Institutions in strategic niche management –

The case of low temperature two-way district heating innovation of Skanssi

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Tiivistelmä – Referat – Abstract

Murroskirjallisuus tutkii yhteiskunnan kestävyyteen liittyviä haasteita ja tarjoaa niihin ratkaisuja luomalla kestävyysvisioita. Energiajärjestelmän murros on välttämätöntä ilmastonmuutoksen vaikutuksien lieventämisessä ja kestävän elämäntavan saavuttamisessa. Kaukolämpö on keskeinen osa suomalaista energiajärjestelmää ja suurin osa lämmöstä tuotetaan fossiilisilla polttoaineilla.

Tapaustutkimus käsittelee Turun Skanssin alueelle toteutettavaa matalalämpöistä ja kaksisuuntaista kaukolämpökokeilua. Paikalliset kokeilut, ns. niche innovaatiot, ovat yhteiskunnallisten murrosten lähtökohtia, jotka luovat visioita kestävistä vaihtoehdoista. Vaihtoehtoisten ja kestävien järjestelmien leviämisen ja käyttöönoton haasteena ovat erilaiset hidasteet, kuten institutionalisoituneet käytännöt. Tutkimuksen tavoitteena on tarkastella Skanssin kaukolämpökokeilua murroskirjallisuutta hyödyntäen, sekä tarkastella sen toimeenpanoon vaikuttaneita instituutioita.

Tutkimusmateriaali kerättiin haastattelemalla paikallisen kaukolämpökokeilun suunnittelun ja toimeenpanon keskeisimpiä toimijoita. Haastatteluaineisto analysoitiin teoriaohjaavaa sisällönanalyysiä hyödyntämällä. Haastatteluaineiston lisäksi sekundaariaineistona hyödynnettiin internetistä löytyvää materiaalia.

Kaukolämpökokeilu aloitettiin energiayhtiön ja kaupungin toimesta. Kokeilua kohtaan oli useita odotuksia, kuten energiajärjestelmän päästöjen vähentäminen ja hajautetun lämmöntuotannon järjestäminen Skanssin alueelle. Kokeilun toimeenpano oli pysähtynyt vuonna 2018 ja kaksisuuntaista järjestelmää ei oltu saatu aikaan. Skanssin hidas rakentuminen hidasti myös kaukolämpökokeilun toimeenpanoa. Lisäksi useat regulatiiviset, normatiiviset ja kulttuuris-kognitiiviset instituutiot vaikuttivat kaukolämpökokeilun suunnitteluun ja toimeenpanoon. Kaksisuuntaista järjestelmää käsittelevää sääntelyä ei ollut olemassa, mikä lisäsi epävarmuutta kokeiluun. Lisäksi kokeilu ei vastannut asukkaiden tai rakennuttajien vakiintuneita toimintatapoja, rooleja tai kiinnostuksen kohteita.

Tulokset osoittavat, että kaksisuuntainen kaukolämpö on vielä vakiintumaton osa energiajärjestelmää ja täten sen toimeenpano on hidasta ja epävarmaa. Aineiston keräämisen jälkeen kaukolämpöalalla on tapahtunut muutoksia ja näillä muutoksilla voi olla vaikutusta myös Skanssin paikallisen kokeilun kehittymiseen. Paikalliset kokeilut ovat keskeisiä energiamurroksen edistämiselle, joten olisi tärkeää, että kaukolämpökokeilua jatketaan alueella.

Avainsanat – Nyckelord – Keywords

energiamurros, kestävyysmurros, kokeilut, instituutiot, kaukolämpö, tapaustutkimus

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Tiivistelmä – Referat – Abstract

Sustainability transitions literature addresses societal challenges relating to sustainability and offers alternative visions as solutions. Transition of the energy system is central in mitigating climate change and attaining sustainability. District heating is a fundamental part of the Finnish energy system, and the majority of heat is produced with fossil fuels.

This case study investigates the low temperature and two-way district heating experiment of Skanssi in Turku. Transitions evolve from local experiments i.e. niche innovations, which propose visions of sustainable alternatives. The implementation and diffusion of these alternatives is challenged by various hindrances, such as institutionalized practices. The aim of the study is to investigate the district heating experiment of Skanssi by utilizing sustainability transition literature. In addition, the study examines the institutions that hampered the implementation of the local niche innovation.

The research data was collected by interviewing the central actors related to the development and implementation of the local district heating experiment. The interview data was analyzed using theory-guided content analysis. Internet based material of the case was utilized as secondary data.

