428	-1
08/2014	+3	428	-3
03/2015	+2	422	-8
08/2015	+5	419	-8

Table 5.3 Numbers of districts in the individual datasheets with changes

It has to be mentioned, that Table 5.3 shows the changes of numbers but not the actual district changes. Due to name changes and data that were missing in some periods, it needed further research to clarify, which districts were actually merged with others. The result of this research is the table that contains all the merges found from 2010-2015 and it can be found in the Appendix.

Reflection to Dansk Fjernvarme statistics and data

In April 2016, Dansk Fjernvarme published an article about fusions in the district heating sector. The number of fusions by year was also presented, as shown on Figure 5.5 (Nielsen, 2016), together with the fusions found by this research. This data does not provide further information, however, if compared to the findings of this study, it can be seen that the results are similar and in the overall amount of the fusions there is only a slight difference, to which an explanation can be the different timeframes. What makes the comparison difficult is the fact that present research is not organizing the fusions by calendar year, but following the data collecting frequency of Energitilsynet. In the data presented on Figure 5.5, in cases where a datasheet was made in the calendar year after the previous one, fusions are considered to be in the earlier year. Moreover, since the latest used data is from August 2015, it cannot be compared to the data of Dansk Fjernvarme in this time period due to the lack of precise data for the rest of that year. The article also has a data of six fusions for 2016, however this can only be an early estimate.

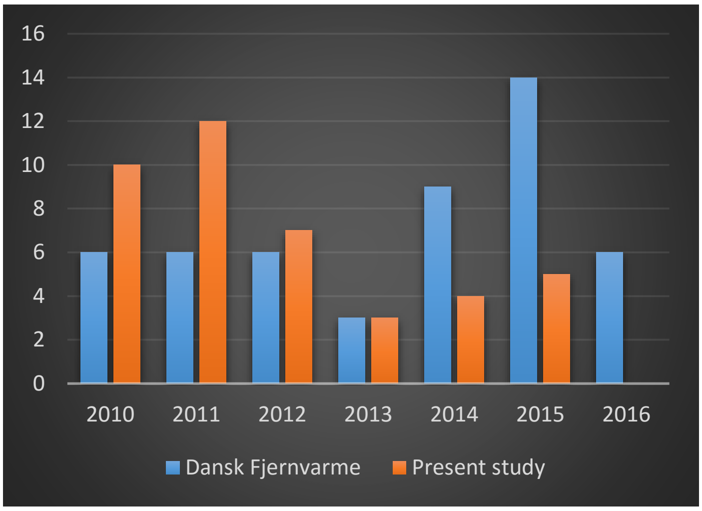

Figure 5.5 Number of fusions by year. Source: Dansk Fjernvarme

5.2.3. Fusions from the perspective of the companies

As mentioned before, a non-profit principle applies to district heating companies. This is achieved through two basic rules: the company is not allowed to increase its income through utility services, and consumers are not allowed to receive any subsidy of the utility service. This principle does not apply to fuel supply, legal assistance and consulting services, as these are considered to be commercial activities. The costs of Danish district heating companies are divided to production, distribution and administration, which make 72%, 23% and 5 % in average, respectively. (Danish Energy Agency, 2015) This means, that 95% of the costs are related to production and distribution, the two areas where economy of scale can apply most effectively, which can be a strong motivation for merging.

Dansk Fjernvarme executed a survey with asking 294 experts working in the Danish district heating sector. This survey, presented in the 09/2014 issue of Fjernvarmen shows, that 37% of them have an informal working partnership with another company, 42% have a formal partnership and 6% are already in fusion. (Faaborg, 2014)

Another study based on 160 answers from district heating company leaders, published in the 05/2015 issue of Fjernvarmen states, that 59% of the companies work together with another district heating company nearby, on some level. This includes running the plant together, sharing the administration tasks, security or purchasing fuel materials together. According to Dansk Fjernvarme, this kind of partnership is typically the first step towards company fusion. According to the survey, 29% of the district heating companies were planning a fusion within the following 2-3 years. In addition to this, 70% of the Danish district heating companies use the same IT software products which means that this is not an obstacle. (Jespersen, 2015)

The difference between the two surveys can be explained by the different definition of co-operation between plants. The first survey was more extensive in the meaning of more answers were received from throughout the district heating sector, therefore it may be more representative. In the second survey, significantly less answers were taken, on which the statistics were based. This means that the 79% of co-operations mentioned in the first survey and the 59% in the second, might address the same issue but due to the differences in quantity of data, their comparison is doubtful.

This process of companies merging is expected to continue in the near future, partially due to future requirements in increasing efficiency (Faaborg, 2014). As mentioned before, district heating systems are expected to be flexible in the future and large systems have better chances to achieve that goal. Besides, in order to maintain the high level of district heating service and at the same time, keeping it affordable to the consumers is a challenge that can be made easier in large-scale systems.

5.2.4. Summary

According to the statistic sources, many changes have happened in the past years to the district heating companies. These changes are found to be a significant decrease in the number of companies throughout the time-frame of this study. This reduction in the number of district heating companies in Denmark can be well explained by the number of fusions, as presented. It can be seen that merging is a popular choice for district heating companies, which is not only visible on the fusions that have already happened but also on the intention of companies to merging, as seen in the surveys. The process of companies merging in the district heating sector is expected to continue in the future therefore making it a question of importance.

After fusion as a phenomenon and the number of fusions has been presented throughout the time period of the research, it is important to examine its effects on the district heating prices, which is presented in the following.

5.3. Evaluation of fusions

After the fusions have previous been presented, it is necessary to analyze them from the primary perspective: which districts have decided to merge and what effect they had on the prices in the districts? This analysis is presented in the following, by comparing the prices in the districts before and after the fusions.

5.3.1. Price range of merged districts

First, the merged districts need to be examined from the perspective of the prices, before they merged. The heating price in average in these districts was 15,204 [DKK/year] which is not significantly different from the average price through the years, which has been presented earlier. For further investigation, the method used previously can be used again, meaning that the same categories can be applied. The total number of 56 merged districts falling into the individual categories are presented on Table 5.4.

	I.	*II.*	*III.*	*IV.*	*V.*	*VI.*	*VII.*
Districts	2	3	12	21	12	4	2

Table 5.4 Number of merged districts in price ranges before merging

What can be seen from this table is that the merged districts by price ranges are distributed similarly as the districts normally do, as presented on Figure 5.2. If we compare the distribution of districts by price ranges to the average distribution of districts within the timeframe, it can be seen that they are of similar character, as shown on Figure 5.6 and Figure 5.7.

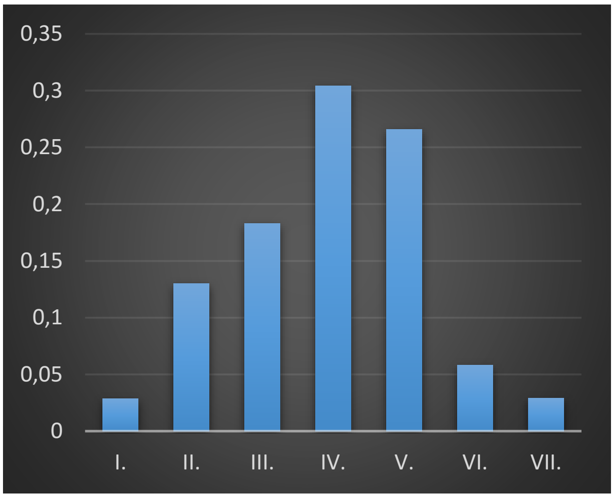

Figure 5.6 Average distribution of districts

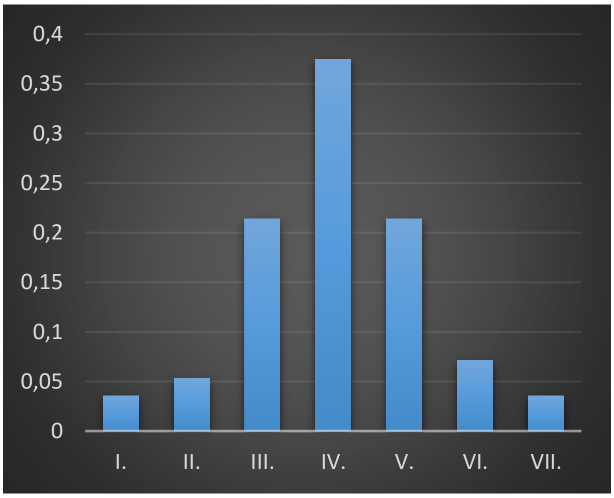

Figure 5.7 Distribution of merged districts before merging

The difference between the two distributions is that the deviation of values from the average is less in the case of merged districts. This is mainly the consequence of less data and it shows, that merely higher or lower prices do not represent higher or lower probability of merging. After merging, the average price in the same districts is 13,848 [DKK/year], which means an approximately 10% decrease. The districts are put in the same price ranges after the merges happened, in order to make them comparable. The results are presented on Table 5.5 as numbers of districts and on Figure 5.8 as distribution.

