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## Planning for a sustainable city region? Regional district heating in Stockholm

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## Planning for a sustainable city region? - Regional district heating in Stockholm

### Abstract

District heating is an old and established energy system in Sweden, accounting for 9 % of the national energy balance. The systems have traditionally been built, planned and managed by the municipalities and over the years the district heating systems in Stockholm have grown into each other and later been interconnected. This have led to that there today are three large systems with eight energy companies and the system can be considered a regional system. The strategy to create a regional system has existed for a long time from regional planning authorities. However, since the municipalities have planning monopoly the regional planning is weak. The overall aim for this study is to analyse the planning and development of an important regional energy system, the district heating system in Stockholm, to understand how the municipal and regional planning have related to each other. The study is conducted through studying municipal and regional plans in Stockholm's county between 1978 and 2010. The results show that district heating has been considered important all along and that a regional, or rather inter-municipal, perspective has existed throughout the period, although with large differences between different municipalities. Regional strategies for an interconnected system and combined heat and power plants have been realised gradually and district heating have throughout the period been considered important for different environmental reasons.

### 1 Introduction

In Sweden, district heating (DH) is an important part of the energy system, accounting for approximately 55 TWh of the annual energy supply of 612 TWh, and a 55% share of the total heating market.<sup>1</sup> In some cities, the district heating systems are old, well-established, and have developed into *regional energy systems*, with Stockholm being the foremost example. The first municipality-owned DH systems were built at the end of the 1940s and the

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<sup>1</sup> Swedish Energy Agency (2009), *Energiläget 2009*, Swedish Energy Agency: Stockholm, p. 63

beginning of the 1950s.<sup>2</sup> During the post-war era, Swedish cities went through a rapid population expansion, and the municipalities were given responsibility for the development of the built environment and technical infrastructure.<sup>3</sup> Obviously, the development of buildings and infrastructure occurs simultaneously, such as had happened in Stockholm during the planning of suburbs along with the new subway system.<sup>4</sup>

Between the mid-1960s and 1975, the Swedish “million program” was carried out, with a million apartments built to rectify the existing housing shortage. While building these areas (which were largely constructed by the municipalities), the DH system was expanded, thus binding customers to the municipally-owned energy utility. The building continued in the subsequent period, and although it did not occur at the same pace or scale, district heating systems grew rapidly, both nationally and in Stockholm.<sup>5</sup> A general trend was that small systems had grown and were then later *interconnected* to larger systems, mostly because of the economical advantages this provided. The economies of scale that could be generated in systems and plants is one of the reasons for this.<sup>6</sup> Since the construction of DH systems was first initiated in the municipalities, they at first naturally have a local extension. However, as they grew across municipal borders, they became regional, or at least inter-municipal.

Stockholm County<sup>7</sup> has a long tradition of (as well as specific legislation for) regional planning, which is carried out through regional plans released approximately every ten years. However, since Swedish municipalities have a tradition of strong local self-government as well as planning monopolies, regional planning in Sweden has typically been weak.<sup>8</sup> Stockholm County is no exception. The various regional plans that have been developed since the mid-1950s have in many cases been contested,<sup>9</sup> and since the regional plans are not legally binding, it has been difficult to get support from municipalities.<sup>10</sup> At the same time, the municipalities have cooperated in various groupings over the years, and the DH system today is an example of contemporary, concrete and functional regional cooperation. How is it

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<sup>2</sup> Werner, S. (1989), *Fjärrvärmens utvecklings och utbredning*, Värmeverksföreningen: Stockholm

<sup>3</sup> Hall, T. (1991), *Urban Planning in Sweden*, In: *Planning and Urban Growth in the Nordic Countries*, GB: Clays p. 197

<sup>4</sup> Hall, P. (2002), *Cities of Tomorrow*, Singapore: Blackwell Publishing p. 337

<sup>5</sup> Werner, S. (2007), *Low Carbon District Heat in Sweden*, Euroheat & Power 4(2007):4, 20-25

<sup>6</sup> Fredriksen, S. & Werner, S. (1993), *Fjärrvärme – Teori, teknik och funktion*, p. 101, Malmö: Studentlitteratur

<sup>7</sup> An administrative region consisting of 26 municipalities. In Sweden the counties are responsible for health care and regional planning and development.

<sup>8</sup> Nyström, J. (2003), *Planeringens grunder*, p 208 ff ; Nilsson, J-E. (2006), ”Regional planering i Sverige” In Blücher, G. & Graninger G. (Eds.) *Planering med nya förutsättningar : Ny lagstiftning, nya värderingar*, Linköping Interdisciplinary Studies No. 6, Linköping: Linköpings Universitet

<sup>9</sup> See for example Office of Regional Planning, Stockholm County Council, (RTK) (2002), *Stockholmsregionen – 50 år av regionplanering 1952-2002*; Hägglund, S. (1987), *Storstockholmsproblemet – dess uppkomst, politisering och lösning*

<sup>10</sup> Nyström, J. 2003, p. 208 ff

possible that cooperation has been achieved in the case of energy, more specifically in district heating? To understand the municipalities' planning with regard to energy and district heating, I have studied the municipalities' General plans (Generalplan) and Comprehensive plans (Översiktsplan) in Stockholm County between 1978 and 2010, a total of 76 plans. I have done so by focusing on two aspects: energy and district heating, and if a regional perspective on these matters is visible in the plans, or if they solely focus on the individual municipality. These plans were compared with the regional plans during the period (a total of 10) to identify similarities and differences.

Few earlier studies have been conducted on municipalities' energy planning,<sup>11</sup> and no studies have been done comparing regional and local plans while focusing on energy. As such, this study fills a gap in the literature. The study is also interesting because district heating is considered to be one of the primary climate change strategies in many municipalities,<sup>12</sup> and the DH system in Stockholm is one of the reasons why Stockholm was selected as Europe's environmental capital in 2010.<sup>13</sup>

The overall aim for this study is to analyse the planning and development of an important regional energy system, the district heating system in Stockholm, to understand how the municipal and regional planning have related to each other. By analysing and comparing regional and municipal plans, an understanding can be generated on whether a regional perspective has been present all along, or whether it came about by default.

