Distribution: General

STEP-UP : Trajectory 4
Market model heating networks: Benchmark of DH markets in Sweden, Denmark, and Belgium

Virginia Gómez Oñate

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VITO NV
Boeretang 200 - 2400 MOL - BELGIE
Tel. + 32 14 33 55 11 - Fax + 32 14 33 55 99
vito@vito.be - www.vito.be

BTW BE-0244.195.916 RPR (Turnhout)
Bank 375-1117354-90 ING
BE34 3751 1173 5490 - BBRUBEBB

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SUMMARY

District Heating (DH) is becoming an indispensable technology to help countries attaining their 20/20/20 goals. Although its advantages are already acknowledged, the installation of DH systems is uneven in Europe. Countries such as Sweden and Denmark count with an already mature heat market while the number of installations in Belgium, for example, are symbolic. In countries where DH has not penetrated the market, the appropriate areas for installation should be identified first.

DH is a cheaper and more efficient technology for high heat density areas, such as cities. While on the other hand, heat pumps result more beneficial in lower heat density areas, as rural areas (Vad Mathiesen, 2013).

While technology is not a barrier, the security on positive business models is pointed out as the main barrier to overcome. Being a long term investment, DH project developers are in need of securing their business model for the years to come. However, the lack of investment security can be solved by proper legal measures and an energy long term planning. In non-regulated heat market countries, the open questions and uncertainties discourage the start-up of projects.

Belgium does not count with supporting measures for DH neither at national nor at regional level. However, some cities are taking the lead in finding the way to create and promote the heat market in their jurisdiction while some regional initiatives have been taken to support green heat generation. This will, hopefully, set the example and provide the framework for the general energy planning of the region, or preferably, the country.

Inevitably, we turn to Sweden and Denmark; two countries with a high penetration of DH. In this document a summary of their introduction strategy for DH is outlined. A long-term energy planning and an initial regulation of the heat markets are common factors. Having said that, Belgium (or the city) should not literally implement the same framework but critically analyse those and their impact on the specific local circumstances. Clarifying the long-term objective with respect to DH is indispensable to decide on the next steps.

In this report, general notes on policy framework and business models are given in CHAPTER 2 and CHAPTER 3. Afterwards, the specific situation of Denmark and Sweden is analysed in respectively CHAPTER 4 and CHAPTER 5, and subsequently compared to the Belgian situation in CHAPTER 6. The report concludes with a summary of possible options to boost the implementation in CHAPTER 7.

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CHAPTER 1 INTRODUCTION

District Heating (DH) is defined as a technological concept comprising infrastructure for delivering heating services at district level (DHC+ Technology Platform, 2012). The distribution infrastructure is designed to satisfy local heating requirements. It takes the form of a piping network that allows multiple energy sources to be connected to many energy consumers (DHCAN, 2013).

In many processes, when electricity is generated or waste is burned, large amounts of energy are set free into the environment in the form of surplus heat. The fundamental idea behind modern DH is to recycle this surplus heat which otherwise would be lost or unused. In the case of surplus heat from industries, DH systems do not use additional fuel because they employ the residual heat. Furthermore, DH can be powered by many kinds of renewables and decentralized generation like combined heat and power (CHP), biomass, geothermal or solar thermal (Euroheat).

District heating technology is common in the Nordic countries where there is a large heat demand because of the cold climate (Goop, 2012).

In general, the heating and cooling sector constitutes a major player on the energy market responsible for more than half of the total final energy consumption in the European Union (DHC+ Technology Platform, 2012). Therefore, an efficient and responsible implementation is of crucial importance.

In general, heat production and consumption should preferably be geographically close to one another. Due to high investment costs and grid losses it is not economically viable to transmit heat over long distances. This implies that it is economically viable to build district heating networks only in areas where the heat demand density is sufficiently high (Goop, 2012).

It is also beneficial if the consumers (heat loads) themselves are situated close to each other since this reduces the heat losses that occur from the distribution network. Thus, the ideal situation is that of large urban areas, with high heat load density.

The networks are costly and this is a barrier to the further expansion of existing DH networks as well as the establishment of new ones (Svensk Fjärrvärme, 2010).

In a nutshell, local conditions in terms of waste heat availability, density of population, soil conditions among other factors have a large impact on the costs of establishing a DH network.

DH offers various advantages compared to individual heating systems: Despite the long-term investment, DH is cost-effective reducing energy costs, more energy efficient with low emissions and has the possibility to offer flexibility and to reduce the energy import dependence.

Cost-effective: When compared to individual heating systems, DH reduces energy system costs by reducing primary energy demand by reducing heat losses (DHC+ Technology Platform, 2012) and by replacing imported energy with local resources in high heat density areas, such as cities. It is estimated that in total, the expansion of DH and cooling will decrease the European primary energy consumption by 7%, fossil fuels by 9%, and the carbon dioxide emissions by 13% while still supplying the exact same energy services (Aalborg and Halmstad University, 2012). It also avoids flames and gas transport at household level increasing safety and reducing heating costs and space requirements (Rezaie & Rosen, 2012).

More energy efficient with low emissions: In 2010, the energy industry alone accounted for approximately 30% of the EU-27 greenhouse gas emissions (European Environmental Agency). Usually combined heat and power DH networks are more energy efficient due to the simultaneous production of heat and electricity (International Energy Agency, 2008) and can provide better pollution control than localized boilers (Euroheat). It is the cheapest method of cutting carbon emissions, and has one of the lowest carbon footprints of all fossil generation plants (Carbon footprints of various sources of heat, 2009), (Gebremedhin, 2012). Therefore, the implementation of these types of systems helps the country attaining its goals and favors its position in the emission trading system (EU Emissions Trading System).

Offering flexibility: Another advantage is the possible combination of DH the system with thermal energy storage for intelligent use. Then the complete system can be controlled in an intelligent way using demand response (Nuytten, Claessens, Paredis, Bael, & Six, 2013). This way of control helps operating and balancing the grid.

In the following chapters, the policy framework and the business models implemented in countries where DH is already mature as Sweden and Denmark are analyzed. In CHAPTER 6CHAPTER 6, the Belgian situation is benchmarked to the initial situation of those countries. The possibilities for a further expansion of DH in Belgium are examined in CHAPTER 7.

CHAPTER 2 POLICY FRAMEWORK

Although the high-initial investment is usually seen as the main barrier for DH implementation, the long-term business models could be secured by an appropriate regulatory framework.

Within the Ecoheat4 EU project, a checklist has been composed about what to consider when implementing support measures for district heating and cooling systems. As a summary, policy makers should take into account the long term objective, the actual status of their district heating and heat market as well as the effects and interactions of the new measures with the existing legal framework. The list is presented below (www.ecoheat4.eu):

Issue	Advice
National energy policy	Acknowledge the major benefit (higher energy efficiency) with district heating and cooling in the national energy policy. This will give the essential national policy support for applying proper supporting measures for district heating and cooling.
General versus specific measures	Consider whether you want a general solution for a community problem (as energy inefficiency) or you want to give direct financial support to district heating systems. Since natural gas and fuel oil are the major energy commodities used for heating in Europe, taxes on carbon dioxide emissions or fossil energy would be the general support measures for all future alternative heat supply. Then DH has to compete with other non-fossil heat supply. Another general measure is specific national or local climate change investment programmes, where district heating and cooling can be supported, if the programme aims are fulfilled.
Maturity of district heating	If DH is mature in the country, avoid giving direct financial support to developed and mature district heating systems. Direct financial support should only be applied for extra stimulation of district heating system expansions in refurbishing, expansion, and new development countries. When applying more general support measures as fossil fuel taxation and climate change investment programmes, mature district heating systems will also benefit if they fulfil the general program aims.
Financial support character	Consider the support effectiveness between initial investment grants and annual supports as feed-in tariffs, CHP bonuses, or green certificates. Investors put a higher risk reduction value in upfront investment grants, since annual support later can be changed or completely removed by another parliament composition. Hence, annual financial support has a long term political risk.
Heat planning	Consider to add heat planning to other community planning activities as waste management, traffic, water, sewage, and land use

	planning.
Planning perspective	The district heating and cooling benefits will be bankable with proper waste planning, location planning of energy-intensive processes, and building regulations. District heating and cooling providers will then take active parts in developing these plans.
Market distortions	District heating and cooling sometimes loose competitiveness from market distortions. Erase these distortions, rather than introducing counteracting support measures directed towards district heating and cooling systems.
Policy conflicts	Avoid conflicts with other policy areas. It is common that energy prices are kept low by subventions for social reasons, as the lower VAT rate in United Kingdom. Solve the social problems without interfering with energy policy.
Sector dimension	Consider which sector dimension (planning, generation, distribution, demand, or organisation) to support. Generation measures dominate, but distribution measures are appreciated by district heat providers, since the financial risk in distribution are reduced.

Table 1 : Summary advice on issues to consider when implementing measures to support DHC systems (Source: ecoheat4.eu)

Within the same project, a checklist of 12 examples of best practice support measures have been elaborated for district heating and cooling. It is available at (www.ecoheat4.eu). These measurements can be classified within Planning, Support and Burden:

The *Planning measures* refer to the long term vision at policy level regarding heat planning and national energy policy. Long term planning of building regulations and waste treatment can also have a positive impact on the development of district heating.

The *Support measures* are meant to make district heating investment possible in the current market and regulatory framework. The possibilities are broad from the direct investment support to favorable loans or tax reduction.