	I.	*II.*	*III.*	*IV.*	*V.*	*VI.*	*VII.*
Districts	0	2	10	17	15	10	2

Table 5.5 Number of merged districts in price ranges after merging

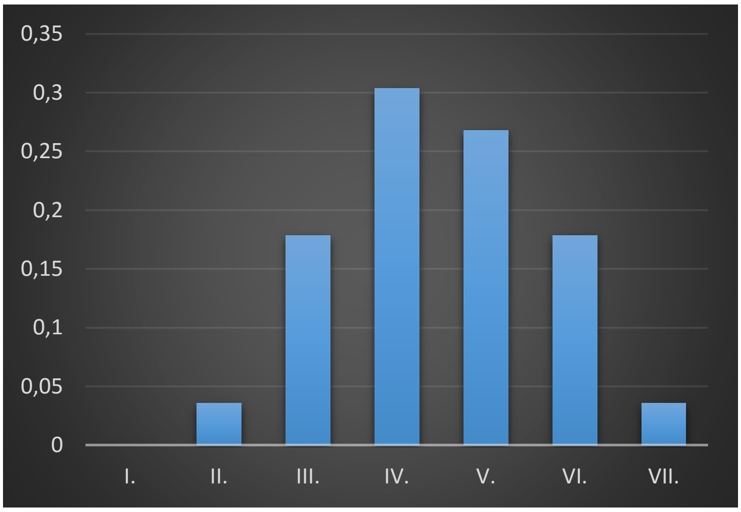

Figure 5.8 Distribution of merged districts after merging

Table 5.5 shows, that those districts where the company was merged, were clearly shifted towards higher category numbers, meaning lower prices. No district was left in the most expensive category, and the number of districts in category II., III., and IV. decreased. In the meantime, the number of districts in category number V. and VI. increased and there was no change in category VII.

When looking at the distribution of districts on Figure 5.8, it can be seen that the districts moved towards spreading out in the lower price categories, in contrary to the distribution before merging, where they rather gathered around the average price, presented on Figure 5.7.

After comparing the price ranges of the individual districts before and after the merges, it was found that out of the 56 districts, 22 changed to lower price category, 15 changed to higher, while in 19 cases, there was no category change. Naturally, this does not mean that the prices did not change, and therefore an additional analysis was necessary in these 19 cases, regarding the specific prices in these cases. This analysis showed, that out of the 19 districts, prices decreased in 6, increased in 7 and did not change in 6 cases.

However, the type of the fusion is also an important factor in this question, which is analyzed in the following.

5.3.2. Categorization of merges

Merges vary by their circumstances and even though no difference has been made between them in present study so far, it can be interesting to differentiate them. The most conspicuous difference between them is regarding the size of merging district compared to the district it is merging to, which might provide new information. By this quality of the merging, three categories were set, explained as follows.

First, those merges were put in a category, where two heating networks were recognized in the same town. In these cases, the merge did not happen between two geographically separated towns, but within one, which could happen for several reasons but it makes their comparison with the other cases questionable. In the timeframe of the research, there were three of these.

The second category is including smaller towns merging into a bigger district nearby that has dominantly higher heat production than the merging companies. This category included 29 merges.

The third category is for smaller towns which merge together and create a new district heating company. There were 25 cases of these.

If the number of districts in which the heating price decreased, increased and did not change are organized by this categorization, the following data is found, as shown on Table 5.6

	Decrease	*Increase*	*No change*
Purchase of heat plant	0	2	1
Small to big	20	1	8
Small to small	2	12	11

Table 5.6 Distribution of merged districts by price change

This comparison shows, that those districts could significantly decrease their prices, which had the opportunity to make a fusion with a bigger district nearby. However, in order to find out how the prices and costs really changed, detailed analyses are required.

5.3.3. Summary

The analysis presented in the first part shows that fusions in the Danish district heating sector does have an effect on the prices and this effect is highly dependent on the circumstances of the fusion. In vast majority of the cases, it can help to decrease the consumer prices, however, this effect is the strongest at those cases where a larger heating district is given, to which the district can merge to. It could be seen that according to the price categorization method used in present study, fusions can be set into three categories, depending on whether they increased, decreased or did not change price category as a consequence of the fusion. This was used as a basis for selecting specific cases for further research, as described in the Methodology chapter. In the following second part of the analysis, detailed analysis of these cases is presented from the financial perspective.

5.4. Price analysis

In the following, the consumer district heating prices of the selected districts are presented throughout the timeframe, first. Detailed research has been performed regarding the price structures of the selected districts, including both fixed and variable parts. In this research, only those amounts were taken into consideration, which needs to be payed for an already existing and connected household, therefore connection fees, network extension fees and other fees are not taken into account. The changes of the specific price elements were investigated through the timeframe. This is described in the following, followed by the change of the overall prices of the districts and the merged districts throughout the timeframe, based on the data of Energitilsynets price statistics. The change of price for standard household of 130 [m^2] in the selected districts can be found in Appendix 7.

5.4.1. Aars Fjernvarme

In Aars, the prices are annually published by the district heating company, which publications have been used a sources of data (Aars Fjernvarmeforsyning, 2010), (Aars Fjernvarmeforsyning, 2011), (Aars Fjernvarme, 2012), (Aars Fjernvarme, 2013), (Aars Fjernvarme, 2016). The fixed part of the prices are made of an annually payed energy saving fee, a fixed fee payed by square meters and a renting fee for the heat meters. The variable part is of the heat price payed by consumed [MWh] of heat and since 2013, an energy saving fee, also based on the consumed [MWh] of heat. The price elements throughout the time frame are shown on Table 5.7. The values here are without sales taxes.

Title	*Unit*	*2008/09*	*2009/10*	*2010/11*	*2011/12*	*2012/13*	*2013/14*	*2014/15*
Variable								
Heat	DKK/MWh	350	350	350	320	330	350	340
Energy saving fee	DKK/MWh						5	5
Fixed								
Energy saving fee	DKK/year	150	150	150	150	150	150	150
Fixed fee	DKK/m2	15	15	15	15	15	15	15
Renting meter	DKK/year	500	500	500	500	500	500	500

Table 5.7 Change of price elements in Aars

As it can be seen, the fixed parts and the variable energy saving fee are constant through the timeframe, meaning that all the changes in the district heating price is made through the variable price of heat. This data shows that the variable heat price did not change immediately, as he fusions were in 2009 and 2010, but they are slightly reduced in the following years.

If we take a look at the standard district heating prices of a 130 [m^2] household in Aars and the merged towns within the timeframe, it can be seen that the prices did decrease after the fusions, especially for consumers in the merged districts, but also to those in Aars. However, the prices later increased slightly for those living in Aars, compared to before the merging, even though it is not significant (about 5-7%). The changes of prices in the individual towns are presented on Figure 5.9 and an additional table with the specific values can be found in the Appendix.

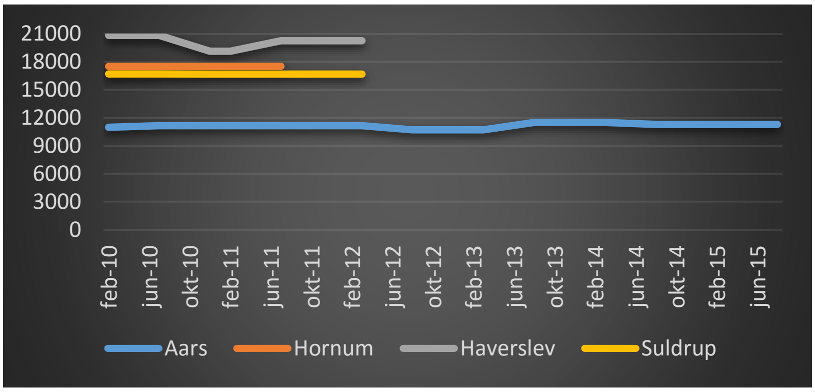

Figure 5.9 Prices in Aars and the merged districts 2010-2015

It can be stated, that the households in the district attached to Aars did experience a significant decrease in their district heating prices, such amount in fact, that it caused this case to be an example in present analysis for where prices decreased to another price category.