## 2 Method

I studied Stockholm region (Stockholm County) municipalities' strategic plans, including General Plans, Comprehensive Plans, Regional Plans and Regional Energy Plans. The time period chosen is 1978 to 2010, since the regional energy company STOSEB (Greater Stockholm Energy Company) was founded in 1978,<sup>14</sup> a new Regional Plan was released that

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<sup>11</sup> For some examples see Djuric Illic, D., Henriksson, M & Magnusson, D. (2009), *Stockholms fjärrvärmenät idag och imorgon – en tvärvetenskaplig studie av ett regionalt energisystem*; Stenlund Nilsson, J. (2003), "Municipal energy-planning and development of local energy-systems", *Applied Energy*, vol 76 nr 1-3 (2003), 179-187 ; Lindquist, P (2000), *Lokala energistrategier. Integration av energi och miljö i fem svenska kommuner under 1990-talet*, Tema T Rapport 35, Linköpings universitet; Palm, J (2004), *Makten över energin – policyprocesser i två kommuner 1977-2001*, Linköping Studies in Arts and Science nr 289, Linköpings universitet; Palm, J, (2006), "Development of Sustainable Energy Systems in Swedish Municipalities: A Matter of Path Dependency and Power Relations", *Local Environment*, vol 11, nr 4, pp 445-457.

<sup>12</sup> The National Board of Housing, Building and Planning (Boverket) (2009), *God bebyggd miljö i kommunerna – Resultat från miljömålsenkäten 2006 – 2009*, Karlskrona: Boverket, p 43

<sup>13</sup> European Union (2010), homepage, <http://ec.europa.eu>, 2010-04-13

<sup>14</sup> STOSEB was a regional planning body with focus on energy, in which all municipalities in Stockholm County was a part. In the beginning 15 of the 26 was a member, although in the following years all municipalities became members. STOSEB carried out Regional Energy Plans through municipal cooperation and also arranged

year, and because during this period energy became an important subject in the municipalities following the oil crises in the 1970s.<sup>15</sup>

Also during this period, a change in planning legislation was introduced in 1987 with the new *Planning and Building Act* (PBA), thus creating more standardised planning for the municipalities. Prior to this, the municipalities' strategic plans could take many different forms, such as General Plans, Land Use plans or Development Plans.<sup>16</sup> Since the change in legislation, all municipalities have developed Comprehensive Plans.<sup>17</sup> This creates a limitation in the study, since prior to 1987 there was a difference in accepted planning documents between the municipalities. Moreover, some municipalities accepted two to four different plans, while others did not accept a single one. The material was gathered through the municipalities and a visit to the national archive, where the plans, both before and after 1987, are stored at the National Board of Housing, Building and Planning in Karlskrona. The plans were studied with focus on two aspects: how district heating and energy are discussed and included in the plans, both generally and from a regional perspective. Since the study is also longitudinal, it is possible to observe shifts taking place over the years, and see which measures have actually been carried out. In a study of this kind, one has to accept that the focus is on the planning documents, not the process, and thus it is not possible to answer questions about the decisions behind the plans (although the plans do show the municipalities' future strategies).

### 3 Stockholm County

Stockholm County shows significant heterogeneity in many aspects. While the central municipalities are densely built, others in the Stockholm archipelago are sparse (see Figure 1). The difference in population between the municipalities is large, with approximately 800,000 in the largest municipality (Stockholm), and 11,000 in the smallest (Vaxholm).<sup>18</sup> The extension of today's district system can also be seen in Figure 1, and consists of three large systems, the central-south, the northwest and the southeast.

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meetings regarding planning of the energy future. STOSEB was discontinued in 2003. Source: STOSEB (2003), *25 energiska år – Om Stor-Stockholms Energi AB*, Trosa: STOSEB

<sup>15</sup> Palm, J. (2006)

<sup>16</sup> The General Plans was legally binding documents, why few municipalities actually ratified them, although they often carried out the plan. That is the reason for the number of different types of plans. See Hall, T. (1991).

<sup>17</sup> The Comprehensive plan is not a legally binding document, although it's content and time frame are regulated in the PBA. It should be seen as a strategic plan. See Nyström, J. (2003).

<sup>18</sup> Statistics Sweden (SCB), (2010), *Tabeller över Sveriges befolkning 2008*, Örebro: SCB