The last type of measure, *Burden*, refers to an increase of taxes on fossil fuels generating CO_2 emissions. The carbon dioxide tax is a fuel taxation based on the carbon content in the fossil fuel. When there is a tax on electricity consumption, the fuels used for generation of electricity are generally exempted from taxation since the transfer of this cost to the electricity consumers would result in double taxation of electricity. For cogeneration plants, tax is then paid only for the part of the fuel used for heat production.

The complete list of the 12 support measures can be found in Annex A.

These classification will be used through the document to summarize the experiences of other countries.

CHAPTER 3 BUSINESS MODELS

Under the assumption that there is no regulatory framework, the financial and economic factors become then the most critical barriers for the development of DH. Only when the investment shows to be profitable, the projects will crystallize.

A number of independent studies, summarized in (JRC scientific and policy reports, 2012), indicate that the total costs of CHP DH is less than the traditional energy supply option of individual heating and electricity-only generated at a power station. The higher capital costs were offset by lower running costs.

There also exist studies concluding that CHP-DH requires a larger investment cost when compared to the separate production case, mainly due to the investment in the cogeneration unit (Poncelet, 2012-2013). According to Poncelet, the lower fuel and emissions costs do not yet overcome the additional investment.

A new discussion arises on the assessment of current technologies from the environmental point of view and whether the CO_2 costs are appropriate to reach the environmental targets of the countries. Nevertheless, this discussion falls out of the scope of this deliverable.

As a general conclusion, every technology should be employed whenever the appropriate conditions are met. DH is a cheaper and more efficient technology for high heat density areas, such as cities. While on the other hand, heat pumps result more beneficial in lower heat density areas, as rural areas (Vad Mathiesen, 2013).

DH networks technology require high initial capital expenditure and financing; initial investment costs are high. This long-term commitment fit poorly with a focus on short-term returns on investment. However, when the lifetime cost and energy system benefits are kept in mind, DH infrastructure provides a long-term and secure investment opportunity in real value. These types of investments are important for a healthy and stable economy (DHC+ Technology Platform, 2012).

The investment calculation exercise must include the uncertainty of the volatility of energy prices. Especially critical is the increase in gas prices, cost of raw materials, demand and technology evolution.

Currently, consumers have various options for heat procurement:

1. The first model is the most common one in Europe. The final user owns his heat generating equipment (e.g. boiler) and buys a continuous flow (as natural gas by contracting the local gas net operator) or batches (as fuel oil) in order to generate the heat (Ecoheatcool and Euroheat & Power, 2005-2006).

2. In a second option, the final user buys the heat directly from an urban district heating system or a local boiler or CHP plant owned by the supplier. The supplier offers the services of delivering heat to the consumers.

In order to obtain a positive business model for the supplier, a minimum number of households in the energy district must participate and contract its services. One of the options to obtain this is to impose a legal obligation on the household to connect to the energy district and/or guarantee a minimum annual consumption to the district heating investor in long term contracts. A minimum number of consumers can be incentivized by fiscal incentives to adhere to DH. In this business model, the role of the regulatory body becomes relevant and will have a considerable impact on the market.

3. Finally, a variant of version 2 is that all the households of a district form a cooperative investing in district heating. This business model is one of the most followed in Denmark. In this case, the consumers control the direction of the company which supplies them with heat providing a control feeling. Thus, behavioural impact is to be expected as the consumers have shares on the company.

The business model to promote should be evaluated when introducing heat regulation.

3.1. Market Structures

The generated heat has to be transported to the load location to be consumed. The main steps in the heat value chain are: production, transport and supply. Depending on the degree of integration of those activities, the market will be structured in different ways. In (3E, Stibbe, & GreenVis, 2013), the possible options are discussed and illustrated as in Figure 1 - Figure 4 below:

1) Fully integrated heat company where the production, transport and supply are integrated

In this first option there is no competition unless access to third parties is granted. Consumers should be protected against any abuse of the lock-in created. On the other hand, organizational costs are kept low and administration efficient. All the risks lie in the one single entity. A schematic representation is shown in Figure 1.

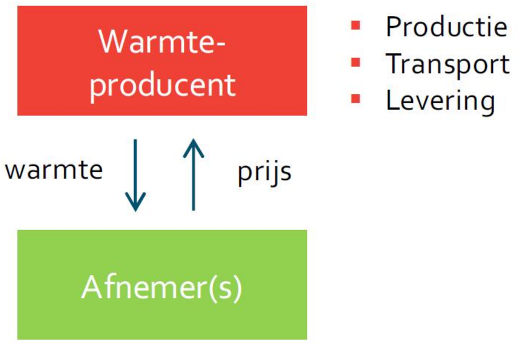

Figure 1: Completely integrated heat company (3E, Stibbe, & GreenVis, 2013)

2) All the steps in the value chain are separated

In this second option, all steps in the value chain are legally independent companies. In this case, the risks are split. The supplier buys heat from the producer and pays the company in charge of transporting it to the consumer. The schema is shown in Figure 2.

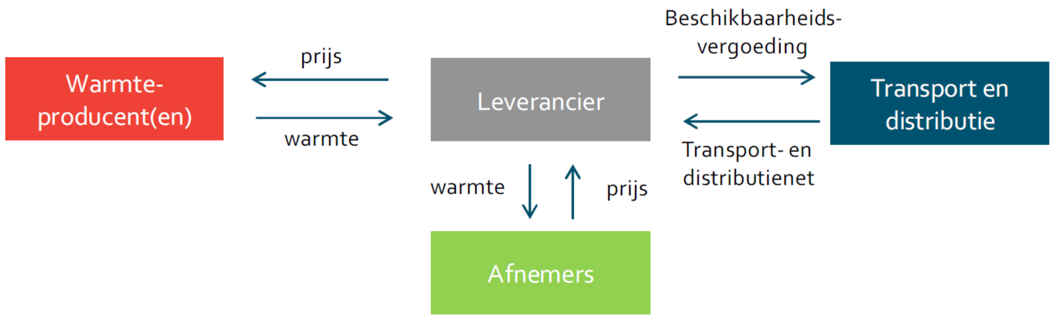

Figure 2: All steps in the value chain separated (3E, Stibbe, & GreenVis, 2013)

In between these two options, there are structural possibilities where the producer of heat is as well the supplier to the consumer or where the supplier undertakes the transport tasks as well. See Figure 3 and Figure 4 below. Depending on the expertise of the company, it can perform different roles in the market.

3) The producer is the supplier of heat to the consumer

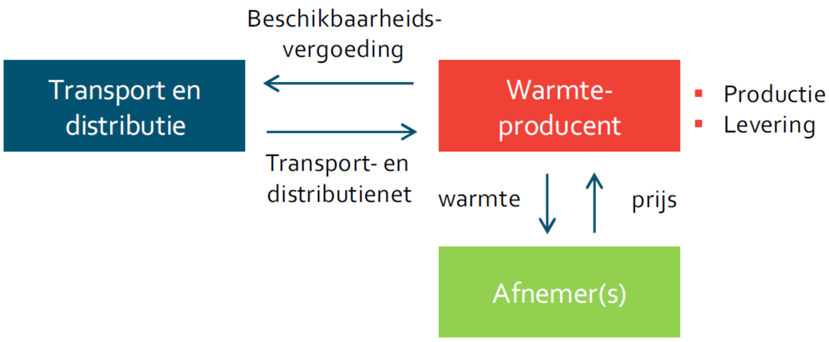

Figure 3: Production and supply combined in a company (3E, Stibbe, & GreenVis, 2013)

4) The supplier is the company in charge of transporting the heat

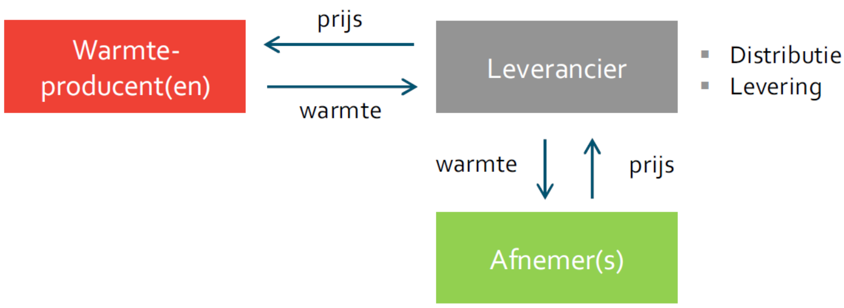

Figure 4: Distribution and Supply combined in one company (3E, Stibbe, & GreenVis, 2013)

In all the cases, the consumer has only one point of contact and receives a clear invoice for the heat consumed. In this classification, who owns and maintains the network is not discussed, likewise which party undertakes the administrative/billing procedure is not included in the figures. Normally, the heat supplier, the entity closing the contract with the consumer would be in charge of billing. Eventually, these tasks could be undertaken by an independent third party managing the network.

The choice of market structure shall be made after a risk evaluation for the different parties. In general, transport is a natural monopoly although competition can be open for the production of heat. At the supply side, the consumer normally makes a contract with a single seller, producing a lock-in and making the change of heating source not so easy sometimes.

The level of market unbundling, whether a vertically integrated company is allowed, is a critical choice to ensure consumer access to cheap heat. It is not unrealistic to assume that the heat market, in a mature state, will be structured in the same way as the electricity market: that is an unbundled infrastructure where production, distribution and supply are legally independent. Recently, Sweden reopened the Third Party Access[1] discussion. The main argument of the promoters of that measure is lowering the heat price for consumers. More details can be found in Section 5.2 of this document.