5.4.2. Gauerslund Fjernvarme

For Gauerslund, a detailed price chart was only available for 2016. According to this, there is a variable price of the consumed heat that needs to be payed per [MWh], together with the fixed annual cost of renting the heat meter and the fixed cost per [m^2] of the household. For the years before 2016, there was no information regarding the fixed costs. The variable heat price was given by the price statistics of Energitilsynet. The results are presented on Table 5.8, again, without sales taxes.

Title	*Unit*	*2008/09*	*2009/10*	*2010/11*	*2011/12*	*2012/13*	*2013/14*	*2014/15*	*2015/16*	*2016*
Variable										
Heat	DKK/MWh	355	353	420	408	460	460	470	390	390
Fixed										
Fixed fee	DKK/m2	-	-	-	-	-	-	-	-	20
Rent. meter	DKK/year	-	-	-	-	-	-	-	-	275

Table 5.8 Change of price elements in Gauerslund

In this case, the variable heat price increases in 2010 and even more in 2012, with a significant descend in 2015. The fusions took place in 2009 and 2013, which means that the price increased short after the first fusion and decreased short after the second one.

Figure 5.10 shows the annual consumer prices for a household of 130 [m^2] in Gauerslund and the merged districts within the timeframe. It can be seen, that one year after the first fusion the price in Gauerslund slightly decreased. One year after the second fusion, there is also a slight decrease.

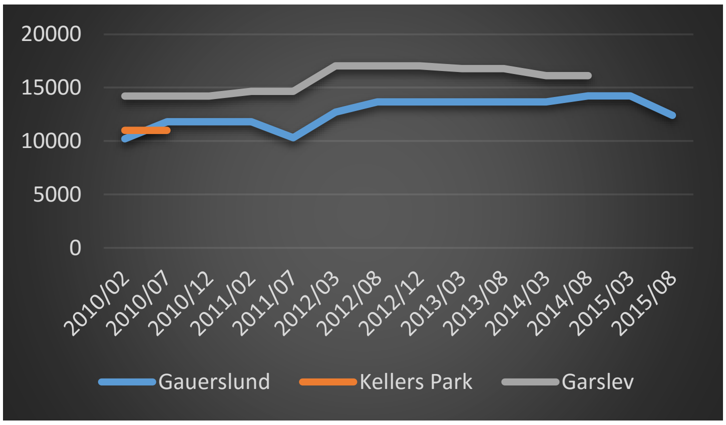

Figure 5.10 Prices in Gauerslund and the merged districts 2010-2015

The households in the merging districts did experience some price change that was either increase (Kellers Park) or decrease (Gårslev), but neither change was of large extent. Therefore Gauerslund has become an example in present study for when fusions did not cause price category change.

5.4.3. Odsherred Forsyning

In Odsherred, above the variable heat price, a subscription fee is payed annually, together with a fixed fee which is based on the size of the household. None of these are constant during the time frame, the fixed price elements increase constantly, while the variable heat price increases from 880 in 2012 up to 960 in 2015. However, this price is reduced as of January 2016, which is out of the time frame of the study. The specific values are presented on Table 5.9.

Title	*Unit*	*2012*	*2013*	*2014*	*2015*	*2016*
Variable						
Heat	DKK/MWh	880	960	960	960	680
Fixed						
Subscription fee	DKK/year	1000	1100	1200	1200	1200
Fixed fee <75m²	DKK/year	1900	2300	2400	2400	2400
Fixed fee >75m²	DKK/year	2100	2500	2600	2600	2600

Table 5.9 Change of price elements in Odsherred

Figure 5.11 shows how the annual district heating consumer price for a 130 [m^2] household has been changing in the area. Odsherred Forsyning took over the district heating service in 2012 and the price increased by 33% from 16,093 to 23,785 [DKK/year] simultaneously. Although, it has to be mentioned that the price is announced to drop to 20,135 [DKK] as of 2016, which is out of the timeframe of the study (Odsherred Forsyning, 2015). It can also be seen from the numbers, that this district is significantly smaller than the others which are subject to present study. This corresponds to the conclusion of Energitilsynet, stating that it is typically the small districts, where the prices are exceptionally high (Energitilsynet, 2015).

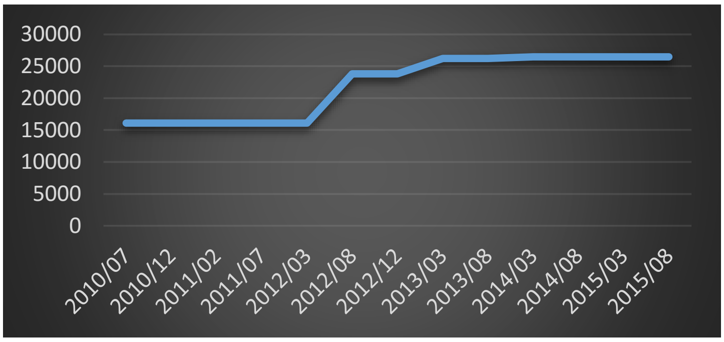

Figure 5.11 Change of price for a household of 130 m2 in the Grevinge-Herrestrup area

In Grevinge-Herrestrup, the district heating consumer price increased significantly and it can be connected to the fusion with Odsherred Forsyning A/S. Therefore it has become an example in present study where the fusion was followed by a change to a higher price category. However, it has to be mentioned that this fusion was not between two district heating companies, therefore comparing it to the others is questionable.

5.4.4. Hammel Fjernvarme

For the price analysis of Hammel Fjernvarme, similarly to the previous ones, the latest published data and the price statistics were used. In this district, above the variable heat price, a fixed subscription fee is payed on an annual basis as well as a fixed fee per [m^2]. The latest data available was used, which was the published prices for the 2016/17 heating season. Since no other source was available, it was assumed, that the fixed parts remained constant through the time frame. The results are shown on Table 5.10. The variable heat price slightly increased between 2010 and 2013 and decreased after 2015.

Title	*Unit*	*2008/09*	*2009/10*	*2010/11*	*2011/12*	*2012/13*	*2013/14*	*2014/15*	*2015/16*	*2016/17*
Variable										
Heat	DKK/MWh	210	210	240	270	290	355	355	335	335
Fixed										
Subscription fee	DKK/year	-	-	-	-	-	-	-	-	220
Fixed fee	DKK/m^2/year	-	-	-	-	-	-	-	-	8
Fixed fee over 10,000 m^2	DKK/m^2/year	-	-	-	-	-	-	-	-	6

Table 5.10 Change of price elements in Hammel

The changes in the annual consumer district heating prices for a standard 130 [m^2] household in Hammel and the merged districts are presented on Figure 5.12. It can be seen, that all the districts which were merged to Hammel had significantly higher prices before the merging.

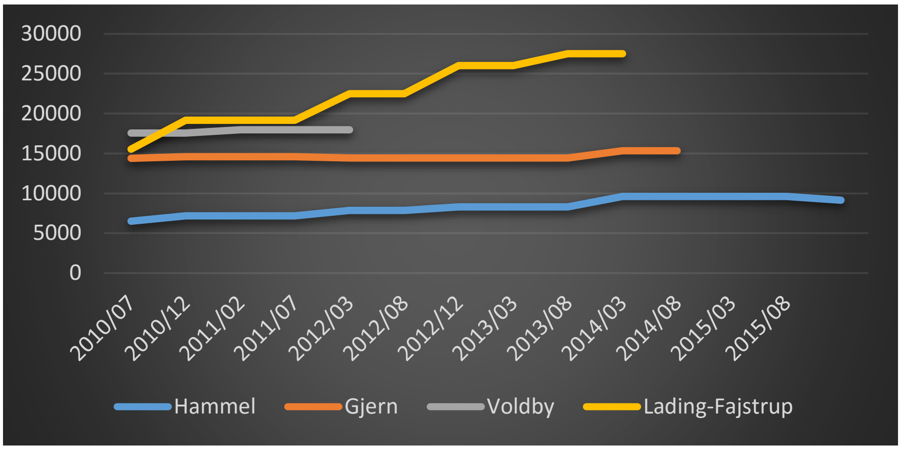

Figure 5.12 Price in Hammel and the merged districts 2010-2015

Hammel Fjernvarme is another example for when fusions were followed by change to a lower price category for the households in the merged districts. The district heating consumer price in Hammel did not change significantly.