The local district heating experiment was initiated by the regional energy company in cooperation with the city of Turku. The experiment was expected to decrease greenhouse gas emissions and to provide decentralized heat production in the Skanssi area. The implementation of the experiment had halted in 2018, and a two-way heating system had not been realized. Slow construction of the houses in the area hindered the implementation of the experiment. In addition various regulative, normative and cultural-cognitive institutions effected the planning and implementation of the experiment. The lack of regulation concerning two-way heating systems increased uncertainty around the experiment. Furthermore, the experiment did not suit the practices, roles and interests of both the inhabitants and housing developers.

The findings show that two-way district heating systems are still highly uncommon, and thus their implementation is inert and uncertain. After the data collection of this study there have been changes in the district heat sector, which may have influenced the development of the experiment in Skanssi. Since local experiments are essential in advancing the energy transition, it would be important to continue implementation of the local district heating experiment.

Avainsanat – Nyckelord – Keywords

energy transition, sustainability transition, experiments, institutions, district heating, case study

Contents

Introduction

Climate change, decreasing natural resources and urbanization pose new global challenges. Current lifestyles, especially in the western countries, now highly exceed the sustainable limits of planetary boundaries (see e.g. Steffen et al., 2015; WWF, 2018). As a consequence, societal systems and practices of everyday life must be transformed in order to live in a sustainable equilibrium. Even though the famous Brundtland report discussing sustainable development was published already in 1987, it is only in recent years that clear and ambitious climate targets have been set. For instance, the European Union seeks carbon neutrality by 2050 (COM, 2018). Finland has the same goal, but is aiming already for the year 2035 (Osallistava ja osaava Suomi, 2019). In order to reach these ambitious climate targets, emissions need to be reduced in every area of life.

Academic literature concerning sustainability transitions has evolved to tackle the wicked environmental problems of the 21st century. Sustainability transition research investigates societal systems, such as mobility or energy systems, and envisions how to transform these systems sustainable. These evolutionary visions, called transitions, propose a process of shifting from the current, unsustainable system to a sustainable one. Transition literature views the change as holistically: all dimensions of the current system, such as lifestyles, businesses and technologies, need to be transformed to achieve a sustainable system. (Geels & Schot, 2010, 11-12.)

A transition of the energy system is essential in achieving political climate targets. Three quarters of the total greenhouse gas emissions were caused by energy use in Finland in 2015 (SVT, 2016). 25 % end-use of energy was utilized for space heating (SVT, 2019). Thus, energy and heat consumption are major sources of carbon emissions, both at the societal and the individual total emission levels. Urbanization in particular forces us to develop new and sustainable forms of energy production (New Urban Agenda, 2017).

District heating is the most common technology for household heating in Finland (Energiateollisuus, 2019A). This cornerstone of the Finnish energy system is still highly dependent on the use of fossil fuels: natural gas, peat and coal still constitute about half of the raw materials of district heat production (see Figure 1). However, small openings can be seen at the district heating sector, which hints towards an increased interest in sustainability. For instance, the use of waste heat as a district heat source has increased (Energiateollisuus, 2019C) and a Finnish energy company has a pilot using deep geothermal energy as a heat source in the district heat system (St1, 2019). In addition, the owners

of an apartment building have begun to sell and distribute surplus heat to the district heat grid of a regional energy company (Talonyhtiö aloittaa…, 2017).