The regulator should protect the consumer from any type of abuse deriving from the monopole or the lock-in. Moreover, the quality of service and comfort shall be ensured at all times, including the potential cases of bankruptcy of the heat supplier, distributor or producer.

3.2. Heat Price

Calculating the heat price can be a complex exercise due to the amount of factors that influence the costs. This could lead to complex energy bills and no transparent pricing which should be avoided.

There exist various pricing models for heating in DH networks; The most common ones are alternative pricing, also called Not More Than Otherwise (NMTO)[2], cost plus pricing or a combination of both (Bjorkqvist, Idefeldt, & Larsson, 2010) (Difs & Trygg, 2009) (Larsson, 2011).

The alternative pricing model charges to the heat load on average no more costs than when using natural gas for the individual central heating. This approach is not based on the cost of heat supply, but on a comparison with similar gas references. On the other hand, the cost plus pricing method charges on basis of the costs incurred reasonably attributable to the heat supply. On top of these cost, the heat supplier adds a reasonable capital return.

There exist different levels of regulated prices in different countries. In some eastern countries, the heat price is fixed by the regulator or a cap is set. Hungary, Poland, Lithuania, and Estonia regulate the heat price by the cost-plus method (Farkas, Korhonen, & Kuusela, 2011). In the latter case, even if the DH costs are higher than the cap price, the company is not allowed to charge the real costs. In other countries, such as Denmark and the Netherlands, the heat price calculation method is regulated. Finally, Sweden deregulated the market in the 90's. Nowadays, there is an ongoing

[1] Third Party Access (TPA) as defined by the European Commission in 1992 is a regime providing for an obligation on companies operating transmission and distribution networks for offering services to third parties to the extent that there is capacity available.
[2] Translation from the Dutch principle used to determine heat rates named *Niet Meer Dan Anders principle*.

discussion regarding the re-introduction of heat price regulation in the country. However, the heat market has been already established for some years. Regulating a market where there are commercial interests in is extremely delicate.

The Netherlands exercises a combination of both pricing mechanisms; the Dutch Competition Authority sets policy rules with respect to the elements and method of calculation the reasonable price for heat supply (29 048, A, Art. 5) (D. Bennink, 2009).

There are various disadvantages in these heating pricing methods:

- The cost plus pricing may promote investment to a certain extent but cannot enhance the efficiency of the heating market simultaneously (Zhang, Ge, & Xu, 2013). It is usually based on historical data of real plants and may not cover all of the current costs. Since the profit allowed is typically derived from the total costs, there is an incentive to inflate costs and thus increase profits (Poputoaia & Bouzarovski, 2010). There is no economic incentive to lower costs or to increase efficiency.
- On the other hand, the alternative pricing is mainly used to prevent loss of consumers although it can force the utility to invoice prices well below its real costs (Larsson, 2011) resulting in a non-sustainable business model.

Other pricing methods have been described in the literature such as marginal cost prices, shadow prices or equivalent marginal cost pricing. There are briefly described below.

The *marginal cost* is often defined as the cost to produce the last unit, in this case the cost of a unit increase in DH. In energy systems with several production plants, the plant with the highest operational cost is the one that produces the last unit of DH (Difs & Trygg, 2009). There are several ways to determine the marginal cost for DH depending, for example, on what the by-product of the CHP generation is, electricity or heat (Sjödin & Henning, 2004).

The *shadow prices* represent the marginal costs of a unit increase in energy demand and reflect a price that may be uniformly charged to all consumers (Sherali, Soyster, Murphy, & Sen, 1982). (Andersson, 1994) interpreted shadow prices and used as a theoretical tariff.

(Zhang, Ge, & Xu, 2013) presented a new pricing model named *Equivalent Marginal Cost Pricing*. Based on Electricity Value Equivalent theory, they adapted the model to include exergy[3] as the measurement of heat value. It reflects the quality and quantity of the heat encouraging producers to provide steady and suitable products for users. The shortcoming of this method is that it is influenced by the units' characteristics and applies only to co-generation plants utilizing an extraction steam turbine.

Another pricing method that takes into account the temperature of the consumed heat is the one developed by (Poredos & Kitanovski, 2002). In this model, the actual value of the thermal energy can be obtained by a qualitative or exergy analysis of its conversion, transport and distribution.

However, none of the three latter pricing mechanisms explained seem to be widely used. The alternative pricing model is the most commonly found, especially in incipient heating markets.

[3] Exergy of a thermodynamic system is the maximum theoretical useful work (shaft work or electrical work) obtainable as the system is brought into complete thermodynamic equilibrium with the thermodynamic environment while the system interacts with this environment only (Tsatsaronis, 2007).

→ The heat price at consumer side

The heat consumer will have to pay for different concepts: mainly the quantity heat consumed and the use of the infrastructure:

1. Most of the heat companies charge a connection fee to the consumer. That is usually a one-off fee covering the costs of physically connecting the end-user to the district heating infrastructure at the beginning of the contract.

2. The cost of transport and distribution of the heat from the generation facility to the consumer site is also part of the final bill. It is billed proportionally to the amount of heat consumed. These costs would depend on the size of the network.

3. The consumed heat is billed. There are mainly three components in the heat price: the energy price, the fixed costs, and capacity cost.

    a. The most common one is *the energy price* which is charged per unit of energy delivered. It can be differentiated during the year with higher prices in winter time and lower prices in the summer.
    b. Another frequently used component is *the fixed costs*. There are however numerous examples of companies describing a price component as fixed, even when it is not. A frequently used price component is a fixed cost based on one or several previous years' consumption. Although it is fixed for the present year, it is in the long run directly proportional to the energy use and can therefore be considered variable (Larsson, 2011). The fixed cost is usually related to the connection or access grant to the district heating infrastructure.
    c. *Capacity cost* is another commonly used price component, especially in the pricing models of larger consumers such as apartment buildings. It is designed and described as a way of limiting the peak load of DH, something that is associated with high costs for the DH production. In most cases the capacity price is however directly linked to the energy use rather than the real-time capacity use (Larsson, 2011).
4. Finally, other charges such as maintenance and operation costs or taxes can be a concept of the consumer bill as well.

In Table 2, a summary of the different billing concepts for the consumed heat at end-user side is presented.

Concept	Granularity	Units
Connecting fee	One off	€
Transport and distribution cost (depending on network size)	Annual	€/kWh
Heat price – Energy	Annual	€/kWh
Heat price – Fixed costs	Annual	€/year
Heat price - Capacity costs	Annual	€/kWh usually
Other charges: e.g., M&O costs	Annual	Depending on the supply company

Table 2 Summary of the concepts and billing parameters of at the heat consumer side.

As an example, the heat tariff for different heat consumers in Amsterdam can be found in the following link: http://www.nuon.nl/Images/tarievenblad-nuon-stadswarmte-kleinverbruik-amsterdam-eerste-helft-20138-8064.pdf The heat tariff is two fold: variable and fix costs. The fix costs are also break down between monthly and yearly fix costs

CHAPTER 4 DENMARK

Denmark is one of the consolidated countries regarding the implementation of DH. Back in the 90s, they implemented eight supporting measures in order to avoid competition between collective heat supply systems and individual systems, ensure energy efficiency, and make investments economically more feasible (Aronsson B., 2010).

With more than 55% of the net energy demand for heating being supplied by DH systems, Denmark has one of the highest shares of district heating in the world. This fact has given the country a unique opportunity to increase the efficiency of electricity and heat production by using CHP plants for the production. In 1980, only 18% of the electricity produced at thermal plants was produced in combination with heat. In 2011, this share had increased to 63% (Agency, 2012).

Most major cities in Denmark have big district heating networks, including transmission networks operating with up to 125°C and 25 bar pressure and distribution networks operating with up to 95°C and between 6 and 10 bar pressure. The largest district heating system in Denmark is in the Copenhagen area operated by CTR I/S and VEKS I/S. In central Copenhagen, the CTR network serves 275,000 households (90-95% of the area's population) through a network of 54 km double district heating distribution pipes providing a peak capacity of 663 MW [4].

This development is the result of a strong political effort. Use of surplus heat from large electricity plants for district heating has been promoted by state subsidies (Act from 1977). During the 1980s and 1990s, many district heating plants have been converted to combined heat and power production, mainly gas fuelled. This development has been enabled by government-led heat planning establishing the framework for local authorities. The financial incentive to invest in the CHP conversion was facilitated by an electricity generation subsidy for small-scale CHP plants. The new Energy Agreement states that an analysis of the future role of district heating is to be carried out (Agency, 2012).

Subsidies were of significant impact. They were maintained while needed and afterwards abolished in 2000. These included: subsidies for converting older houses to DH, completion of planned networks (speed up process) and conversion from coal to gas.

Other measures with a very positive impact were the energy taxation, the planning regulation, and the heat price regulation. There were also some other measures taken such as implementing a CHP requirement, banning electrical heating, a waste planning and a law on district cooling that contributed with a positive impact.

All but one of the above measures are still applicable. Only subsides are neither existing nor planned today. The Danish policy framework will be studied more in detail in the following section.

4 http://www.ctr.dk/Images/Publikationer/Environmentally%20friendly%20district%20heating%20to%20greater%20cph.pdf

4.1. Policy Framework

As mentioned already in CHAPTER 2, the policy supporting measures can be divided in three categories: Planning, support and burden. Here below the Danish policy measures which boosted DH in the early stage of the heat market are summarized.