5.5.Cost analysis

As presented in earlier, 72% of the costs of district heating companies is related to production, 23% is related to distribution and 5% to administration in average. It has to be pointed out, that the calculation method for these values is not known and they show an average for the whole country. This means that the share of costs for specific cases may vary greatly from this share. This could be an explanation for the results of comparison on

Table 5.6, as fusions mean a growing heat demand to be covered, and in the case of larger plants, this can decrease the costs per [MWh] produced, which means decrease of the prices. However, this cannot be stated as a conclusion without further detailed research regarding the company costs. In the following, the costs of the selected district heating companies are presented, based on their published annual cost reports. When making the analysis, all the financial items in the annual reports were considered to be costs, which represent a value that has reduced the financial assets of the company in the specific period of time to which the report is applied. It has to be noted that different companies might use different cost categories in their financial publications, therefore all the costs needed to be made comparable. Therefore, all costs were divided into the three categories: production, distribution and administration. This process of division is presented in the following, after the clarification of the three used cost categories. Apart from the specific costs in each categories, their shares to the whole are also presented, as well as the summed amount of sold heat each year, and the degree days of the specific years, to which the data of Aars Fjernvarme is used in all cases. This was done based on the assumption that even though local differences may occur, due to the relatively small geographical distance between the districts, this does not play a significant role and the tendencies can still be seen.

5.5.1. Assorting of costs

As mentioned, all costs of the companies were sorted into one of the three categories. In some cases, the costs were already sorted to these, but in most of the cases it required to be done manually. All the expenses connected to the physical manufacturing of the heat are sorted to production. These typically mean fuel costs, operation and maintenance or depreciation of production units. To distribution, all the costs were assorted, which are connected to the transportation of heat from the point of exit from the production unit. This means operation, maintenance and depreciation of the distribution pipes and heat centrals, as well as costs connected to the meters and eventually those properties which are in the merged areas that no longer operate as production units. All financial costs, personal costs, and other costs which cannot fit into the two previous categories were sorted to administration costs. This assorting method is used in the following, the detailed analysis tables can be found in Appendix 8, 9, 10 and 11.

5.5.2. Aars Fjernvarme

In the case of Aars, the fusions happened in January 2009 and 1st of June 2010. For the years between 2009 and 2013, the source of data were the public releases since detailed financial reports were not available (Aars Fjernvarmeforsyning, 2010), (Aars Fjernvarmeforsyning, 2011), (Aars Fjernvarme, 2012), (Aars Fjernvarme, 2013), while for the later years the detailed report for the years 2014/15 was used (Aars Fjernvarme, 2015), also containing detailed data for the year 2013/14.

The production costs, rent costs, salaries and administration costs were given for all years. Energy saving activity as costs were only given for the latest two years. Reparation and maintenance costs were given for all years, but only the last two years were in detail, namely heat centrals, distribution network, meters, waste line and security accessories. The share of these in the overall reparation and maintenance sum were calculated for both years and the average of the two results was used to distribute the summed cost for the earlier years. This distribution was as follows: waste line: 67.3% (production), distribution network: 19.4% (distribution), heat centrals: 12% (distribution), security accessories: 0.8% (production) and meters: 0.5% (distribution).

The same method was applied in the case of other financial costs. When comparing the datasheets, it can be seen that what is titled as "Other financial costs" in the earlier datasheets, is most likely the summary of operation of properties, depreciation of material actives and other costs in the new sheets. Based on the last two years, their share is around 1%, 89% and 10%, respectively. These percentages then were applied to all years. The operation of property costs are distributed as follows: operation of property Gislumvej 21A Aars (administration), property tax Aars Dybvad Møllevej (production) and property tax Suldrup (distribution). Due to lack of any data, the amount of these costs were assumed to be the same as in the year 2013/14. Depreciation of material actives includes heat centrals and units (production), office machines (administration) and impairment in Aars and Suldrup (production). Here, the same distribution method was applied as presented earlier. The Other financial costs is a summary of items such as loans, creditor interests and reimbursement of prepayments. These were considered to be administration costs.

After the costs were sorted to the three categories, the individual years can be compared. The results are presented on Table 5.11, together with amount of sold heat [MWh] and degree days of the year, compared to a normal year [%]. These factors are used to help the understanding of changes in the demand.

Costs	*2008/09*	*2009/10*	*2010/11*	*2011/12*	*2012/13*	*2013/14*	*2014/15*
Production	12,564,554	21,431,935	18,744,457	24,645,920	27,566,937	23,200,000	31,392,868
Distribution	11,732,890	11,373,240	14,067,865	14,549,918	19,227,915	17,266,000	17,314,333
Administration	14,414,746	17,030,445	16,801,427	19,194,762	14,144,388	17,759,000	18,382,473
Sum	**38,712,190**	**49,835,620**	**49,613,750**	**58,390,600**	**60,939,240**	**58,225,000**	**67,089,674**
Prod. %	32	43	38	42	45	40	47
Distr. %	30	23	28	25	32	30	26
Adm. %	37	34	34	33	23	31	27
Sold heat MWh	62,425	73,434	82,447	83,612	97,732	91,650	88,800
Degree days % of normal year	91	106,4	104,5	88,1	103,9	81,55	85,59

Table 5.11 Distribution of costs in Aars

It can be seen, that apart from a few examples, all production, distribution and administration costs have increased throughout the time frame. This can be explained by the amount of sold heat [MWh]. It can be seen, that costs increase between 2008/09 and 2012/13, while the amount of heat sold has also been increasing, presumably also because of the growing demand in the system due to the fusions and due to the high percent of degree days, meaning cold winter seasons in 2009/10, 2010/11 and 2012/13. The fusions in 2009 and 2010 can be seen in the numbers in the increase of sold heat despite of the reduction of degree days from 2009/10 to 2010/11 and 2010/11 to 2011/12. After 2012/13, a slight decrease can be seen both in costs and in sold heat, which can be explained by the warm winter of 2013/14, showed by the low amount of degree days. Another factor to influence these numbers is increasing energy savings, which means lower amount of sold heat at same degree days, this can be the explanation for the year 2014/15. It also has to be mentioned, that for the year 2014/15 an amount of 5,000,000 [DKK] was reserved for a future biomass plant. This is considered to be production cost, therefore it contributes to the high value significantly.

To avoid the effect of the weather change and changing demand, the share of production, distribution and administration costs compared to the summary of costs can be applied. When looking at these shares, it can be seen, that the percentages differ greatly from the country average mentioned earlier (72%, 23% and 5%, respectively). The share of production has increased from 32% in 2008/09 to 47% in 2014/15. Meanwhile, distribution decreased by approximately 4% (30% in 2008/09 and 26% in 2014/15) and administration decreased as well, by nearly 10% (37% in 2008/09 and 27% in 2014/15).

5.5.3. Gauerslund Fjernvarme

Gauerslund has had two fusions within the time period, in 2010 and 1st of June 2014. In order to be able to see the changes in the costs, the cost analysis was performed annually from the year 2008/09 up to 2014/15. The sources were the detailed financial reports, which were available for the entire period (Gauerslund Fjernvarme, 2009), (Gauerslund Fjernvarme, 2010), (Gauerslund Fjernvarme, 2011), (Gauerslund Fjernvarme, 2012), (Gauerslund Fjernvarme, 2013), (Gauerslund Fjernvarme, 2014), (Gauerslund Fjernvarme, 2015). The company who made the analysis – and therefore the method of cost analysis - was changed in 2011 therefore the different cost categories needed to be made comparable.

The method applied from 2008 until 2011 did not separate distribution costs, but offered detailed information on operation and maintenance and depreciation, which could then be set to the three categories. In operation and maintenance, the specific costs for production units and distribution network were given. In depreciations, the values were set into four categories: production units, other units, distribution network and meters, and other units, operation materials etc. During the analysis, these values were sorted into one of the three cost categories. The reports from 2011 included the overall production, distribution and administration costs, which made the comparison work easier. The results are presented on Table 5.12, together with the same factors as before.

Costs	*2008/09*	*2009/10*	*2010/11*	*2011/12*	*2012/13*	*2013/14*	*2014/15*
Production	16,170,723	17,429,813	20,400,512	21,239,585	25,212,899	22,206,449	25,674,690
Distribution	8,465,947	8,698,164	9,094,626	10,030,801	9,960,406	9,500,790	11,002,997
Administration	1,318,462	1,473,782	1,619,946	2,069,712	2,331,756	2,898,660	2,804,416
Sum	**25,955,132**	**27,601,759**	**31,115,084**	**33,340,098**	**37,505,061**	**34,605,899**	**39,482,103**
Prod. %	62	63	66	64	67	64	65
Distr. %	33	32	29	30	27	27	28
Adm. %	5	5	5	6	6	8	7
Sold heat MWh	44,838	50,274	56,959	59,292	58,343	49,503	50,705
*Degree days % of normal year**	91	106,4	104,5	88,1	103,9	81,55	85,59

Table 5.12 Distribution of costs in Gauerslund

It can be seen, that, similarly to the previous example, all costs have been increasing through the time period. The fusion with Kellers Park in 2010 can be seen in the sudden increase of demand from the year 2010/11, despite of the lower amount of degree days. The second fusion in 2014 is shown by the increase of demand between 2013/14 and 2014/15, although the amount of degree days also increased here. Again, the exceptionally warm winter in 2013/14 can be seen in decrease of both costs and amount of heat sold. Advancements in energy saving can be the explanation for the fact, that almost the same amount of heat was sold in the winters of 2009/10 and 2014/15, while in the meantime the number of households must have grown due to the fusions in 2010 and 2014. In the years 2009/10, 2011/12 and 2012/13, 600,000 [DKK] was assigned for a new production unit. These amounts therefore increase the production costs.