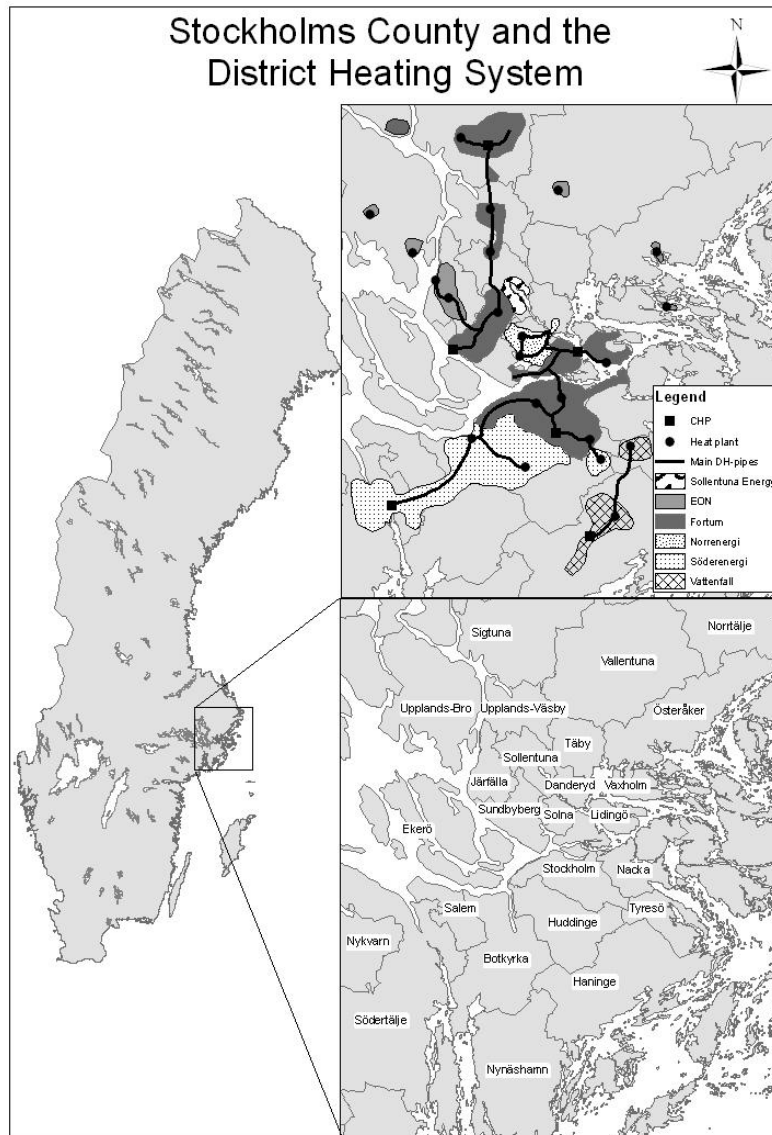


Figure 1. The municipalities in the Stockholm county and schematic picture over the DH-system.

## 4 Planning in Sweden

The research on planning in Sweden and internationally is often focused on the planning process. Thus, few studies focus solely on the plans. A few studies have analysed comprehensive plans after the introduction of the new PBA.<sup>19</sup> A general conclusion from these studies is a clear difference in both the quality and quantity of the municipalities' plans. While some municipalities used the plans as a vision, others planned because they had to. Few plans were as comprehensive as one would wish, and the

planning processes were not satisfactorily described.<sup>20</sup> Moreover, the plans are not legally binding, and are also rather vaguely formulated to keep options open for the future.<sup>21</sup> Other studies have focused more on specific aspects in the plans, such as water issues,<sup>22</sup> impact assessments,<sup>23</sup> and the presence of energy systems in the plans.<sup>24</sup> For the purposes of this

<sup>19</sup> See for example Nyström, J. 2003 & Khakee, A. 2000, *Samhällsplanering*, Lund: Studentlitteratur

<sup>20</sup> Khakee, A. (2000) ; Nyström, J. (2003)

<sup>21</sup> Nyström, J. (2003), p 181

<sup>22</sup> Gullstrand, M, Löwgren, M & Castensson, R. (2003), "Water issues in comprehensive planning: a review of the Motala River Basin", *Journal of Environmental Management* vol 69 nr 3 (2003) 239–247

<sup>23</sup> Åkerskog, A. (2006), Outputs from implementing impact assessment in Swedish comprehensive plans 1996-2002, pp. 117-131, In, Emmelin, L. (ed.) *Effective environmental tools - critical reflections on concepts and practice*, Research report, 2006:03, Blekinge Institute of Technology



study, the last study mentioned, performed by Björn Ekelund, is the most interesting; he found that mainly medium- or large-scale plants and networks (both existing and planned) are presented in the plans, and that the spatial impact of future energy systems is seldom presented.

As mentioned above, regional planning in Sweden is weak, and the impact of regional plans in Stockholm County has been marginal. Some of the explanations for this include the suggestion that the Stockholm region has always had a history of internal competition, with the municipality of Stockholm seen as the “big brother”, especially since the expansion of Stockholm municipality’s territory was followed by conflicts.<sup>25</sup> Other reasons for the weak impact of the regional plans have been the municipalities’ monopoly on planning, and the overall difference between the municipalities with regard to population, economy and political governance. The general opinion on regional planning has not been positive following conflicts regarding plans during the 1970s, and a lack of continuity in the plans.<sup>26</sup> Because of these problems, the most recent regional plans have employed a somewhat different approach, particularly with regard to the process. For example, efforts have been undertaken to gather the municipalities together, to include citizens in the process, and to make the plans more *strategic* than before.<sup>27</sup>

#### 4.1 Strategic planning of large technical systems

A number of studies have examined the development of infrastructure. Thomas P. Hughes introduced the field of large technical systems, and while studying the development of electrical systems he found that they developed in similar patterns and through phases: from invention and development to technological transfer, system growth, momentum, and finally consolidation. Different social groups are important in the different phases, and *system builders* have a crucial role in developing the system. In the momentum phase, the system has grown to a size that makes it more difficult to control development. Hughes and others, have concluded that large technical systems seem to have an inherent objective of expansion, since the load factor and economic mix of the system can be maximised by expanding systems, thus

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<sup>24</sup> Ekelund, B. (2006), *Rumslig legitimitet – när hållbar utveckling medvetandegörs*, Luleå: Luleå University of Technology, pp 86 ff

<sup>25</sup> Hägglund, S. (1987), pp 28 ff

<sup>26</sup> Nyström, J. (2003), p. 208

<sup>27</sup> Nyström, J. (2003), p 209 & Office of Regional Planning, Stockholm County Council , 2002 pp 34 ff

generating a maximum return on the investment. This occurs not only through expansion, but also through the *interconnection* of smaller systems.<sup>28</sup>

The development of infrastructure of this kind has a *strategic* dimension, and this is also true for most regional planning. This is not only the case in regional planning, as Khakee and Eckerberg<sup>29</sup> concluded that a transition from overall planning to strategic planning in Swedish municipalities may be needed. Albrecht<sup>30</sup> argues that all planning is generally heading from land use planning towards *strategic spatial planning*. Land use planning is still visible on a more detailed level, as can be seen in the Swedish Detailed Development Plans. However, following general structural changes—from government to governance as well as globalisation and privatisations—new demands are being put on planning. It is no longer possible to control development in the same way as before. It is therefore more important to involve a greater number of actors in the planning process, in order to identify common goals and a framework for spatial development. At the same time, Kitchen<sup>31</sup> argues that all planning has a strategic dimension since considerations and decisions regarding a specific development need to be made. What is specific about spatial strategising is that the goal is to form the dynamics around how city regions should be developed. The difficulty lies in picturing the whole unit in question: what and where is the city and what is its relationship to the systems that stream through the city? Similarly, Healey<sup>32</sup> believes that it is fundamental to understand the region as a whole and to involve all actors. However, she also argues that a problem with strategies that are more specific to the region is that only some of the strategies are actually implemented; their main focus is secure agreement among actors in the region to attract funding or to meet legal demands. Other strategies serve a political purpose, such as through rhetoric outlining the promises of a local government, or establishing already obvious directions.