4.1.1. Planning

→ **General heat planning**

The purpose of this measure is to avoid competition between collective heat supply systems as natural gas and DH and individual systems in order to ensure efficient use of surplus heat and fuels of DH (Aronsson B., 2010).

→ **Waste planning**

With this measure, Denmark aimed to solve environmental waste issues at the lowest possible socio-economic cost. In this country, waste is considered to be a partly renewable fuel. This measure had a positive impact in the planning, the generation and the distribution to DH when it is available (Aronsson B., 2010).

→ **Ban on electrical heating and obligation to connect**

Denmark passed a general ban on using electrical heating if the building is or will be supplied by any collective heat supply as DH. In this way, dwellings are indirectly obliged to connect (Aronsson B., 2010).

Local authorities have the power to require that all or part of a local authority area connect either to a natural gas supply or DH (Executive Order no. 581 of 22 June 2000 on connection etc., to public heat supply installations). The degree to which this power is exercised varies considerably from area to area (Danish Energy Authority, 2005).

→ **Law on district cooling**

In Denmark, municipalities are allowed to operate district cooling (DC) schemes on commercial terms only if this activity is handled by a separate limited liability company. The purpose is to give the municipalities the possibility to operate commercial DC schemes as they already own the DH utilities suitable for DC (Aronsson & Hellmer, 2009).

4.1.2. Support

→ **Subsidies**

In the 90s, Denmark implemented direct subsidies for converting old houses to DH, completion of planned networks (speed up process) and conversion from coal to gas (Aronsson & Hellmer, 2009).

→ Heat price regulation

The Danish model is based on cost covering prices including investment to cover the necessary costs with renewable mindset (cost-plus). The regulation is motivated by the fact that DH companies are local natural monopolies. Ideally, the final cost should not be more expensive than the local heating option. This can be promoted with higher costs in taxes for gas and electricity (Lauersen, 2013). More details about the Danish business models and heat pricing are given in Section 4.2 of this document.

→ CHP requirement

The Danish legislation did not explicitly ban condensing electricity production, although the electricity act makes it practically impossible to receive an approval for an electricity only thermal installation (Aronsson B., 2010).

4.1.3. BURDEN

→ Energy Taxation

Taxes on energy (electricity and gas) also have an impact on the development of technologies. A final relative low cost of energy does not encourage the development of new supplying alternatives. Denmark counts with one of the highest energy taxes. See section 6.1.3.

On top of the taxes, the European Union implemented a trading system (EU ETS) for CO_2 emissions in 2005. The idea with a system of this kind is to utilize market mechanisms in order to reduce emissions where it is most efficient. The system requires all emitters to have a permit for each unit of CO_2 emitted and the total number of permits is set to match a predetermined limit on emissions. The permits are then traded on a market so that companies that are able to reduce their emissions at a low cost can do so and sell their permits to other companies with higher abatement costs. This burden is applicable in all European countries.

4.2. BUSINESS MODELS

In the Danish heating market, the heat transport and supply are integrated. The production is not necessarily integrated. The heat suppliers buy the heat from third party companies: utilities or municipalities. Sometimes the latter are owners of the waste incinerators. Most large condensing/extraction plants are owned by either Vattenfall or DONGenergy, and they deliver around half of all heat in Denmark.

The main business model is based on cooperatives which are consumer owned or owned by municipal utilities or companies.

The public policy in Denmark has a regulatory approach with a specific heating law. District heating has a strong position in the Danish heat market (Aronsson & Hellmer, 2009). The heat price calculation method was regulated without a cap. The majority of the companies follow the heating price based on cost plus: calculation of real costs including investment and financial costs. Prices must cover costs even when they are more expensive than alternative heating options, which is the case in a few examples.

According to the Danish Energy Agency, in 2008, 1% of DH consumers pay more for the heat than it would cost to produce it with oil boilers. On the other hand, 4% of DH consumers pay more for the heat than it would cost to produce with individual natural gas boilers.

The heat pricing in Denmark is composed of a fixed and variable part. The fix payment is often related to the space or volume of the building. The variable one is linked to the amount of heat supplied. On the other hand, the tariff of natural gas consumers is 100% variable, meaning settlement by consumption only (Danish Board of District Heating, 2013).

To facilitate the transition of natural gas consumers to DH, lower costs than when using natural gas had to be guaranteed. Therefore, a new DH tariff has been recently developed. This tariff uses a price that guarantees a total cost for DH consumers of maximum 90 % of the equivalent annual cost of heating based on natural gas. This guarantee has been approved by the Danish Energy Agency and relates only to natural gas supply irrespectively of the current heat supply of the consumer (Danish Board of District Heating, 2013).

This measure has only an impact on existing buildings, which attain savings of 10% compared to natural gas. For the new construction buildings, this measure is considered economically neutral to the individual alternative. (Danish Board of District Heating, 2013)

In (January) 2009, the heat price varied between 0,2 DKK/kWh and 1,388 DKK/kWh (0,02 – 0,18 €/kWh)[5] with an average of 0,624 DKK/kWh (0,08 €/kWh) (Aronsson & Hellmer, 2009). For 2013, the heat price can be found in the following link: http://www.hofor.dk/fjernvarme/prisen-pa-fjernvarme-2013/ . It stays in around 0,7 DKK/kWh or 0,09 €/kWh.

[5] 1 DKK ≈ 0,13 €

CHAPTER 5 SWEDEN

District heating is the dominant source of heat and hot water in Sweden while the oil share has been steadily decreasing. Over 50% of the total market for heat was provided through district heating in 2007 which is an increase of approximately 22% compared to 1978. This increased share for district heating has taken place primarily at the expense of the use of oil and, since the beginning of the 90s, also at the expense of electrical heating. As a consequence, the total energy used for heating and hot water preparation has decreased in the residential sector from slightly above 90 TWh in 2000, to slightly below 80 TWh in 2006 (Ecoheat4EU, 2009-2011).

Apartment buildings in Sweden heated by DH account for 84% of the total heated area of such buildings. The corresponding value for the one/ two family house is 12%. In 2009, an average of 10.9 MWh was used in each apartment for heating and hot water (Energimyndigheten, 2011). In 2008, about 42.5 TWh of district heating was used for space heating and hot water in residential buildings, of which 22.3 TWh was used in apartment buildings and 5.4 TWh in one/ two family houses (Energimyndigheten, 2009).

At the same time, district heating is the most commonly used system in public buildings, making up for around 90% of space heating. The provider of hot water with industrial buildings represents the remaining 10% (Ecoheat4EU, 2009-2011).

District heating systems are operational in Sweden since 1948. Karlstad was the first city implementing a district heating system in the country (Aronsson & Hellmer, 2009).

Due to the oil crisis in the 70's, the Swedish government started an implementation plan for alternative energy sources. Assuming that the hydropower capacity was close to its maximum, combined heat and power plants were supported (Aronsson & Hellmer, 2009). Later in the 1970's and 80's, the introduction of nuclear power in Sweden reduced the need of CHP plants resulting in a focus on heat only plants (Aronsson & Hellmer, 2009). Due to the low prices for electricity, electrical heating gained importance as input in district heating plants as well. It was first after the deregulation of the electricity markets in the 1990's and later in the 2000's that electricity prices increased, promoting again district heating powered by combined heat and power plants (Ecoheat4EU, 2009-2011).

5.1. Policy Framework

The Swedish energy policy has a competition-based approach, including direct competition between district heating and other heat sources and competition between heat producers at the wholesale level. The regulation is market driven, including control by antimonopoly services (Ecoheat4EU, 2009-2011).

The Swedish market for DH is deregulated with one exception, the transmission and distribution. As it is subject to natural monopoly due to the fact that it would be economically difficult for competing companies to establish and operate parallel networks in the same city, it has to undergo regulation. The national grid is run by a public company called *Svenska Kraftnät (Swedish National*

Grid), although management of the regional and local grids is deregulated. Yet, consumers have the possibility to switch to other heating methods. The foremost alternatives are heat pumps and wood pellet burners, which often are more cost efficient options than DH for one/two family houses (Boverket, 2008). The possibility of third-party connection in Swedish DH networks is currently not statutory.

For the years to come Swedish authorities are planning measures to promote energy efficiency, while also increasing the share of renewable energy and reducing emissions of greenhouse gases (Energimyndigheten, 2010). One goal is to reduce the energy intensity (energy use per unit of gross domestic product) by 20 % in the period 2008-2020 and another is to reach a share of 50 % renewable energy in the total energy use by 2020. District heating is bound both to influence the development of a changing energy system and to be affected by it (Goop, 2012).

5.1.1. Planning

→ Long term planning

Planning has been a very important part of the establishment and introduction of district heating in Sweden. After 60 years of district heating expansion and new development, district heating in Sweden is strictly market based. The oil crises of the 70's were the start of a long term Swedish energy policy. District heating has since been a very important tool in this policy. In 1980 the oil dependency was strong and several program stared to replace oil ending in the introduction of Carbon tax in 1991 (Ecoheat4EU, 2009-2011).

Sweden is implementing a climate change program which gives support to greenhouse gas reducing projects. These programs are not specifically targeting DH but they do include things like expansion of DH and transition to biofuels for example (Ecoheat4EU, 2009-2011).