As for the shares of costs between production, distribution and administration, Gauerslund is closer to the national average, compared to Aars. The share of production slightly increased in the investigated time period, from 62% to 65%, while distribution costs decreased from 33% to 28%. The share of administration costs increased from 5% to 7%.

5.5.4. Odsherred Forsyning

The district heating service in Grevinge/Herrestrup used to be provided separately but it was merged to Odsherred Forsyning in 2011. Further research revealed that this case differs from the others because even though it was two companies merging, Odsherred Forsyning had not provided district heating service before. This means that the comparison with the other cases is questionable, however, due to the increasing prices, it is of interest, therefore included in the analysis. Unfortunately, financial reports cannot be found from the time before it, therefore the cost analysis is done within the timeframe 2011-2015.

In the financial reports provided by Odsherred Forsyning, production costs, distribution costs and administration costs were separately given for the year 2011, while only the sum of production and distribution costs were given for the years between 2012 and 2015.

The results are shown on Table 5.13 together with amounts of sold heat and production cost per [MWh] heat between 2012 and 2015.

Costs	*2011*	*2012*	*2013*	*2014*	*2015*
Production	8,103,348	8,498,863	8,125,000	6,722,000	6,053,000
Distribution	616,075	0	0	0	0
Administration	791,283	803,499	730,000	610,000	739,000
Sum	**9,510,706**	**9,302,362**	**8,855,000**	**7,332,000**	**6,792,000**
Prod. %	85,20	91,36	91,76	91,68	89,12
Distr. %	6,48	-	-	-	-
Adm. %	8,32	8,64	8,24	8,32	10,88
Sold heat MWh	-	7,679	5,783	4,893	5,424

Table 5.13 Distribution of costs in Odsherred

Differently from other cases, costs are decreasing in this district. The summary of production and distribution costs has reduced by 31% by 2015 compared to 2011, while the summary of all costs has been reduced by 29%. In the meantime, the amount of produced heat also decreased by 30% between 2012 and 2015. These result the production cost per [MWh] heat to be fairly constant, and, compared to the other districts, quite high. All the reports and data from Odsherred Forsyning are presented by calendar year, which certainly makes it difficult to compare the numbers with the other districts. However, the warm winter of 2013/14 can still be seen on the reduced amount of sold heat in 2014, assuming that the coldest months (and therefore those with the highest amount of sold heat) are January and February. The shares of costs has not undergone major changes through this time period, with the exception of the increase of share of administration cost in 2015. Naturally, with such a low amount of data, any statement is difficult to be made and cannot be stated with complete certainty.

5.5.5. Hammel Fjernvarme

Hammel has had two fusions within the timeframe, with Voldby in 2010 and Gjern and Lading-Fajstrup in 2014. The sources were the officially published financial reports between 2009 and 2015 (Hammel Fjernvarme, 2011), (Hammel Fjernvarme, 2012), (Hammel Fjernvarme, 2013), (Hammel Fjernvarme, 2014), (Hammel Fjernvarme, 2015).

Assorting the costs to the three categories was rather simple due to the fact that all of the reports were executed similarly throughout the timeframe. The only assumption that was necessary is the sharing of reparation and maintenance and depreciation between different areas. This was done according to the same method as in the case of Aars, meaning that for those years where these costs were detailed (2011/12 and 2012/13), their share was calculated, then the average of these years were used to distribute the costs in the other years. Namely, reparation and maintenance was distributed as follows: ground and buildings: 4%, technical installations: 77%, distribution network: 16%, newly attached distribution network: 29% and meters: 5%. Also, there was an income of around 33%, coming from the attach fees. This was included in the calculations of course, but not in the cost analysis.

Production costs were separated already, however, for the purpose of present analysis and in order to make this district comparable with the others, reparation and maintenance costs of technical installations and production buildings were added to it, as well as depreciations of buildings and boiler units. Distribution costs are set by reparation and maintenance of distribution network and newly added distribution network, as well as meters and depreciation of the transmission network. Salaries, administration costs and other financial costs are included as administration costs.

The results are presented on Table 5.14 together with the amount of sold heat and cost per MWh sold heat. These data was only available for the period from 2011/12.

Costs	*2009/10*	*2010/11*	*2011/12*	*2012/13*	*2013/14*	*2014/15*
Production	20,955,635	32,650,123	31,902,871	32,577,769	35,101,411	45,646,993
Distribution	2,068,918	2,851,762	2,203,226	2,694,340	2,683,678	6,069,300
Administration	6,379,925	6,853,386	7,410,819	8,032,876	8,523,973	11,298,207
Sum	**29,404,477**	**42,355,271**	**41,516,916**	**43,304,985**	**46,309,062**	**63,014,500**
Prod. %	71	77	77	75	76	72
Distr. %	7	7	5	6	6	10
Adm. %	22	16	18	19	18	18
Sold heat MWh	-	-	64,182	68,637	63,327	87,496
*Degree days % of normal year**	106,4	104,5	88,1	103,9	81,55	85,59

Table 5.14 Distribution of costs in Hammel

Not differently from other cases, costs show an increasing pattern. The sudden increase in 2010, despite of the lower amount of degree days, can be explained by the fusion with Voldby. The sudden increase in both costs and sold heat from 2013/14 to 2014/15 can be explained with the fusion with Gjern and Lading-Fajstrup in this period. The share of costs has not changed significantly, although it should be noted that after the first fusion in 2010, the share of production cost increased while administration costs dropped. After the second fusion, the share of production costs slightly decreased while the share of distribution increased.

6. Results of the analysis

In the first part of the analysis, it has been shown through the categorization that the number of heating districts in the categories has been changing in a way that more and more districts have been shifted to lower price categories. It has also been presented that the number of heating districts has been reducing in the years 2010-2015. It was found, that before merging, the distribution of districts by price categories does not differ significantly from the country average, and that after the fusions the distribution generally shifted towards lower price categories.

In the second part of the analysis, four specific cases were investigated, of which two have changed to lower price category (Aars and Hammel), one did not change (Gauerslund) and one changed to higher category (Grevinge/Herrestrup).

It could be seen, that the fusions typically have an effect on the merging districts by decreasing their prices, with the exception of Grevinge/Herrestrup. When looking at the main districts, this effect is not always obvious. In the case of Aars and Gauerslund, the price-reducing effect of fusions can be seen in the consumer prices, but not in the case of Hammel. Therefore it can be concluded that the connection of this reduction to the fusions is not always clear. This is because the cost analysis was only performed for a limited period of time, and not all the factors are known which can have effect on the company financials. Moreover, these factors might not have immediate effects but they might appear years later in the financial reports.

It can be seen from the cost analysis, that fusions always mean increase in demand, therefore sold heat with the exception of Grevinge/Herrestrup. This naturally increases the production which can be seen in increase of costs, and typically in increase of share of production and distribution costs, which means decrease the share of administration costs. It has been seen, that in the case of Aars, share of production costs has increased by 15% between 2008 and 2015, while distribution has decreased by 4% and administration has also decreased, by 10%. In Gauerslund, production has increased by 3%, distribution has decreased by 5% and administration has increased by 2%. In the case of Grevinge/Herrestrup, the share of administration costs has increased by 2.5% while production and distribution has decreased.

In Hammel, production has increased by 1% while distribution has increased by 3% and administration has decreased by 4%.

It can be seen, that in those cases, where the prices were changed to a lower category, fusions always had an effect of increasing shares of production and distribution and decreasing the share of administration costs.

7. Method critics

In this chapter, the methods used in the project are discussed from a critical point of view.

The approach to fusions was achieved through the price statistics. When finding the fusions, the work was done manually which increases the possibility of failure in data handling, meaning increased uncertainty. The extent of this uncertainty cannot be estimated, however, this does not reduce the validity of the results to a great extent.