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<sup>28</sup> Hughes, T. P. (1983), *Networks of Power: Electrification in Western Society 1880 – 1930*, Baltimore: Johns Hopkins University Press; Hughes, T.P. (1987) “The Evolution of Large Technical Systems”, In: *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, W. Bijker, T.P. Hughes & T. Pinch (eds.), Cambridge, Massachusetts, (1987), pp 51-82; Joerges, B. (1988), Large Technical Systems: Concepts and issues, In: Mayntz, R. & Hughes, T.P (1988), *The Development of Large Technical Systems*, Frankfurt: Campus Verlag ; Summerton, J. (1994). “Introductory Essay: The Systems Approach to Technological Change” In: Summerton, J. (1994) (Ed) *Changing Large Technical Systems*, Boulder, CO: Westview Press, pp. 1-21

<sup>29</sup> Khakee, A. & Eckerberg, K. (1992), “Metodik för konsekvensanalys av kommunal planering” In: Khakee, A. & Eckerberg, K. (1992) *Mellan lag och förväntningar – Översiktsplanering utvärderas*, Umeå: Umeå University, pp. 38-56

<sup>30</sup> Albrechts, L. (2004), Strategic (Spatial) Planning Reexamined, *Environment and Planning B: Planning and Design*, vol. 31 nr 5, pp. 743–758.

<sup>31</sup> Kitchen, T. (2007), *Skills for Planning Practice*, Basingstoke: Palgrave

<sup>32</sup> Healey, P. (2009), “In Search of the “Strategic” in Spatial Strategy Making”, *Planning Theory & Practice*, vol. 10, nr. 4, pp. 439-457



The empirical findings will be presented in the following section.

## 5 The development of the district heating system in the Stockholm region

I will start by presenting how the system has evolved from the late 1970s to today. The development will also be explained later by studying the regional and municipality plans. Figure 2 shows the development of the systems, and should be seen as relatively schematic, although they are correctly represented according to the maps in the regional plans.<sup>33</sup>

As can be seen, the development of the system has been relatively extensive. In 1978, the system consisted of small, isolated islands with district heating and relatively small plants. However, in some parts of the region the system was well-built early on, especially in Stockholm and in the southwest and southeast portions of the region. Some changes can be seen between 1978 and 1992: the systems grew and became *interconnected* (although some islands continued to exist). In the southwest, the systems were interconnected and have since developed into one system. Some smaller systems in the outer parts of the region have grown and some new ones have also been established during the period. The difference in 2010 compared to in the past is not the growth of the system (although most systems have expanded to some extent), but rather that the systems in the central part of the region have become interconnected. Today, this part of the region is supported by three larger systems, as compared to 1992, when there were 13 systems.

The development of the plants can also be seen. Most of the same plants that existed at the beginning of the period still exist, although some smaller ones are not used to the same extent and others have been phased out. Some new plants can be seen, but new sites are rare. One important new site, a CHP plant, can be seen in northern part of the region, where large interconnected networks also have been built.

The increase in the amount of energy produced in the system (the heat load) is relevant to the present in this part of the region. In 1978, the heat load was about 7 TWh per year, about 9 TWh in 1992, and by the end of the period it was 13 TWh per year.<sup>34</sup>

An important factor connected to this development is the market transition that occurred during the period. The deregulation of the electricity market started a transformation of the Swedish energy market, resulting in municipally-owned energy companies being acquired by

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<sup>33</sup> Plans used are: STOSEB (1981), *STOSEB 80*; STOSEB (1985), *STOSEB 85*; STOSEB (1992), *STOSEB 92*; RTK (2001), *Energiförsörjningen år 2000-2030 – Underlag till Regionplan 2000*; RTK (2009), *Regional utvecklingsplan för Stockholmsregionen –RUF 2010 - Utställningsförslag* and the energy companies (E.ON, 2010; Fortum, 2010; Vattenfall, 2010; Söderenergi, 2010; Södertörns fjärrvärme, 2010 & Norrenergi, 2010) homepages for details regarding the present system,

<sup>34</sup> STOSEB (1981); STOSEB (1992); RTK (2010)