5.1.2. Support

The support measures aim at promoting efficient and environmentally friendly use of energy and a reduction in electricity use for heating in residential buildings. It is stated that subsidies can be given to single or double households as well as to residential buildings for conversion to heat pumps or the use of bio fuel or the use of DH. Up to 30% of the investment cost can be subsidized with a maximum value of SEK 30.000 (3.500 €) (Ecoheat4EU, 2009-2011).

In Sweden there is a system of green electricity certificates to support electricity production from renewable sources. Producers of electricity which are classified as "green" receive a certificate for each unit of electricity produced. Examples of green electricity production are wind power, biofuel-based production and small-scale hydropower. Companies supplying electricity to end consumers are then required to hold such certificates corresponding to a given proportion of the sold electricity. This creates a market value for the certificates giving economic support to green electricity producers and transferring the cost for supporting the system to the electricity consumers. The certificate system is planned to remain in place until 2035 (Energimyndigheten, 2009).

5.1.3. BURDEN

In district heat production, the electricity tax mainly affects the production of heat in electric heat-only boilers and in heat pumps. In Sweden there is a tax on electricity consumption; therefore, the fuels used for electricity generation are generally exempted from taxation (Goop, 2012). After a 30 year period, this tax can be regarded as very successful since it has resulted in an extensive use of surplus heat from the industry as well as the use of biomass and energy from waste (Ecoheat4EU, 2009-2011).

5.2. BUSINESS MODELS

In Sweden the heat production, transport and supply are integrated. Cooperations regarding supply of surplus heat are common: in Stockholm, for example, several utilities are linked together and cooperate to exchange heat. In the majority of the cases, the same company has the total responsibility for production, transport and supply.

The owner of the systems are municipalities or private companies. In Sweden, cooperatives are not that common as in Denmark.

The heat pricing model differs amongst companies: mainly heat pumps use the alternative pricing (Not More Than Others) to base the price on, others follow the real cost model with a small profit added (cost plus).

In Sweden, another less common price component has been observed. It is called flow cost. It is generally only based on the volumetric flow of the DH water through the customer heat exchanger, but occasionally also include the temperature of the return water. It is used in order to promote more efficient heat transfer with low return temperatures. Some companies only apply the flow cost when the flow per delivered unit of energy is above a certain threshold value, e.g. 20 m3/MWh. It therefore gives consumers an indication of when it is time to replace or perform maintenance to the heat exchanger (Larsson, 2011).

Nowadays, the Swedish market for district heating is a deregulated market. Prior to the de-regulation of the energy markets January 1, 1996 all district heating plants and distributing networks were owned and operated by each municipality. After the de-regulation all companies engaged in the energy sector were supposed to operate in a business-like manner with the exception of transmission and distribution. Being a natural monopoly, transmission and distribution activities are regulated (Aronsson & Hellmer, 2009).

As a consequence of the de-regulation, the heat prices increased led to consumers protests. The protesters argue that the energy companies were taking advantage of the natural monopoly that the district systems constitute. The energy companies, on the other hand, argue that they are acting in a heat market, where they are competing with other heating systems. However, the protesters argue that the lock-in effects are such that once district heating is chosen, it is almost impossible to change systems because of the high investment costs. The protests have led to two government investigations regarding the possibility of an introduction of obligatory Third Party Access (TPA) to the district heating systems, as a way to create competition within the market. Some of the energy companies oppose such an introduction, while others are in favor, as they see an opportunity to enter the market and compete for customers. However, there is no clear evidence that prices would actually decrease. TPA may have small positive effects on competition, but it may have significant impacts on the possibility of running the systems in a cost-effective manner (Magnusson & Palm, 2011).

(Hansson & Assarsson, 2009) investigated the impact of firm ownership on pricing, production costs and profitability in the Swedish DH market. They observed that private firms are more profitable than fully or partly governmentally owned firms. Furthermore, their results concluded that the level of profitability is positively correlated with high prices to consumers rather than negatively correlated to low production costs. In that sense, none of the firms' types have enough incentive to minimize production costs and thus, none are achieving socially optimal outcome. Their research points out private own company under regulation as the most efficient.

In Annex B, the heat prices for small apartment buildings in 2008 and 2009 are shown. The prices varying from 40 to 90 öre/kWh incl VAT (0,04 – 0,09 €/kWh incl VAT[6]) with an average price of about 70 öre/kWh incl vat (0,07 €/kWh incl VAT).

[6] 1 SEK ≈ 0,1 €

CHAPTER 6 BELGIUM - FLANDERS

In the current Belgian situation, the legal status of heat has not yet been defined by the policy makers. Moreover, there is a lack of standardization in contract structures for DH developers (Pöyry & Maunsell, 2009).

From the technological point of view, there exist a long-term uncertainty since it is possible that other technologies enter the market in the future which could be more competitive and thus, jeopardize the viability of DH installations.

Furthermore, current policy frameworks in Belgium are mainly based on centralized systems. This may create an uneven playing field for renewable/decentralized systems. A critical review of the policy framework is needed to overcome the systematic barriers present.

In Belgium, some ten DH networks have been installed until now (Aernouts & Jespers, 2012). As mentioned before, nowadays, there is no specific support or policy measures implemented to promote or ensure DH implementation in the country.

Nevertheless, the Belgian potential has been confirmed by the heat roadmap Europe pre-study (Aalborg and Halmstad University, 2012). The latter study identified Belgium as a hot spot country with potential to develop DH. It was classified as part of the new development countries group together with the UK, Ireland and Spain.

Interest in district heating is also growing within the country; in Flanders for instance, a district heating association “Warmtenetwerk Vlaanderen” was inaugurated in 2011. In 2012, two Members of the Flemish Parliament organized a workshop in the Flemish Parliament on the issue.

6.1. Policy Framework

Belgium is a federal state composed of three regions: the Flemish, the Walloon and the Brussels-Capital region. Environmental law for DHC and CHP related matters is the sole competence of the regions.

Nevertheless, the concept of some of the measures seen in the previous chapters is transferrable into the specific Belgian situation. Not DH mature countries, like Belgium, should take into account the experience of countries such as Denmark and Sweden where the implementation of DH has proven to be successful. An application of the techniques and best-practices should be adapted to each particular regional and local circumstance. Both technological and policy issues need to be addressed locally.

With a wider DH penetration, a new market for heat will be created. Initially, this market should be regulated in order to avoid abuse and to protect the consumer. Furthermore, the acceptance by all the residents of the district and stakeholders to the DH project should be assured so that investors calculate positive long-term business plans. In order to set a levelled playing field, standard rules need to be made, so that all parties - heat providers, heat generators, heat distributors, heat consumers - know their rights and obligations. The contracts must be unambiguously describing existing and new relationships.

Finally, for a similar implementation across Belgium, a homogenous legislation is needed in the three regions of the country. Observing the implementation in the Nordic countries, a regulated heat market obtains a desirable result.

6.1.1. PLANNING

In Belgium, the long-term energy policy is unclear at this point in time and it is actually missing. Policy makers should make a pact amongst all the political forces for a defined and clear energy policy.

The waste planning is the sole competence of the regions. For the case of Flanders, household waste is already partly considered renewable fuel while it is not yet the case in the other two regions of the country (BW2E).

This long term planning will also preserve the projects from the uncertainty of withdrawal of political support. Clear decision making-processes are needed from the public side (Rebel, 2012). In any case, a direct or indirect obligation to connect in case the building would be supplied with DH would secure the business model of the system.

6.1.2. SUPPORT

In Denmark, the highest impact measure was the direct support of the implementation of DH. Belgium should accurately determine the necessary support level to avoid any type of speculation. This measure should be temporal and at the same time promote efficiency and secure the long-term financing.

Currently, specific incentives for the development of district heating are not yet granted in any of the regions although CHP incentives are implemented. Each region passed its own legislation regarding CHP penetration and incentives. This lead to a non-homogeneous development across the country even though the three regions have opted for a support mechanism based on a public service obligation to support electricity suppliers and transmission system based on the trade of CHP certificates (Commission Wallonne pour l'Energie, 2011), (Brugel) and (Vreg).

In November 2013, the Flemish Energy Agency (VEA) released a supporting scheme for green heat installations larger than 1MW, surplus heat and production and injection of biomethane. The goal is to breach the investment gap compared to other classical installations. More details can be found in (Energie sparen).

Following the energy efficiency directive and the renewable energy source directive, Belgium has started working on developing a heat source and demand map. Some concrete support mechanisms for implementation are being drafted as a first step (Vlaams Mitigatie Plan 2013-2020, 2013). These actions will give an overview of the needs and potential to develop DH networks at local level. Overall, the support schemes and policy should allow the penetration of DH at the correct locations identified by the heat and demand maps exercise.

The introduction of a support scheme should be done in combination with a general heat planning, and a correct energy taxation since it also has an impact on the development of technologies.

6.1.3. BURDEN

Belgium has relatively low energy taxes when compared to Denmark and Sweden (see CHAPTER 4 and CHAPTER 5). In the latter countries, energy savings promotion is the reason for the high taxes in electricity and gas.

The natural gas prices for households in 2013 was approximately 50% higher in Denmark and Sweden than in Belgium (Eurostat Statistics a).

Regarding electricity prices for households in the second half of 2011, Belgian prices were 30% lower than Danish's prices but 4% more expensive than in Sweden (Eurostat Statistics b). 55.7% and 34.8% of the Danish and Swedish electricity price is related to non-recoverable taxes and levies while only 24.5% of the Belgian price are taxes (Eurostat Statistics b). The rest of the price components are the energy generation itself and the network costs.