In the statistical analysis the districts were not weighted by size or population. As for the price statistics, even though they have come from an official authority, their reliability has some uncertainty. This critic is based on the missing date that could be seen in some of the reports, as well as the fact that some districts were missing from one sheet then appeared again on the next one. These cases were filtered when searching for fusions, but again, it was done manually. The way price categories were set was rather arbitrary. They were based on the latest available data and the category borders were not changed through the analysis.

In the second part of the analysis, four cases were further analyzed. This was done in order to find out more about the specific cases and the circumstances of the fusions, but it was done through the analysis of a very limited number of cases, which holds significant uncertainty compared to larger number of analyses. When selecting the cases for further studying, some methods were followed, as described earlier, but such sampling always holds the possibilities of bias, which also happened in this case: finding a district where the price category was increased was extremely difficult to find and the one which were eventually used is not a good example. Grevinge/Herrestrup Energiforsyning A/S was indeed merged to Odsherred Forsyning A/S but latter had not been a district heating company before. Therefore the comparison with the other cases is questionable. The presence of such fusions might be assumed in the analysis. This is due to the fact that when performing the nation level analysis, the existence of such cases was not considered to be an option, therefore it was not dealt with. Again, it is not possible to estimate the number of these cases, but it is suspected not to be significant. Another issue when selecting the cases was, that the cases were preferred to be one of the latest fusions. Even though this approach resulted in accessible data, studying older fusions would have made it possible to analyze long-term effects which present research is not capable of.

When conducting the cost analysis, the assorting process to the three categories was done manually, which holds some uncertainty and can include bias. This was attempted to avoid by using consequent cost assorting method, therefore the uncertainty it might cause was kept to minimum. The analysis of the financial factor of a district heating company is rather complicated because the financial years they use are not separable from one another. This means that years might pass by until a decision will have financial effects and the length of this time is not even predictable from an outsider point. Therefore it can be argued that it causes uncertainty of the results to some extent. The extent of such uncertainty could be significantly decreased by expanding the timeframe of the research.

Finally, it has to be mentioned, that the whole analysis was excluding the tax and incentive system. If it would have been included, it might would have helped with making conclusions from the analysis and could have helped explaining the results.

7.1. Quantitative methods

When using quantitative methods, reliability of the results is strongly connected to the amount of collected data. The timeframe of the project was chosen to be between 2010 and 2015, which can be problematic, because it does not only mean limits in time but also limits in data, on which the analysis and conclusion were based. Also, the number of cases investigated is also quite limited, which means that generalization can be limited as well. (Kaspersen, 2016)

7.2. Qualitative methods

The problem with using qualitative methods, in this case, interviews, is that no generalization can be done based on the gained knowledge. The reason for this is subjectivity: the interpretation and understanding of collected data is made by the data collecting person and therefore all the gathered data is biased by the researchers own understanding. (BibDok, 2016)

8. Conclusion

The research question of present project has been the following:

How do fusions affect the district heating consumer prices in Denmark?

To answer this question, a nation-level analysis has been performed, regarding the district heating consumer prices in Denmark, followed by the analysis of changes in the heating districts in the country. After this it was concluded that a decreasing effect can be seen on the national level, but in order to understand what happens in the specific cases, more detailed analysis was required.

It can be concluded from the studied cases, that fusions can have benefits to the main district and the merged district as well, although, in different amounts. For the merging districts, it is nearly always beneficial, because merging usually means lower district heating consumer prices, as it has been shown.

For the main districts, the picture is much more subtle. In those cases where fusions caused the main district to change to a lower price category, it always appeared in the financial analysis as increase of share of production costs and decrease of administration costs. In the case where there was no category change, the share of production and administration has increased while the share of distribution decreased, while in the case where the change was towards a higher price category, the share of production and distribution has decreased while the share of administration has increased.

Even though, the district heating consumer prices often decreased in the main districts, these reductions did not always happen and when they did, it was not clearly provable that they did as consequence of the fusion.

It can be stated that fusions in the Danish district heating system are typically beneficial and help to reduce the district heating consumer prices for the merging districts, with not having significant effect to the prices in the main district.

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Appendix

Appendix 1: Semi-structured interview-guide

Topic question	Interview question	Reason
District heating system	- How is the heat produced? - Has there been any changes recently? - Or is there any planned?	To gain background information for further analysis.
Fusions	- What were the motivations behind the fusions? - How do they evaluate the fusions after some time has passed? - Price statistics don't show decreasing prices in the main district, why is that? - Are there any plans for further fusions?	To gain further information that cannot be seen from the pure data.

Appendix 2: Summary of e-mail conversation with Jan Clement

16. May 2016 13:54: What were the motivations behind the fusions?

17. Maj 2016 12:55: The fusions were made because the economy was attractive for both us and the neighbour plants. Payback time was approx. 3 years for the consumers int he neighbour plants and now we all have lower prices than before the merges.

4. July 2016 13:22: I need the financial reports from before and after the fusions have happened, is there a way that you could send them to me?

4. July 2016 15:25: We do not have the financial reports from the smaller plants we merged with (made fusions with). At these plants we had the major changes in economy, in general the prices dropped from 15.000 in Hornum, 18.000 in Suldrup and 19.000 in Haverslev to our price approx. 11.000 kr. This year 9.900.

In Aars we had some advantage in taking over the smaller plants but taxes have change many time during the last 6 years therefore it is very difficult to state something from our reports, especially because the waste treatment was done in another company. In Aars we could keep low prices because of the mergers even with higher taxes but I believe our advantage is in the range 500 -1000 kr./costumer pr year. Right now closer to 1000 kr because of the "grundbeløb" from the gas engines being very high, close to 1 million per year, per MW installed.

Appendix 3: Summary of interview with Jan Clement on May the 19th 2016 at Aars Fjernvarme

- How is the heat produced?
  There is a waste to energy unit in Aars with two waste lines of 8.5 and 10 [MW], built in 1986 and 1995 with a woodchip boiler as a backup and a small heat storage. It was bigger than needed before the fusions and therefore lot of surplus heat was to waste.
- Has there been any changes recently?
  No.
- Is there any change planned?
  Yes, a bigger heat storage is in plans as well as solar plants on the field north of the plant that has already been purchased.

- Price statistics don't show decreasing prices in the main district, why is that?
  District heating did get cheaper everywhere but changes in the tax system caused some increase.
- Are there any plans for further fusions?
  No, because there aren't any more suitable districts nearby.

Appendix 4: Summary of e-mail conversation with Kasper Nagel from Dansk Fjernvarme

3. May 2016 14:57: My timeframe is 2010-2015 but I looked into the previous statistics as well and found that the number of districts increased rapidly from 362 in July 2007 to around 450 in 2009. I was wondering what the reason could be and my guess is that district heating became more and more popular and that is still the case but now fusions are offering a more feasible solution, therefore the numbers are falling.. What is your opinion about this?

4. May 2016 11:26: The problem using the price statistics from Energitilsynet is that earlier (probably around 2007) not all plants reported their prices which they should. Energitilsynet then began being more thorough and the number of plants reporting their prices increased. I think that is why you have this increase.

Appendix 5: Table of merged districts in the timeframe

Price range before merge	Merging district	Merged district	Price range after merge
2010 February-July			
3	Brønderslev Kraftvarme	Brønderslev Varme	3
1	Farstrup	Aalborg	7
3	Hindsholm	Kerteminde	5
2	Hou	Boulstrup-Hou	3
4	Nordborg	Sønderborg	6
5	Rudkøbing	Midtlangeland Fjernv.	5
4	Tullebølle	Midtlangeland Fjernv.	5
5	Rødekro	Aabenraa-Rødekro	4
2010 July-December			
3	Hald-Ege	Viborg Fjernvarme	5
5	Kellers Park	Gauerslund Fjernv.	5
2010 December-2011 February			
7	Præstø Kraftvarme	Præstø Fjernvarme	2
7	Silkeborg Kraftvarmeværk	Silkeborg Fjernvarme	5
2011 February-July			
6	Annasvej	Greve Strandby	6
6	Eghøj	Greve Strandby	6
6	Greve Strandby 2	Greve Strandby	6
2011 July-2012 March			
4	Gjerrild	NRGi	3
3	Glesborg	NRGi	3
4	Balle Varmeværk (8444)	NRGi	3
5	Bording Kraftvarmeværk	Ikast	5
3	Hedehusene Fjernvarme	Høje Tåstrup	5
3	Hornum (9600)	Aars	5
3	KE Bygas	KE Varme	4
5	Langeskov Fjernvarme	Kerteminde	4
4	Nordby-Mårup Varmev.	NRGi	3
4	Rosmus Varmev.	NRGi	3
3	Stenvad	NRGi	3
4	Tirstrup	NRGi	3
3	Tranebjerg	Ballen-Brundby	3
4	TRE-FOR Fredericia	Fredericia Fjernvarme?	5
3	Voldby (8500)	Hammel	7
2012 March-August			
2	Haverslev	Aars	6
4	Suldrup Varmeværk	Aars	6
4	Rebild Varmeværk	Skørping	5