## The Development of the District Heating Systems in Stockholm County - Networks of Heating

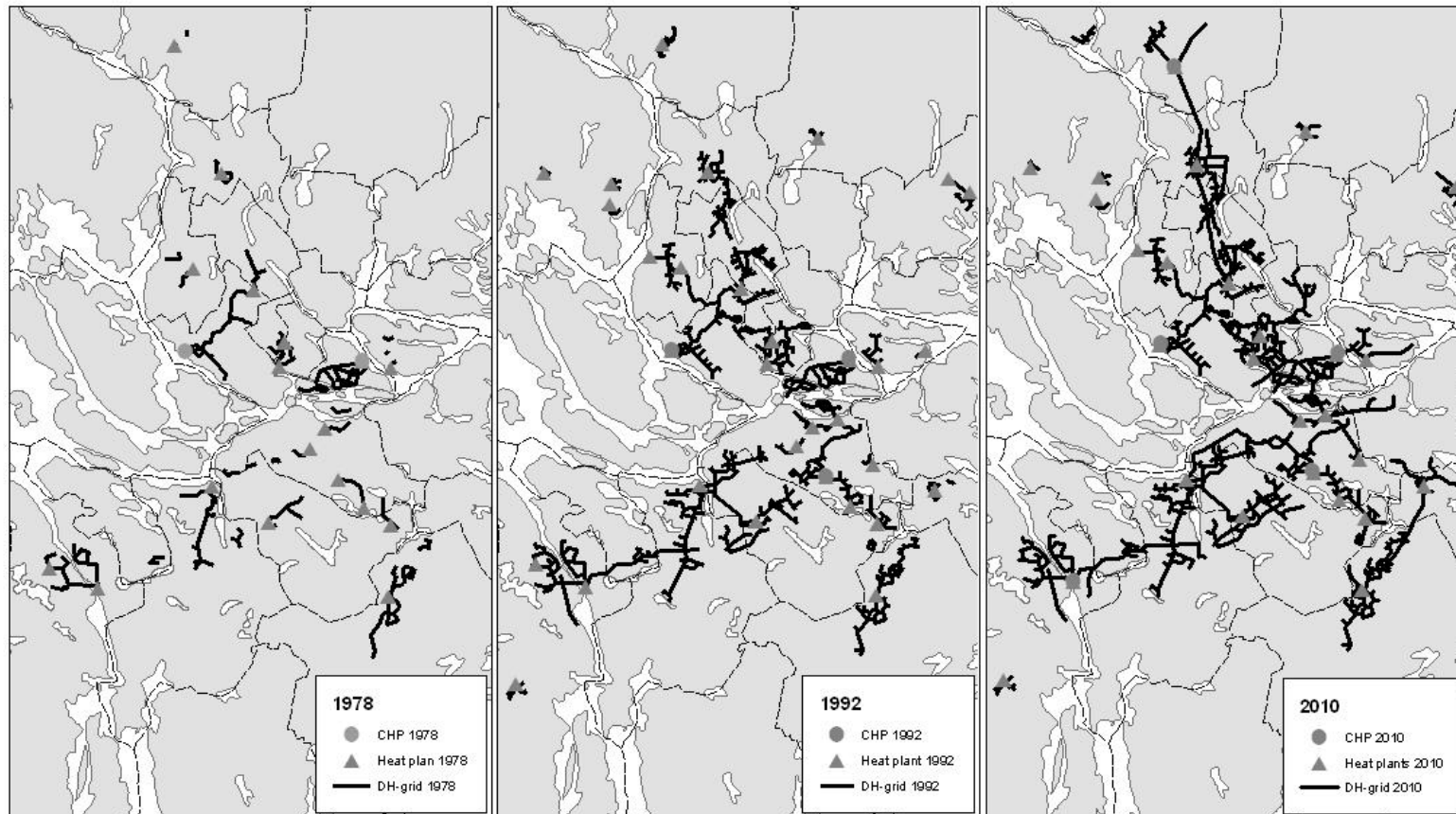


Figure 2. The development of the systems between 1978 and 2010. Source: STOSEB (1981); STOSEB (1985); STOSEB (1992); RTK (2001); RTK (2010)

private companies, and the establishment of larger, municipally-owned companies.<sup>35</sup> A similar shift has occurred in Stockholm County. In 1978, the municipalities owned most of the energy companies, although 11 of the municipalities with district heating today did not have systems at the time (all of these municipalities, however, have owned and sold companies over the period). The situation today is different, with ownership having become concentrated among five large companies (see Figure 1): Fortum (private, although 9% is owned by Stockholm municipality), the Söderenergi group<sup>36</sup> (owned by three municipalities in the southwest region), E.ON (private), Norrenergi (owned by the central municipalities Solna and Sundbyberg) and Vattenfall (owned by the state). Two small municipally-owned companies, Sollentuna and Norrtälje, also exist.

### 5.1 Regional planning in Stockholm

The following section will focus on the study of the regional plans. The regional energy plans and “the real” regional plans were produced at a similar pace in the 1970s, mid-1980s, the 1990s, and the early 2000s, and a new regional plan is about to be accepted. The content of the plans can be seen in the summary in Table 1; these represent the *strategies* often connected to the energy systems and district heating activities outlined in the plans.

The studied plans share some common features over the years, especially with regard to district heating: a vision to expand and interconnect the systems as well as to build CHP plants. This can, for example, be seen in the first conclusion in STOSEB 80:

*The Swedish Parliament has decided that 10,000 MW of nuclear power should be phased out by 2010. The best alternative as a substitute for the nuclear power should then be CHP. (...) as far as possible, the region's basis for heating should be utilised for electricity production in CHP plants. It is thus necessary to create large interconnected district heating systems.*<sup>37</sup>

The desire to establish large interconnected systems, as well as the aim of building larger CHP power plants, can be seen in the 2001 regional plans:

*Aim: Reserve land for bio-fueled CHP plants (...) Expand and interconnect the district heating systems.*<sup>38</sup>

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<sup>35</sup> See Bladh, M. (2002); Högeslius, P. & Kaijser, A. (2007)

<sup>36</sup> Consists of three companies, Söderenergi, that produces energy for the distributing companies that is Södertörns Fjärrvärme and Telge Nät. These companies are joint owned by three municipalities in the region.

<sup>37</sup> STOSEB (1980), p. 165, my translation

<sup>38</sup> RTK (2001), p. 88, my translation

Table 1. Content and strategies in the regional plans with regard to district heating and energy. Source: STOSEB (1981); RTK (1982), *Regionplan 1978 för kommunerna i Stockholms län*; STOSEB (1985); RTK (1985), *Skiss 85*; STOSEB (1992); RTK (1991), *Regionplan 1991 för Stockholms län*; RTK (2002), *Regional utvecklingsplan 2001 för Stockholmsregionen – RUF5 2001*; RTK (2001); RTK (2009), *Stockholmsregionens energiframtid 2010-2050 – Vägen till minskad klimatpåverkan*