A comparison table for electricity and gas household prices in different countries divided per penetration of DH systems is shown in Table 3.

Natural gas prices households 2013	Electricity prices households second half 2011
DK: 0.114 €/kWh, 55.9% tax and levies SE: 0.123 €/kWh, 45.3% tax and levies	DK: 0.298 €/kWh 55.7% tax SE: 0.204 €/kWh 34.8% tax
BE: 0.065 €/kWh, 20.6% tax and levies	BE: 0.212 €/kWh 24.5% tax

Table 3: Energy prices comparison between Denmark, Sweden and Belgium (Eurostat Statistics a) (Eurostat Statistics b)

The final price of electricity and gas has an impact on the financial viability of the DH projects. Compared to other countries with a more developed DH market, Belgium applies low taxes to electricity and gas. However, the impact of increasing taxes should be thoroughly analyzed before application.

6.2. BUSINESS MODELS

As mentioned before, Belgium has little experience with DH systems. One of them is implemented in Roeselare city., There the heat is distributed from a city loop to private apartments, using waste material as heating source (Alfalaval.com).

The project was initiated in a somewhat unusual way. The company handling the insurance for all the apartments refused to sign a new policy due to the fire hazard arising from obsolete oil boilers. Residents then decided to replace them with highly efficient gas burners. Rumours reached the municipal waste plant operator Mirom and soon a better alternative was presented jointly by Mirom and Van Marcke (Alfalaval.com).

In October 2013, Antwerp city released a procurement process for the design, construction and maintenance of district heating in the Nieuw Zuid Antwerp area. The tender states maximum heat tariffs that can be charged to the heat consumer. The estimations are based on alternative pricing model: the heat tariff should not be higher than the average standard individual gas boiler including maintenance and operational costs as well as investment costs.

To secure the business model of the project developer, an obligation to connect to the district heating network will be imposed from the city level. To secure the customers against the monopole by the implementation of tariff caps, stringent KPIs which includes the heat availability 99% of the year will be imposed. The tariffs are indexed every half a year.

The tender stipulates as well that the heat production will be closed for 20 years, while the heat distribution will be closed for 40 years (no third party access granted). This gives exclusivity and certainty to early involved partners/parties.

In Herenthout, a project was developed consisting of the construction of nineteen energy efficient dwellings. The aim was to reduce the primary energy consumption for space heating and hot sanitary water.

The owner is the social housing company Zonnige Kempen in Westerlo (Zonnige Kempen). The inhabitants of the buildings pay for the heat delivered at their dwellings. The company helps people with a low income by offering them a proper and affordable house, as owners or tenants. In addition, Zonnige Kempen aims to provide sustainable buildings with a low energy invoice. The payback period for Zonnige Kempen was 7,9 years.

CHAPTER 7 OPTIONS TO DEPLOY DISTRICT HEATING IN BELGIUM

In Table 4, an overview of the previous chapters can be found. The table summarizes the policy framework and the business models in Denmark, Sweden and Belgium for DH.

	Denmark	Sweden	Belgium – Flanders
Policy framework	Back in the 90s, they implemented eight supporting measures. Clear and long term planning. Incentives abolished in 2000. Ban on electric heating. High energy tax	In the 70'ties a long term energy policy started Competition-based approach Incentives to reduce use of electrical heating in residential buildings. High energy tax	No long term planning. Regional CHP incentives. Following European Directives Lower energy tax
Business models	The heat transport and supply are integrated. The main business model is based on cooperatives which are consumer owned or owned by municipal utilities or companies	Production, transport and supply are integrated. The owner of the systems are municipalities or private companies Before January 1, 1996 all district heating plants and distributing networks were owned and operated by each municipality. Nowadays the heat market is deregulated.	Ad-hoc business models.
Heat price	The majority of the companies follow the heating price based on cost plus. Alternative pricing is applied compared to natural gas consumption (max. 90% of costs)	The heat price differs amongst companies: mainly heat pumps use the alternative pricing, others calculate the real cost model with a small profit added.	Ad-hoc. Mainly alternative pricing.

Table 4: Summary of Danish, Swedish and Belgian policy framework and business models for DH.

7.1. NATIONAL & REGIONAL LEVEL

A clear long term energy plan can be extracted as a lesson learnt from the examples of Denmark and Sweden in the implementation of DH. Both countries implemented several types of long-term measures to accomplish their goals on DH adapted to their specific energy situation and geography.

The countries started with a regulated heat market that have liberalized at different paces and levels.

7.2. CITY LEVEL

In general, Belgian cities cannot deviate from the guidelines of the regional and federal government. However, they have some degree of freedom to manoeuvre and steer the market such as some fiscal and promotion measures.

As a recent example, the city of Antwerp released a tender for the design, construction and maintenance of a district heating network in an area. The production, transport and supply will be integrated in the same company. While the production will be locked for 20 years, the distribution will be locked for 40 years.

There is no general legal framework so the project developer company generally undertakes all the risk. However, apart from the measures stated in the paragraph above, the Antwerp city will also oblige the household to connect to the DH although a minimum demand will not be guaranteed.

In order to protect the consumer, strict KPIs are imposed to the exploiting company as well as a heat price cap. The heat price is estimated after a feasibility study of individual gas heating and thus, based on alternative pricing.

De maximumtarieven (in Euro exclusief BTW) voor de periode april 2013 t.e.m. oktober 2013 werden op volgende bedragen vastgelegd:

Bedragen in Euro, exclusief BTW	Tarief kleinverbruiker	Tarief beschermde kleinverbruiker	Tarief middelgrote verbruiker	Grote verbruiker*
Aansluitbijdrage	€1900 per gebouwunit van een collectief gebouw (3680 voor eengezinswoning)	€1900 per gebouwunit van een collectief gebouw (3680 voor eengezinswoning)	€15725+€64*Nuttig Vermogen per aangesloten gebouwunit per jaar	geen tarief gedefinieerd
Herinvesteringsbijdrage	100% x aansluitbijdrage	100% x aansluitbijdrage	100% x aansluitbijdrage	geen tarief gedefinieerd
Groene warmtebijdrage	Op Projectbasis te bepalen	Op Projectbasis te bepalen	Op Projectbasis te bepalen	geen tarief gedefinieerd
Vastrecht	€185 per aangesloten gebouwunit per jaar	€60 per aangesloten gebouwunit per jaar	€480 per aangesloten gebouwunit per jaar	geen tarief gedefinieerd
Verbruiksafhankelijk warmtetarief	€0,05290 per kWh warmte	€0,04724 per kWh warmte	€0,04709 per kWh warmte	geen tarief gedefinieerd

Figure 5 : Maximum heat prices per type of client[7]

[7] https://enot.publicprocurement.be/enot-war/preViewNotice.do?noticeId=156441&saveSearchParams=true&publicationNumberBDA=&mar

There are various ways for the city to start the implementation of the District Heating:

- Specific projects can be initiated by a municipal energy company
- A procurement process can be open.
- A social company can be supported to undertake projects.

Commonly, a pricing model based on alternative pricing helps to overcome the initial barrier and to motivate a wave of consumers to connect to the district heating network. Consumer's comfort, quality and reliability of supply should be always watched over. Being a long term investment, protection against potential company bankruptcy should be also provided.

In any case, to secure the long-term investment, obligation to connect to the district heating could be linked to the construction permit of certain areas. Other fiscal 'alleviating' measures such as reducing taxes or rewarding the consumer connecting/using district heating can motivate the companies' investment decision.

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ANNEX A: TOP 12 SUPPORT MEASURES FOR DISTRICT HEATING AS IDENTIFIED BY ECOHEAT4.EU

Top 12 support measures	Short description of the support measure	Sector dimension
Planning – Heat planning and/or zoning	Strategic energy planning, probably at municipality level. May include encouraging or even enforcing particular energy solutions (zoning). Currently applied in Germany, Denmark, Spain, France, Italy, *Lithuania*, Norway, and United Kingdom.	Distribution
Planning – National energy policy	The framework within which relevant legislation, possibly including measures on this list, may be framed. Currently applied in the Czech Republic, Germany, Denmark, Croatia, *Lithuania*, and Norway.	Planning
Planning – Building regulations	Using existing regulatory framework to encourage deployment and to ensure unnecessary barriers are removed. Currently applied in Ireland, France, Norway, and United Kingdom.	Demand
Planning – Waste planning & landfill bans	Promoting in a strategic way disposal of waste, so that the energy can be recovered and put to use in district heating schemes. Currently applied in Denmark and Norway.	Generation
Support – Investment grant, DH distribution	Financial support for district heating pipes through provision of grant, probably from government, but other sources also possible. Currently applied in Germany, Spain, France, Italy, Lithuania, Norway, Romania, and the United Kingdom.	Distribution
Support – Operation support, CHP including feed-in tariff	Supporting CHP through regulatory means, one prominent example being by means of a Feed In Tariff or a CHP bonus. Currently applied in the Czech Republic, *France*, Italy, Lithuania, *Belgium,* and Romania.	Generation
Support – Investment grant, DH connection	Financial support for connecting customers to existing mains network through provision of grant, probably from government, but other sources also possible. Currently applied in Germany, *France*, Denmark, Finland, and Sweden.	Demand
Support – Favourable	Providing low interest loans to finance the capital cost of establishing, extending or refurbishing district heating.	All

loans	Currently applied in Germany and Croatia.	
Support – Investment grant, CHP	Financial support for CHP through provision of grant, probably from government, but other sources also possible. Currently applied in Germany and Ireland.	Generation
Support – Tax deduction, DH	Implementing a tax benefit for district heating schemes. Currently applied in Finland, France, Italy, Lithuania, and Norway.	Distribution
Support – Investment grant, renewables	Financial support for renewables through provision of grant, probably from government, but other sources also possible. Currently applied in Germany, France, Croatia, Ireland, Norway, and Sweden.	Generation
Burden – Carbon tax	Implementing a tax penalty on fossil fuels proportional to its fossil carbon emissions. Applicable to all energy systems (energy efficient approaches like district heating would prosper). Currently applied in Denmark, Norway, and Sweden.	Generation

ANNEX B: HEAT PRICES FOR SMALL APARTMENT BUILDINGS IN SWEDEN, 2008 AND 2009[8].