5	Hørning Fjernvarme	Skanderborg	5
4	Grevinge/Herrestrup	Odherred Varme A/S	2
2012 August-December			
4	Agerkær	Rødovre	4
4	Ellegårdens Varmecentral	Vestforbrændning A/S	5
3	Sjælør Boulevard	KE Varme (HOFOR)	4
2012 December-2013 March			
5	Nyborg Fjernvarme	Nyborg og Ullerslev	4
5	Ullerslev Fjernvarme	Nyborg og Ullerslev	4
5	Otterup	Fjernvarme Fyn	6
2013 March-August			
5	Hvidovre Midt	FD Hvidovre	4
5	Hvidovre Syd	FD Hvidovre	4
5	Hvidovre Nord	FD Hvidovre	4
2014 March-August			
4	Gjern Varmeværk	Hammel Fjernvarme	6
1	Lading-Fajstrup	Hammel Fjernvarme	6
2014 August-2015 March			
4	Gårslev Fjernvarme	Gauerslund	4
4	Hundige Fjernvarmeværk	Greve Fjernvarme	4
4	Korsør	SK Forsyning	4
4	Slagelse	SK Forsyning	4
2015 March-August			
4	Hjortekær	Frederikssund/Hjortekær	4
4	Frederikssund	Frederikssund/Hjortekær	4
4	Klinkby	Lemvig Varmeværk	5
2	Nr. Nissum	Lemvig Varmeværk	5
3	Nysted Biogas	Nysted Varmeværk	4
6	Nørresundby	Aalborg	6
5	Skanderborg	Skanderborg-Hørning	5

Appendix 6: Specific prices in the districts where the category was not changed

[DKK/year]	Merging district	Merged district	District heating price		Difference
Feb-Jul/2010			Before	After	
	Brønderslev Kraftvarme	Brønderslev Varme	17,890	17,257	-633
	Rudkøbing	Midtlangeland	11,758	12,301	543
Jul-Dec/2010					
	Kellers Park	Gauerslund	11,004	11,796	792
Feb-Jul/2011					
	Annasvej	Greve Strandby	9,713	10,716	1,003
	Eghøj	Greve Strandby	9,713	10,716	1,003
	Greve Strandby 2	Greve Strandby	10,716	10,716	0
Jul-Mar/2011-2012					
	Glesborg	NRGi	17,895	17,799	-96
	Bording	Ikast	12,464	12,464	0
	Stenvad	NRGi	17,189	17,799	610
	Tranebjerg	Ballen-Brundby	18,311	17,366	-945
Mar-Aug/2012					
	Hørning	Skanderborg	11,034	11,785	751
Aug-Dec/2012					
	Agerkær	Rødovre	15,430	14,890	-540
Aug-Mar/2014-2015					
	Gårslev Fjernvarme	Gauerslund	16,128	14,228	-1900
	Hundige Fjernvarmeværk	Greve Fjernvarme	14,115	15,007	892
	Korsør	SK Forsyning	14,160	14,160	0
	Slagelse	SK Forsyning	14,160	14,160	0
Mar-Aug/2015					
	Hjortekær	Frederikssund/Hjortekær	14,938	14,938	0
	Frederikssund	Frederikssund/Hjortekær	14,938	14,938	0
	Nørresundby	Aalborg	10,348	9,860	-488

Appendix 7: District heating prices in the selected and the merged districts

Per household 130 m², DKK/year	Aars	Hornum	Haverslev	Suldrup
feb-10	10,981	17,519	20,839	16,707
jul-10	11,169	17,519	20,839	16,707
dec-10	11,169	17,519	19,143	16,686
feb-11	11,169	17,519	19,143	16,686
jul-11	11,169	17,519	20,274	16,686
mar-12	11,169		20,274	16,686
aug-12	10,716			
dec-12	10,716			
mar-13	10,716			
aug-13	11,508			
mar-14	11,508			
aug-14	11,282			
mar-15	11,281			
aug-15	11,282			

Per household 130 m², DKK/year	Gauerslund	Kellers Park	Gårslev
feb-10	10,213	11,004	14,213
jul-10	11,796	11,004	14,213
dec-10	11,796		14,213
feb-11	11,796		14,668
jul-11	10,326		14,668
mar-12	12,701		17,038
aug-12	13,676		17038
dec-12	13,676		17,038
mar-13	13,676		16,778
aug-13	13,676		16,778
mar-14	13,676		16,128
aug-14	14,228		16,128
mar-15	14,228		
aug-15	12,418		

Per household 130 m², DKK/year	Odsherred	Grevinge-Herrestrup
feb-10	16,093	
jul-10	16,093	
dec-10	16,093	
feb-11	16,093	
jul-11	16,093	
mar-12	16,093	
aug-12		23,785
dec-12		23,785
mar-13		26,220
aug-13		26,220
mar-14		26,470
aug-14		26,470
mar-15		26,470
aug-15		26,470

Per household 130 m², DKK/year	Hammel	Gjern	Lading-Fajstrup	Voldby
feb-10	6,501	14,389	15,534	17,559
jul-10	7,180	14,584	15,534	17,559
dec-10	7,180	14,584	19,181	17,967
feb-11	7,180	14,584	19,181	17,967
jul-11	7,859	14,425	19,181	17,967
mar-12	7,859	14,425	22,508	
aug-12	8,311	14,424	22,508	
dec-12	8,311	14,424	26,036	
mar-13	8,311	14,424	26,036	
aug-13	9,607	15,339	27,506	
mar-14	9,607	15,339	27,506	
aug-14	9,607			
mar-15	9,607			
aug-15	9,154			

Appendix 8: Cost analysis of Aars

Fusions: Haverslev, Suldrup (2010), Hornum (2009)

DKK	Aars 2008/09	2009/10	2010/2011	2011/12	2012/13	2013/14*	2014/15	
Net income	43101000	51433000	51451000	60517000	59446000	63422000	62420090	
Production costs	5874000	12789000	9439000	14166000	14371000	6584000	5927393	prod
Result	37227000	38644000	42012000	46351000	45075000	56838000	56492697	
Rent	10137000	8458000	11086000	11854000	16437000	14576000	12312863	distr
Salaries (+administration)	14146000	16735000	16445000	18629000	13284000	13516000	13437768	adm
Adm. Costs						3075000	3704164	adm
Energy saving activity						1283000	1577810	prod
Rep. And maintenance	6079000	9123000	9332000	8435000	8733000	10265000	13284207	
Heat centrals	894824,0623	1092534	1117563,3	1010142,155	1045829,454	1511000	1226303	distr
Distr. Net	643136,2884	1772487	1813093,2	1638817,121	1696714,868	1086000	3756496	distr
Meters	50929,76132	43218,5	44208,596	39959,22665	41370,94562	86000	14568	distr
Waste line	4407793,181	6135842	6276408,6	5673114,689	5873540,081	7443000	8236894	prod
Security accessories	82316,70726	78918,34	80726,29	72966,80799	75544,65135	139000	49946	prod
Operation of properties	24810	27380	33250	53400	81760	96000	197279	
Income from rent Gislumvej 21A						111000	106874	
Maintenance Gislumvej 21A	11000	11000	11000	11000	11000	11000	300000	adm
Property tax Dybvad Møllevej 2	2000	2000	2000	2000	2000	2000	1769	prod
Income from water return Suldrup						5000	1719	
Property tax Suldrup	7000	7000	7000	7000	7000	7000	4103	distr
Result	6865000	4328000	5149000	7433000	6621000	14027000	11978606	
Depreciation of material actives	2208090	2436820	2959250	4752600	7276640	7783000	10611389	
Heat centrals and unit	1909347	2107131	2558879	4109598	6292148	6730000	10599056	prod.
Office machines	9646	10645	12927	20762	31788	34000	12333	adm
Impairment Suldrup	201432	222298	269956	433553	663808	710000	0	prod
Impairment Dybvad Møllevej	87665	96746	117488	188687	288897	309000	0	prod
Result						6244000	1367217	
Other financial incomes						199000	164987	
"Afskrivninger og renter"	2481000	2738000	3325000	5340000	8176000			
Other financial costs	248100	273800	332500	534000	817600	1123000	928208	adm
Fixed loan						999000	843282	
Money institutions						92000	12197	
Reimbursment of prepayments						23000	24000	

Worker obligations						9000	8824	
Creditor interests						0	20	
Impairments of financial actives						0	39885	
Result						5320000	603996	
Saving for new investments						0	5000000	prod?
Result	4408810	1617380	1857250	2146400	-1473240	5320000	-4396004	
From previous year						4213000	9725695	
Overall result	4408810	1617380	1857250	2146400	-1473240	9533000	5329691	
Costs								
Production	12564554	21431935	18744457	24645920	27566937	23200000	31392868	
Distribution	11732890,11	11373240	14067865	14549918,5	19227915,27	17266000	17314333	
Administration	14414746	17030445	16801427	19194762	14144388	17759000	18382473	
	38712190	49835620	49613750	58390600	60939240	58225000	67089674	
Prod%	32	43	38	42	45	40	47	
Distr%	30	23	28	25	32	30	26	
Adm%	37	34	34	33	23	31	27	
	100	100	100	100	100	100	100	
	Before fusions	During	During	After				
Sold heat MWh	62425	73434	82447	83612	97732	91650	88800	
Production cost/sold heat MWh	201	292	227	295	282	253	354	
	620,139207	678,645	601,76538	698,3519112	623,5341546	635,29733	755,51435	
Degree days % of normal year	91	106,4	104,5	88,1	103,9	81,55	85,59	

Appendix 9: Cost analysis of Gauerslund

Fusions: Gårslev (2013), Kellers Park (2009?)