<b>Subject</b>	<b>Late 1970s</b>	<b>Mid-1980s</b>	<b>Early 1990s</b>	<b>Early 2000s</b>	<b>Late 2000s</b>
<b>District heating</b>	Expansion and interconnection of DH systems; prepare for future CHP; in the future all dense areas should have DH and take advantage of economies of scale	Expansion and interconnection of DH systems; prepare for future CHP; it is important to investigate possibilities for new plants and take advantage of economies of scale	Expansion and interconnection of DH systems; build CHP; it is important to save existing plants and investigate possibilities for new plants	Interconnection of DH systems; try to expand systems if possible; reserve land for bio-CHP and plan the built environment in cores with existing DH systems	Expand, strengthen and interconnect DH systems; build CHP; take advantage of district heating's economical and environmental benefits and plan new production capacity carefully due to reduced heating demands
<b>Fuel and energy production</b>	Fuel security; insecurity regarding oil in the future; insecure future nuclear power; prepare for independent energy production and plan for more energy production	Fuel transition—oil to coal and electricity in DH; waste as fuel; importance of technical systems; higher-delivering security and capacity; insecure future nuclear power; higher energy efficiency and natural gas in the future	Waste and bio-fuel; waste as fuel in northern Stockholm; system renewal and development; insecure future nuclear power; energy efficiency; environmentally-friendly energy production and natural gas	Waste and bio-fuel; sustainable systems; renewable and local energy production; energy efficiency	More renewable energy; reduce energy consumption
<b>Environment</b>	Pollution caused by oil	Environmental problems	Environmental problems	Climate change	Climate change
<b>Special issues</b>	Excess heat from nuclear power plant		Insecurity regarding possible deregulation of the electricity market		Third party access in district heating systems

A shift from oil for powering the plants to bio-fuel can be seen, and the attitude towards the environment has changed from being a marginal problem to a central concern. The role seen for district heating in a more sustainable future is obvious, particularly in the most recent (2010) plans, where district heating is mentioned as an important part of regional climate strategies:

*The transition of the energy supply shall continue. Basically all energy supply should consist of renewable energy sources by 2050, in order to be able to reduce the region's effect on the climate. The region's district heating system should be used even more.,<sup>39</sup>*

The first part of the study has shown that the DH systems in the central part of region have grown together into regional systems today. The regional plans also show a constant desire to extend and interconnect the individual systems. As will be shown in the next section, however, the regional focus in the municipalities' plans shifts significantly.

## **6 Planning in the municipalities**

The district heating and energy-related portions of the municipalities' plans can be divided into two parts: a regional perspective on district heating, and attitudes towards energy planning.

Most plans presented a general description of the existing system and its plants. The municipality's vision for expansion and new plants is also often presented, and related to the general theme about the municipality's energy future. In addition, the regional perspective is interesting because of the important regional vision for the interconnection of the systems.

### **6.1 Regional perspective on district heating**

One of the first things to be established is the heterogeneity in the region. While the central municipalities have a dense structure—as well as the problems and opportunities that come with this—the peripheral municipalities have a different structure. These areas have sparse infrastructure, small populations, are often located in the archipelago, and are a significant distance from the regional core. By definition, these municipalities have small, local technical systems and thus do not have a regional perspective on district heating systems.

Some municipalities have employed an inter-municipal, or regional, perspective throughout almost all of their plans, from the start of the period to the end. This is most

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<sup>39</sup> RTK (2010), p. 21, my translation

evident in the plans from municipalities in the southwest, as well as some in the centre. Two examples include the plans for Huddinge in 1978 and for Solna in 1990:

*In the longer term the aim is to integrate the DH plants in Huddinge with a greater Stockholm-interconnected system.*<sup>40</sup>

*Technical production systems (e.g., energy, waste, water and sewage) have, and should, to a large extent have regional solutions.*<sup>41</sup>

These municipalities have in common that they had well-built systems to start with (see Figure 2), and they established energy companies jointly owned with neighboring municipalities early on; Huddinge created one in 1970, and although Solna and Sundbyberg established Norrenergi in 1993, the systems were already interconnected prior to 1978.

One important observation is that, until its most recent plan, the municipality of Stockholm did not describe the district heating system as anything but a local system. While this is somewhat of a contradiction (Stockholm Energy and later Birka Energy/Fortum have been the actors responsible for most of the system's interconnectedness since they are the central hub), this may have a number of explanations. First, the systems are primarily local, particularly earlier in the period studied. Second, the comprehensive plans are also strategic documents and what is stated (or not stated) in the plans does not necessarily reflect the entire picture. As is clear, the energy company has long held the goal of expanding regionally; in a plan of this kind, however, the phrasing of text on district heating and future plans seems to be prepared carefully.

Two municipalities that have shown greater regional perspectives in their more recent plans are Södertälje and Sigtuna, in the south and north, respectively (see Figure 1). While these municipalities are both situated in the outer parts of the region, as the built environment has expanded further outwards and competition for land has become a larger problem in the centre, these outer municipalities have become increasingly important for the region from a supply perspective. The large Igelsta plant in Södertälje was built in 1983, and then connected with Botkyrka as an important part of their heat supply.

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<sup>40</sup> Huddinge kommun (1978), *Generalplan Huddinge -förutsättningar*, 1978, p. 5 my translation

<sup>41</sup> Solna stad (1990), *Översiktsplan Solna 1990*, p. 28, my translation



*The plant of Igelsta in Södertälje can produce all DH needed in Botkyrka as well, as long as the temperature is higher than -5 degrees Celsius.<sup>42</sup>*

A bio-fueled CHP plant was built in Södertälje over 2008–2010, and is becoming increasingly important for the supply of the whole southern part of the region—a development that some of the concerned municipalities have been mentioning in their plans. Södertälje has identified the possibility of building a CHP plant from 1990 onwards, and in their most recent plan (2004) they mentioned the regional importance of a CHP plant, and reserved land for the plant:

*In regional plans it is pointed out that seven plants in the region is interesting for transformation into bio-fuelled CHP plants in the future. This would be enough to be able to satisfy the region's long-term energy supply. Igelsta is one of these plants.<sup>43</sup>*

In the north, Sigtuna has become more important in a similar way. Its plant, Brista, was built between 1994 and 1996, and the goal of expanding and interconnecting the system was a key feature of their plans thereafter (indeed, it was identified in their plans before the plant was even constructed). The plans discussed the need for a regional energy plant and although the first potential site for the plant was not approved, Brista was built as a regional plant powered by bio-fuel. While these two municipalities were willing to build regional plants, some central municipalities were not as willing. As seen above, Solna's plan stated that regional plants should be located in the sparser outer areas; Upplands-Väsby and Sollentuna also rejected large, regional plants, despite the fact that STOSEB identified sites in the municipalities as strategic for CHP:

*That of RUFs suggested bio-fueled plant in Vällsta, which have previously been denied by the municipality.<sup>44</sup>*

*If a new large-scale energy production plant is suggested, it should firstly be located at Brista, and secondly at Vällsta. No new large-scale energy production plant shall be sited in Sollentuna.<sup>45</sup>*

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<sup>42</sup> Botkyrka kommun (1990), *Översiktsplan Botkyrka 1990*, p 28, my translation

<sup>43</sup> Södertälje kommun (2004), *Översiktsplan Södertälje 2004*, p. 24, my translation

<sup>44</sup> Upplands Väsby kommun (2005), *Översiktsplan Upplands Väsby 2005*, p. 106, my translation

<sup>45</sup> Sollentuna kommun (2002), *Översiktsplan Sollentuna 2002*, p. 38, my translation



This would indicate that, in some cases, the regional perspective seen in plans is mostly rhetoric used to avoid building in the municipalities' own areas; the regional perspective becomes a useful excuse.

It is evident that basically all plans generally became more regional in their approach in the latter years of the studied time period. At the beginning of the period, most plans were focused only on the municipality in question, and only briefly mentioned the region and neighbouring municipalities. In the later part of the period, regional plans are mentioned more often, as is the notion of cooperation with other municipalities. A more regional approach to the district heating system is thus not surprising; they are also regional systems. However, although "regional planning" is mentioned often even in the earlier plans, STOSEB is very rarely mentioned. When it is mentioned, it is mostly linked to the possible introduction of natural gas (since a large investigation into this issue was). This being the case, however, the municipalities were legally obligated to describe the natural gas systems in their plans since they were of national interest.

## **6.2 Planning for district heating in the municipalities**

As identified above, some municipalities employ a regional perspective on district heating. However, their foremost focus has been their own systems, with less focus placed on neighbouring systems. A significant difference between the municipalities' description of future and existing systems can be seen, with some of the municipalities even mentioning district heating from a inter-municipal or regional perspective early on. In other municipalities, district heating is hardly mentioned at all during the entire period. The strategies (or lack thereof) expressed in the plans reflect the actual development of the municipalities' systems relatively well—those municipalities that gave more attention to their existing and future DH systems are the ones with the most district heating today. These are generally the same municipalities as the ones that employed a regional perspective, although this is also evident early on in other municipalities:

*It is going to be important to increase energy efficiency in the existing areas. To build new houses in areas with existing district heating today is one way. Industrial areas and new housing areas can also be connected to the district heating system.<sup>46</sup>*

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<sup>46</sup> Haninge kommun (1980), *Kommunplan Haninge 1980*, p 9, my translation

This demonstrates the importance of an early vision of expansion, and the importance of combining expansion of the city with expansion of the technical systems that support this growth. In many plans, both older and newer, municipalities expressed a goal of ensuring that new buildings should have district heating. In the later plans, this is linked to contributing to a climate strategy, since district heating is considered to be good for the climate and for city air:

*However, significant efforts by the city and those who live and work in Stockholm have been undertaken to reach the goal of a fossil fuel-free city by the year 2050. The city's main strategy is to make use of "big city advantages" concerning expansion of district heating and attractive public transport.<sup>47</sup>*

*A developed district heating system results in healthier air.<sup>48</sup>*

The notion that district heating is considered positive for the environment can also be seen in the fact that district heating is mentioned in combination with the aim of building more compact cities. This is both a Swedish trend<sup>49</sup> but also a directive from the European Union,<sup>50</sup> by planning more densely and in already built areas, it is possible to use existing and future technical systems, services and public transport systems more effectively and thus use less energy generally. In this planning discussion, district heating is often mentioned as one of the most important technical systems:

*Building compact and in the central part of the region to which Solna belongs, as well as in the paths used by public transport, favours the use of district heating since the systems are already built.<sup>51</sup>*

That there is a connection between district heating and density is evident, since the denser an area is, the more efficient system the system that support it is. This notion is often expressed in the municipal plans, which point to the fact that even though a general aim of expansion exists, the density of the buildings is important to the possibility of connecting to district heating. The expansion of the system to single houses has not been as successive as expansion

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<sup>47</sup> Stockholms stad (2008), *Översiktsplan Stockholm 2008 - utställningsförslag*, p. 7, my translation

<sup>48</sup> Upplands Väsby kommun (2005), p. 145, my own translation

<sup>49</sup> See for example Boverket (2004), *Hållbara städer och tätorter i Sverige – förslag till strategi*, Karlskrona: Boverket; Johansson, B. (2001) *Stadens tekniska system – Naturresurser i kretslopp*, Stockholm: Formas

<sup>50</sup> Commission of the European Communities, (1990). *Green paper on the urban environment*

<sup>51</sup> Solna Stad (2006), *Översiktsplan Solna 2006*, p. 106, my translation

to multi-dwelling units. Indeed, the plans often point out that these areas are often too sparse to use district heating, which is one explanation for why municipalities in the northeastern part of the region do not have large systems.

Another factor pointing towards the importance of district heating is the fact that the system has been connected to different energy questions over the years. At the beginning of the studied time period, the primary aim was reducing oil consumption, as the price of oil was considered a problem following the oil crises, as was air pollution. More recently, climate change is positioned as the major reason for reducing oil consumption.

The earlier plans never described which fuel was used to power the DH plants, although it was oil during that period. Many plans expressed a goal of reducing electricity usage, and that electricity should not be used for heating, especially for municipalities with DH systems.