Företag	Kommun	2008 (öre/kWh incl vat)	2009 (öre/kWh incl vat)
Göteborg EnergiAB	Ale	71,42	71,20
Alingsås Energi Nät AB	Alingsås	77,91	84,03
Alvesta EnergiAB	Alvesta	63,75	64,38
Aneby Miljö & Vatten AB (Aneby)	Aneby	78,88	83,25
Arboga EnergiAB	Arboga	75,42	77,38
	Arjeplog		
Arvidsjaurs Energi AB	Arvidsjaur	79,05	79,05
Fortum Värme.ABs.m. Stockholmsstad	Arvika	74,83	77,55
Vattenfall AB	Askersund	78,50	80,75
Fortum Värme AB:s m Stockholmsstad	Avesta	71,59	75,09
BengtsforsEnergi	Bengtsfors		62,50
	Berg		
Umeå EnergiAB	Bjurholm	62,43	67,32
Neova AB	Bjuv	77,50	81,50
BodensEnergiAB	Boden	51,19	51,19
	Bollebygd		
Bollnäs Energi AB	Bollnäs	64,12	68,15
Borgholm Energi AB (Borgholm)	Borgholm	67,40	72,02
Borlänge Energi .AB	Borlänge	56,28	57,78
Borås Energi och Miljö AB	Borås	64,93	68,37
Södertörns Fjärrvärme AB	Botkyrka	63,70	67,10
E.ON Syd	Boxholm	78,50	70,29
Bromölla fjärrvärme AB	Bromölla	62,70	67,50
Bräcke kommun	Bräcke	75,00	91,25
E. ON Malmö	Burlöv	69,07	71,11
	Båstad		
Farmarenergi i Ed AB	Dals-Ed	78,00	75,37
Norrenergi AB	Danderyd	70,55	74,46
Degerfors Energi AB	Degerfors	74,46	79,46
E.ON Nord	Dorotea	64,40	66,91
	Eda		

[8] Extracted from http://www.svenskfjarrvarme.se/Rapporter--Dokument/Rapporter_och_Dokument/Statistik/Fjarrvarme-i-siffror/Priser/Medelpriser-for-fjarrvarme-till-mindre-flerfamiljshus-1999-2009/

	Ekerö		
Eksjö Energi AB	Eksjö	56,47	59,31
Emmaboda Energi AB (Emmaboda)	Emmaboda	68,74	75,00
EnaEnergiAB	Enköping	65,72	69,05
EskilstunaEnergi&MiljöAB	Eskilstuna	61,44	65,81
LundsEnergikoncernAB(publ)	Eslöv	76,59	80,27
	Essunga		
VästerbergslagensEnergiAB	Fagersta	71,17	73,08
Falkenberg Energi AB	Falkenberg	81,80	89,83
FalbygdensEnergiAB	Falköping	65,74	67,19
FaluEnergi&VattenAB	Falun	71,48	72,39
Rindi Energi AB	Filipstad	70,63	72,75
FinspångsTekniskaVerkAB	Finspång	70,95	72,41
Rindi Energi AB	Flen	68,75	72,50
Forshaga Energi AB (Forshaga)	Forshaga	81,05	82,35
	Färgelanda		
	Gagnef		
	Gislaved		
Rindi Energi AB	Gnesta	78,88	80,13
	Gnosjö		
Gotlands Energi AB	Gotland	73,23	76,63
Fortum Värme AB:s m Stockholmsstad	Grums	72,93	76,90
Grästorps Fjärrvärme AB	Grästorp	73,37	81,00
	Gullspång		
GällivareVärmeverkAB	Gällivare		79,44
GävleEnergiAB	Gävle	58,04	58,04
Göteborg Energi AB	Göteborg	64,05	65,00
Götene Vatten & Värme AB	Götene	64,74	67,87
HaboEnergiAB	Habo	74,25	78,00
Hagfors Bioenergi AB (Hagfors)	Hagfors	73,80	77,00
E.ON Örebro	Hallsberg	71,65	74,10
MälarenergiAB	Hallstahammar	63,38	66,69
HalmstadsEnergiochMiljöAB	Halmstad	67,02	69,06
HammaröEnergiAB	Hammarö	90,97	90,97
Vattenfall AB	Haninge	76,38	78,63
Vattenfall AB.Norrlandsbolagen	Haparanda	61,88	69,38
Sala-Heby Energi AB	Heby	67,72	69,31
HedemoraEnergiAB	Hedemora	63,81	68,96
ÖresundskraftAB	Helsingborg	65,26	69,60
Herrljunga Energi AB (Herrljunga)	Herrljunga	76,24	79,99
HjoEnergiAB	Hjo	64,50	68,75
Fortum Värme AB:s m Stockholmsstad	Hofors	56,90	59,57
Södertörn Fjärrvärme AB (Huddinge)	Huddinge	63,70	67,10

Annex B: Heat Prices for small apartment buildings in Sweden, 2008 and 2009.

Fortum Värme AB:s m Stockholmsstad	Hudiksvall	75,11	78,99
Neova AB	Hultsfred	77,25	80,25
	Hylte		
E.ON Nord	Håbo	75,90	75,90
Fortum Värme AB:s m Stockholmsstad	Hällefors	72,97	75,89
E.ON Nord	Härjedalen	63,22	67,22
Härnösand Energi & Miljö AB	Härnösand	71,68	71,41
	Härryda		
Hässleholm Fjärrvärme AB	Hässleholm	65,23	69,31
Höganäs FjärrvärmeAB	Höganäs	56,36	61,12
	Högsby		
Rindi Energi AB	Hörby	73,75	77,50
Rindi Energi AB	Höör	73,75	77,50
Jokkmokks Värmeverk AB	Jokkmokk	83,37	84,62
E.ON Nord	Järfälla	72,81	74,38
Jönköping Energi AB	Jönköping	67,19	67,98
Vattenfall AB.Norrlandsbolagen	Kalix	72,88	77,25
Kalmar Energi Värme AB	Kalmar	62,92	66,48
Rindi Energi AB	Karlsborg	69,50	75,90
Karlshamn Energi AB	Karlshamn	58,32	60,75
Karlskoga Energi & Miljö AB	Karlskoga	67,89	71,76
Affärsverken Karlskrona AB	Karlskrona	74,75	78,84
Karlstads Energi AB	Karlstad	69,71	73,24
Tekniska Verken i Linköping AB	Katrineholm	71,29	74,29
Kils Energi AB	Kil	79,44	82,49
Tekniska Verken i Linköping AB	Kinda	75,00	78,13
Tekniska Verken i Kiruna AB	Kiruna	78,60	78,60
LundsEnergikoncernAB(publ)	Klippan		80,66
Vattenfall AB	Knivsta	71,25	72,75
Neova AB	Kramfors	77,50	77,50
C4EnergiAB	Kristianstad	63,73	66,29
Kristinehamns Fjärrvärme AB	Kristinehamn	77,43	84,20
Jämtkraft AB	Krokom	51,36	53,68
E.ON Örebro	Kumla		74,10
Statkraft	Kungsbacka	66,90	68,92
MälarenergiAB	Kungsör	69,17	73,63
KungälvEnergiAB	Kungälv	73,54	73,89
	Kävlinge		
Köpingskommun	Köping	43,43	45,61
	Laholm		
Landskronakommun	Landskrona	61,26	64,60
LaxåVärmeAktiebolag	Laxå	76,14	78,77
Lekeberg Bioenergi AB (Lekeberg)	Lekeberg	64,33	71,10
Dala Energi	Leksand	78,75	78,75