	Gauerslund							
DKK	2008/09	2009/10	2010/11		2011/12	2012/13	2013/14	2014/15
Net income	24192066	26031296	32338391		32110042	37670395	33633036	36983874
Income from selling heat	15926313	17615965	23922665		24191024	26837678	22771600	23831200
Costs overall	25955132	27601759	31115084					
Production costs	14386166	15652401	19463825	prod	20639585	24612899	22206449	25674690
				Distribution	10030801	9960406	9500790	11002997
Operation and maintenance	8967479	8658255	8667726					
Production unit	1342800	959594	590275	prod				
Distribution network	7202802	7561080	7944855	distr				
SRO&THERMIS unit (?)	421877	137581	132596	prod				
Administration costs	1312481	1441992	1426857	adm	1931235	2211375	2807787	2719120
Result of primary operation					-491579	885715	-881990	-2412933
Other operational incomes					487609	521388	557867	124274
Energisavings	335195	174233	89072	distr				
Energy saving activity	235195	144233	49072					
Consulting at users	100000	30000	40000					
Result of operation					-3970	1407103	-324123	-2288659
Losses on debts	5781	15796	32743	adm				
Depreciations	947830	1043088	1274515					
Production unit	5000	5000	105423	prod				
Other units	14880	75237	108393	prod				
Distribution network and meters	771757	759039	876849	distr				
Other units, operation materials etc.	156193	203812	183850	distr				
Saving for new investments	0	600000	0	prod	600000	600000	0	
Financial incomes					315148	372903	187286	163852
Financial costs	200	15994	160346	adm	138477	120381	90873	85296
Result	-1763066	-1570463	1223307		172701	1659625	-227710	-2210103
From previous year	2649159	886093	-684370		538937	111638		
Overall result	886093	-684370	538937		711638	1771263	-227710	-2210103

Cost overall	**25955132**	**27601759**	**31115084**	**33340098**	**37505061**	**34605899**	**39482103**
Production	16170723	17429813	20400512	21239585	25212899	22206449	25674690
Distribution	8465947	8698164	9094626	10030801	9960406	9500790	11002997
Administration	1318462	1473782	1619946	2069712	2331756	2898660	2804416
Prod. %	62	63	66	64	67	64	65
Distr. %	33	32	29	30	27	27	28
Adm. %	5	5	5	6	6	8	7
	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Net price/MWh	355,2	350,4	420	408	460	460	470
Sold heat MWh	44838	50274	56959	59292	58343	49503	50705
Prod. Cost/MWh	361	347	358	358	432	449	506

Appendix 10: Cost analysis of Odsherred

Fusion: Grevinge-Herrestrup 2011

	2011		2012	2013	2014	2015
Net income	**9727277**		**8472669**	**7338000**	**7367000**	**7286000**
of which heat sale income	4143041		6757548	5552000	4697000	5207000
Production costs	8103348	prod+distr	8498863	8125000	6722000	6053000
Result	**1623929**		**-26194**	**-787000**	**645000**	**1233000**
Distribution costs	616075	distr	0	0	0	0
Administration costs	524425	adm	752450	603000	553000	735000
Result of primary operation	**483429**		**-778644**	**-1390000**	**92000**	**498000**
Financial incomes					12000	29000
Financial costs	266858	adm	51049	127000	57000	4000
Tax of ordinary result (?)	216571		351353	99000	47000	523000
Result	**0**		**-1181046**	**-1616000**	**0**	**0**
Production	8103348	prod+distr	8498863	8125000	6722000	6053000
Distribution	616075		0	0	0	0
Administration	791283		803499	730000	610000	739000
Sum	9510706		9302362	8855000	7332000	6792000
Prod%	85,20		91,36	91,76	91,68	89,12
Distr%	6,48					
Adm%	8,32		8,64	8,24	8,32	10,88
	100		100	100	100	100
Sold heat MWh			7679	5783	4893	5424
Prod. Cost/sold heat MWh			1107	1405	1374	1116
Price/MWh			880	960	960	960

Appendix 11: Cost analysis of Hammel

Fusions: Voldby (2010); Gjern, Lading-Fjastrup (2014)

1. Maj-30. Apr.	Hammel						
DKK	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	
Net income	29765028	39595412	39935309	42239568	44764399	55692852	
Production costs	15803759	26002196	25489903	26318476	28487136	35294857	Prod
Cost of fusion					0	7485605	
Result	**5976675**	**4022359**	**5118631**	**6121054**	**5954200**	**14397408**	
	23788353	*35573053*	*34816678*	*36118514*	*38810199*	*48781049*	
Salaries	5442638	5666792	6139010	6782018	6943737	7629257	Adm
Adm. Costs	663218	789780	866197	839747	977948	1649372	Adm
Costs of burning	14311982	24321131	23677794	24868463	26533750	33395138	Prod
Rep. And maintenance	1878738	3114285	2321568	2178273	2401378	4207563	Prod/distr
Ground and buildings	83283	138055	132619	68690	106452	186519	prod
Technical installations	1459350	2419088	1830238	1666771	1865322	3268315	prod
Distribution network	314167	520777	411432	342474	401564	703598	distr
New attached distr.	558276	925425	511555	814589	713581	1250298	distr
Attach fees payed (income)	-630671	-1045431	-600160	-899328	-806116	-1412432	
Meters	94333	156371	35884	185077	120575	211266	distr
Other operation costs	1491777	1681065	1812109	1450013	1953386	1899719	prod
Depreciation of material actives	4711384	5339973	5677466	5876032	6090459	10801441	
Depreciation of buildings	0	0	0	0	0	276904	Prod
Transmission network	1102142	1249189	1244355	1352200	1447958	3904139	Distr
Boiler unit and inventory(?)	3609242	4090784	4450111	4523832	4642501	6620398	Prod
Loss/profit by selling units	0	0	-17000	0	0	0	
Resul	**1265291**	**-1317614**	**-558835**	**245022**	**-136259**	**3595967**	
Other financial incomes	40089	58229	75331	108870	85171	208098	
Other financial costs	274069	396814	405612	411111	602288	2019578	adm
Interests, money institutes			10069	128202	266603	334052	
Kommune credit			364405	231961	333619	1683723	

Interests (other)			31138	50948	2066	1803
Result	**1031311**	**-1656199**	**-889116**	**-57219**	**-653376**	**1784487**
Saving for new investments						
Result	**-11014972**	**-21429825**	**-21735883**	**-22019149**	**-24337756**	**-32580849**
From previous year			639650	-614781	-290132	-2900709
			249466	672000	943508	1116222
Overall result	**1031311**	**-1656199**	**0**	**0**	**0**	**0**
Production	20955635	32650123	31902871	32577769	35101411	45646993
Distribution	2068918	2851762	2203226	2694340	2683678	6069300
Administration	6379925	6853386	7410819	8032876	8523973	11298207
Sum	29404477	42355271	41516916	43304985	46309062	63014500
Prod %	71	77	77	75	76	72
Distr %	7	7	5	6	6	10
Adm %	22	16	18	19	18	18
	100	100	100	100	100	100
Income from sold heat			19952822	23544274	25293029	38848119
Income from sold heat Gjern			2703518	1971550	3758956	
Sold heat Hammel	Missing data	Missing data	59032	64860	56966	87496
Sold heat Gjern			5150	3777	6360	
Sum			64182	68637	63327	87496
			497	475	554	522