*The municipality shall act towards reduced electricity use for heating and contribute to the use of alternative energy sources.<sup>52</sup>*

*It is important that electricity from resistance heating decreases.<sup>53</sup>*

How the municipalities describe their DH plants and fuel use over the duration of the period studied also reflects attitudes towards the system. Throughout the period, most municipalities describe their systems; some only mention it while others describe it thoroughly (although the focus is often on the larger plants, similar to what Ekelund described in his study). Early on, however, the fuel used by the plants was seldom (or never) described. This can probably be explained by the fact that most of the plants used oil and that this was not really a concern at the time. Later on, however, the fuel used by the plants has been well described, especially for those municipalities with bio-fueled plants:

*The heating that SFAB (Södertörns District Heating) delivers comes mainly from the Igelsta plant in Södertälje, where bio-fuels are the dominant fuel used.<sup>54</sup>*

*The majority of district heating is produced at Solnaverket, where four heat pumps use the excess heat from purified sewage water.<sup>55</sup>*

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<sup>52</sup> Järfälla kommun (2001), *Översiktsplan Järfälla 2001*, p. 79, my translation

<sup>53</sup> Tyresö kommun (2008), *Översiktsplan Tyresö 2008*, p. 24, my translation

<sup>54</sup> Botkyrka kommun (2002), *Översiktsplan Botkyrka 2002*, p. 28, my translation

<sup>55</sup> Solna stad (2006), p. 106, my own translation

Even though many plans today often focus on describing the positive side of their district heating systems (e.g., that they use mostly bio-fuel), many also describe the plants used for peak loads, which often use oil as fuel.

One aspect rarely discussed in the plans is energy supply security in general and DH in particular. The central municipalities never mention it, while municipalities in the outer parts of the region do mention it occasionally.

*The municipality shall work for a secure and sufficient energy supply for households, companies and other businesses.*<sup>56</sup>

One important exception among the central municipalities is Stockholm, which in its more recent plans has expressed the importance of saving existing plants and saving land for future plans. The importance of effective and sufficient technical systems is also emphasised, probably due to strong competition for land in the municipality (which makes new land with a sufficient protection zone rare) and, simultaneously, the steady encroachment of the built environment to the existing plants.

In the latest plans, a number of municipalities are planning for new district heating plants. Reservation or expressed interest for new plants can be seen in 8 plans of which 6 is CHPs.<sup>57</sup>

## 7 Concluding discussion

I will summarise and conclude the discussion in this final section. One of the most important factors identified in the paper is the fact that most plans describe and discuss district heating, and that the descriptions seem to become more detailed later in the studied time period. The municipalities seem to consider district heating as being important, since there is a need for heating and since it provides a system that is environmentally friendly, centralised and large-scale, and brings in money to the municipality (at least when the energy companies were still owned by the municipalities). The goal of expanding the system has been present in many municipalities for a long time, and strategies for doing so have generally succeeded. There is a difference, however, between the municipalities—particularly between the central and

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<sup>56</sup> Norrtälje kommun (1990), *Översiktsplan Norrtälje 1990*, p. 21, my translation

<sup>57</sup> The municipalities are: Sundbyberg, Haninge, Stockholm, Täby, Österåker, Nacka, Södertälje and Sigtuna. Some of them, for example Södertälje, have already built the plant. There is a difference in when the latest plan are released.

peripheral municipalities—and this is evident in the plans when discussing district heating and energy.

As the systems have grown, they have grown into each other; the systems have become interconnected. Seen from a large technical systems perspective, these systems have effectively grown based on their own momentum, and are thus generating a higher load factor. The system builders met as part of STOSEB to create the strategies necessary for the development of the systems. Expansion goals and the building of CHPs have been expressed in different regional plans' strategies for interconnection, and these goals have recently been realised to a large extent. This has led to the regional system we see today.

However, even if the strategies expressed largely at the regional level have been carried out, it is debatable as to whether it is *because* of these strategies that the system is shaped as it is today. This may not be the case given the history of weak regional planning, although some municipalities have held an inter-municipal or regional perspective for a long time. This is probably because of a tradition of cooperation, since some municipalities have cooperated on other questions; technical systems is “just” another area of cooperation. These systems have then been interconnected because of the technical and economical advantages of doing so, and joint companies have been created in some cases. However, the main interconnections—which in fact have created today's large systems—have in most cases been carried out by one actor: Stockholm's energy company. The fact that, for example, the Norrenergi and Fortums systems are interconnected today is not due to the influence of the municipalities in the south, but rather due to neighbouring municipalities' energy companies.

Some of the important regional strategies have, however, been implemented. The bio-fuelled CHP plants in the north and south are two important examples. A long-term aim for regional plants was realised through these plants, and since the central municipalities rejected plants, these municipalities have taken on a regional responsibility. The central municipalities have also used the regional perspective as an excuse to not build plants, and thus it is interesting that these municipalities ultimately accepted them. However, since this study has only focused on the municipal plans, the decision-making behind their development cannot be explained.

Although the regional perspective can be questioned, the importance of the technical systems is self-evident. Historically, the planning of buildings and district heating has been conducted simultaneously, and to some extent this goal can be seen over the studied period as well. Since the technical systems are also important, although the plants are often seen as disturbing for people living nearby, for some municipalities it has been important to stress the

importance of maintaining them in the future. District heating is also important from an environmental perspective; as a factor in contributing to cleaner city air, district heating today has also become an important part of municipalities' climate strategies. One of the explanations for this is probably that it is an “easy” way to make a big impact, since changing fuel type has a large influence on emissions. It is also obvious that a shift from a demand perspective to a more efficient perspective have occurred in the municipalities over the period, although this has also occurred at the regional level.

The strategy of building CHP plants in the region has taken a long time to fulfil. In the last part of the studied period, however, two important plants have been built, and many more are outlined in the most recent plans. This demonstrates the inertia and the lengthy process involved in building plants for a city region. Moreover, even if there has been a regional and/or national strategy to find an alternative to nuclear power, the time has not been right up until now. The reasons for this being realised now could include higher electricity prices (and thus higher profits), but also the reality that the most recent regional plans highlight the fact that they cannot expect the system to grow much more in the region. As such, the CHP plants are becoming an important way of maintaining high profits.

To summarise, even if one can argue whether the development of the system has been focused on regional systems from the start, the system today is undoubtedly regional. The new market structure that exists today (as compared to when the system was developed) raises new questions regarding cooperation in the system. The system has significant potential for reducing greenhouse gas emissions and producing electricity; through cooperation between regional and municipal actors and, first and foremost, energy companies, the system can be operated and developed as efficiently as possible.

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