LerumFjärrvärmeAB	Lerum	79,51	81,01
	Lessebo		
Fortum Värme AB:s m Stockholmsstad	Lidingö	79,56	82,04
LidköpingsVärmeverkAB	Lidköping	54,76	57,50
LillaEdetsFjärrvärmeAB	Lilla Edet	81,17	78,75
Linde Energi AB	Lindesberg	68,71	68,71
Tekniska Verken i Linköping AB	Linköping	67,65	66,36
LjungbyEnergiAB	Ljungby	54,04	54,04
Ljusdal Energi AB	Ljusdal	63,56	68,87
	Ljusnarsberg		
LundsEnergikoncernAB(publ)	Lomma	78,40	81,88
VästerbergslagensEnergiAB	Ludvika	75,89	77,90
LuleåEnergiAB	Luleå	40,53	41,78
LundsEnergikoncernAB(publ)	Lund		81,88
Skellefteå Kraft AB	Lycksele	73,84	78,84
LEVA i Lysekil AB	Lysekil	75,00	75,00
E.ON Malmö	Malmö	69,07	71,11
Malung-SälenskommunVärmeverket	Malung	59,86	68,75
Skellefteå Kraft AB	Malå	72,08	76,75
Mariestad-TörebodaEnergi AB	Mariestad	61,36	61,36
Marks Värme AB	Mark	81,26	83,76
E.ON Syd	Markaryd	73,63	ej normalprislista enl eon
	Mellerud		
Mjölby-Svartådalen Energi AB	Mjölby	63,64	67,03
E.ON Nord	Mora	67,54	70,10
Vattenfall AB	Motala	78,50	80,75
Mullsjö Energi & MIljö AB	Mullsjö	84,00	84,00
Uddevalla Energi AB	Munkedal	80,72	92,07
Munkfors Värmeverk AB	Munkfors	79,90	84,90
Mölndal Energi AB	Mölndal	73,64	77,47
E.ON Syd	Mönsterås	71,52	73,84
	Mörbylånga		
Vattenfall AB	Nacka	76,38	78,63
E.ON Nord	Nora	71,11	72,54
VästerbergslagensEnergiAB	Norberg	73,60	75,58
	Nordanstig		
E.ON Nord	Nordmaling	67,28	69,70
E.ON Norrköping	Norrköping	60,97	64,24
Norrtälje Energi AB	Norrtälje	73,81	76,72
Skellefteå Kraft AB	Norsjö	73,45	78,82
Nybro Energi AB	Nybro	67,94	72,00
Telge Nät AB	Nykvarn	69,56	79,00
Vattenfall AB	Nyköping	73,13	74,75

Annex B: Heat Prices for small apartment buildings in Sweden, 2008 and 2009.

Fortum Värme AB:s m Stockholmsstad	Nynäshamn	80,03	82,91
Nässjö Affärsverk AB	Nässjö	59,78	60,71
Bionär närvärme AB	Ockelbo		67,35
Olotröms Kraft AB	Olofström	67,61	72,43
E.ON Nord	Orsa	64,13	65,50
	Orust		
Fjärrvärme i Osby AB	Osby	61,80	62,97
Oskarshamn Energi AB	Oskarshamn	69,12	72,76
Elektra Värme AB	Ovanåker	68,49	70,87
Oxelö Energi AB	Oxelösund	54,51	55,60
Pajala Värmeverk AB (Pajala)	Pajala	63,00	63,00
Göteborg Energi AB	Partille	64,05	65,00
Perstorps Fjärrvärme AB	Perstorp	62,57	64,16
Pite Energi AB	Piteå	52,78	55,25
	Ragunda		
Skellefteå Kraft AB	Robertsfors	73,45	78,82
Ronneby Miljö och Teknik AB	Ronneby	66,72	65,51
Rättviks Teknik AB	Rättvik	76,70	76,70
Sala-Heby Energi AB	Sala	66,35	67,94
Södertörns Fjärrvärme AB	Salem	63,70	67,10
SandvikenEnergiAB	Sandviken	64,43	68,18
Fortum Värme. AB s.m. Stockholms stad	Sigtuna	79,56	82,04
ÖsterlensKraftAB	Simrishamn	71,25	73,75
Rindi Energi AB	Sjöbo	73,75	77,50
SkaraEnergiAB	Skara	64,38	66,88
Skellefteå Kraft AB	Skellefteå	72,08	76,75
E.ON Nord	Skinnskatteberg		ej normalprislista enl eon
Skurups Fjärrvärme AB	Skurup	70,63	77,13
SkövdeVärmeverkAB	Skövde	56,94	59,44
Smedjebacken Energi AB	Smedjebacken	68,19	75,60
E.ON Nord	Sollefteå	74,50	74,51
SollentunaEnergiAB	Sollentuna	67,82	70,32
Norrenergi AB	Solna	70,55	74,46
Sorsele kommun (Sorsele)	Sorsele	68,00	68,00
	Sotenäs		
E.ON Malmö	Staffanstorp	71,99	72,71
Stenungsunds Energi och Miljö AB (Stenungsund)	Stenungsund	53,60	62,75
Fortum Värme AB:s m Stockholmsstad	Stockholm	79,56	82,04
Rindi Energi AB	Storfors	81,25	81,25
Skellefteå Kraft AB	Storuman	75,34	78,84
Strängnäs Energi AB	Strängnäs	76,73	76,77
	Strömstad		

Jämtlandsvärme AB (Strömsund)	Strömsund	71,23	74,29
NorrenergiAB	Sundbyberg	70,55	74,46
Sundsvall Energi AB	Sundsvall	64,98	64,98
Rindi Energi AB	Sunne	74,75	77,00
Surahammars Kommunal TeknikAB	Surahammar	80,00	80,00
Svalövs kommun	Svalöv	67,46	69,79
	Svedala		
Svenljunga Energi AB	Svenljunga	74,60	74,60
Fortum Värme AB:s m Stockholmsstad	Säffle	79,64	81,16
Hedemora Energi AB	Säter	76,11	81,98
Sävsjö Energi AB	Sävsjö	70,50	73,35
Söderhamn Energi AB	Söderhamn	65,88	67,75
E.ON Syd	Söderköping	71,24	72,18
Telge Nät AB	Södertälje	69,56	79,00
Sölvesborgs Energi och Vatten AB (Sölvesborg)	Sölvesborg	73,75	76,25
Neova AB	Tanum	81,45	86,00
Neova AB	Tibro	66,25	68,88
TidaholmsEnergiAB	Tidaholm	72,07	74,57
Tierps Fjärrvärme AB	Tierp	70,50	73,63
E.ON Nord	Timrå	69,17	70,90
	Tingsryd		
	Tjörn		
Rindi Energi AB	Tomelilla	73,75	77,50
Fortum Värme AB:s m Stockholmsstad	Torsby	77,01	79,91
Torsås Fjärrvärme AB (Torsås)	Torsås	68,75	72,50
	Tranemo		
Tranås Energi AB	Tranås	54,15	56,09
Trelleborgs Fjärrvärme AB	Trelleborg	73,50	74,20
Trollhättan Energi AB	Trollhättan	59,89	62,29
Statkraft	Trosa	71,24	72,18
Vattenfall AB	Tyresö	76,38	78,63
	Täby		
Mariestad-TörebodaEnergi AB	Töreboda	61,36	61,36
Uddevalla Energi AB	Uddevalla	64,09	66,48
Ulricehamns Energi AB	Ulricehamn	73,10	75,80
Umeå Energi AB	Umeå	61,80	66,75
Fortum Värme AB:s m Stockholmsstad	Upplands Väsby	79,56	82,04
E.ON Nord	Upplands-Bro	75,90	75,90
Vattenfall AB	Uppsala	70,00	72,75
	Uppvidinge		
Rindi Energi AB	Vadstena	68,75	72,50
Vaggeryds Energi AB	Vaggeryd	63,96	66,46

Annex B: Heat Prices for small apartment buildings in Sweden, 2008 and 2009.

Neova AB	Valdemarsvik	72,50	75,38
E.ON Nord	Vallentuna	73,89	74,38
Rindi Energi AB	Vansbro	64,25	66,88
Vara Värme AB	Vara	68,13	68,13
Varberg Energi AB	Varberg	66,40	70,64
E.ON Nord	Vaxholm	73,89	74,38
Vetlanda Energi & Teknik AB	Vetlanda	70,45	76,06
E.ON Nord	Vilhelmina	67,45	71,20
Vimmerby Energi AB	Vimmerby	60,30	67,30
Skellefteå Kraft AB	Vindeln	73,45	78,82
Rindi EnergiAB	Vingåker	76,63	73,47
Rind i EnergiAB	Vårgårda	76,25	76,25
Vattenfall AB	Vänersborg	74,38	77,00
E.ON Nord	Vännäs	68,90	70,57
Vattenfall AB	Värmdö	79,50	79,50
Värnamo Energi AB	Värnamo	64,60	67,54
Västervi kMiljö & Energi AB	Västervik	60,79	63,89
Mälarenergi AB	Västerås	49,57	52,16
Växjö Energi AB	Växjö	58,64	60,03
	Ydre		
Ystad Energi AB	Ystad	72,14	75,89
Statkraft	Åmål	74,16	74,85
Ånge Energi AB	Ånge	77,38	77,38
Jämtkraft AB	Åre	59,73	66,49
Neova AB	Årjäng	77,30	80,25
Åsele Energi AB (Åsele)	Åsele	65,00	68,75
Tekniska Verken i Linköping AB	Åtvidaberg	69,40	72,25
E.ON Syd	Älmhult	68,28	70,29
	Älvdalen		
Bionär	Älvkarleby		
Älvsbyns Fjärrvärme	Älvsbyn	62,50	69,85
Öresundskraft AB	Ängelholm	65,50	66,26
	Öckerö		
Lantmännen Agrovärme AB	Ödeshög	82,53	88,75
E.ON Örebro	Örebro		74,10
Örkelljunga Fjärrvärmeverk AB	Örkelljunga	73,76	73,76
Övik Energi AB	Örnsköldsvik	64,55	67,76
Jämtkraft AB	Östersund	51,36	53,68
E.ON Nord	Österåker	73,89	74,38
Neova AB	Östhammar	79,38	78,86
	Östra Göinge		
Vattenfall AB . Norrlandsbolagen	Överkalix	70,38	75,25
Vattenfall AB. Norrlandsbolagen	Övertorneå	72,00	77,00

	medelpris ej volymviktat	**69,72**	**72,52**
	Max	**90,97**	**92,07**
	min	**40,53**	**41,78**
	std	**7,63**	**7,80**