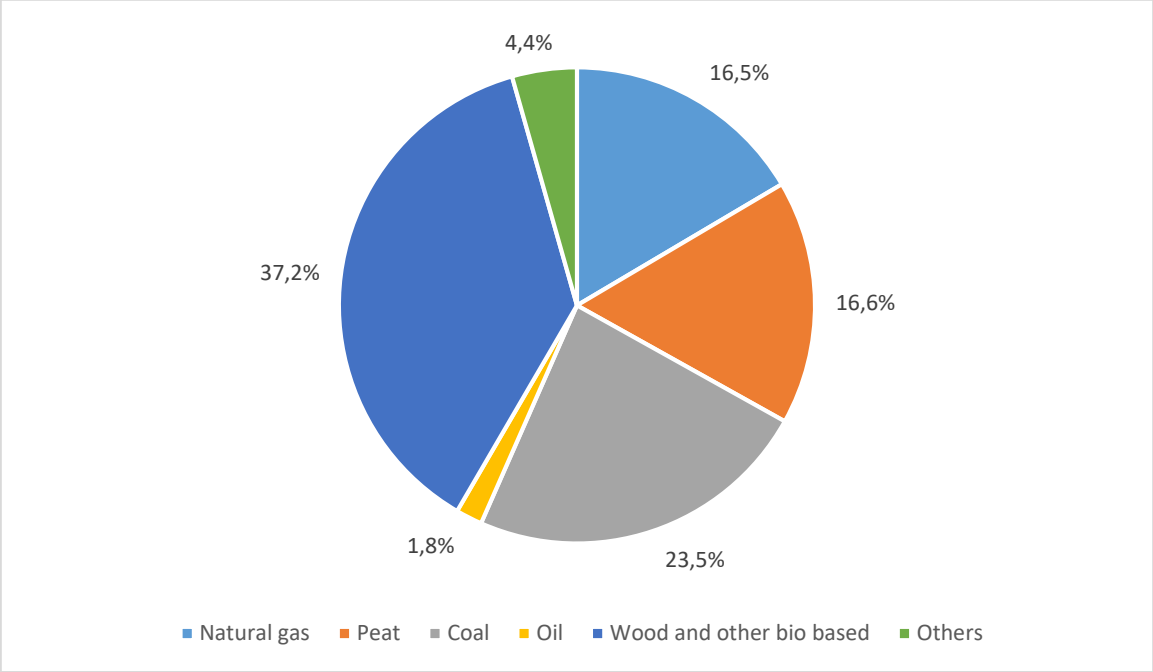

Figure 1 Raw materials of district heat procurement and CHP production in 2018 in Finland. Source: Energiateollisuus 2019C.

According to sustainability transition literature, a transition evolves from an experimental place called a niche. A niche is a protected place, where sustainable innovations and alternative methods of operation are developed and nurtured. Slowly, the niche innovations come into use, begin to contest the unsustainable system and eventually transform it. (Hoogma et al., 2002.) Strategic niche management (SNM) literature (see e.g. Kemp et al., 1998; Schot & Geels, 2008) has evolved to investigate the development of sustainable niche innovations, and it has become a widely used theoretical framework for investigating real life cases. The SNM framework can be used to investigate the conditions and management of a sustainable innovation, and to analyse how the innovation can be shaped to successfully transition the unsustainable system.

The empirical case of this master's thesis is a sustainable niche innovation: the low temperature and two-way district heating experiment in the Skanssi neighbourhood. The innovation creates a vision of a sustainable district heating system through a local experiment. The target of the experiment is to decentralize district heat production by installing renewable heat production into the area of Skanssi. Furthermore, the district heating grid at Skanssi is separated from the general grid by a heat exchanger. As a result, the water temperature in the local grid of Skanssi is only +65 °C. Renewable heat production technologies attain that temperature far more efficiently than +115 °C, which is the conventional temperature in the district heat grid.

As a result, district heat production with renewable energy resources is expected to be much easier in Skanssi. In sum, the experiment aims for a systemic change of the district heating (from now on DH) system. The target is to make the inhabitants of Skanssi into both consumers and producers of heat. The target is also to transform the technological system. Thus, the innovation and its practices differ significantly from the accustomed DH system.

Low water temperature in the DH grid and the two-way DH production and consumption would be a major improvement towards a more sustainable DH system. Similar visions of the transformation of the district heating system have been proposed by Auvinen (2017), Paiho & Saastamoinen (2018) and Schmidt et al. (2017) for example. Lower temperature in the DH grid would improve energy efficiency and decrease heat losses. In addition, it would significantly improve the utilization of renewable energy resources. (Scmidt et al., 2017.) Normally the water temperature of the DH grid varies between 105 to 125 degrees in Finland, and these temperatures are seldom attained by renewable heat production technologies.

Auvinen (2017) sees that DH networks of large cities should be opened for small scale production in a similar manner as with the electricity grids. Nowadays anyone can start producing electricity and sell it to the general electricity grid, and the electricity companies are obligated to buy the energy for a certain price. However, Auvinen (2017) views that the transition of the two-way DH system should be organized in a market-driven way, where private production would be competitive with the larger units. This market-driven transition could be attained by separating the ownership of the DH grid from the ownership of large DH production units in order to avoid a monopoly position in the heat markets (Auvinen, 2017).

Energy systems have been noted to be highly complex and interdependent systems (see Unruh, 2000), which makes the sustainability transition of the DH system challenging. The concept of a socio-technical system is often used to describe the holistic character of a transition. Sustainability transitions affect not only the technological artefacts or infrastructures, but also cultures, user practices, markets and so on (Geels, 2004). Thus, the transition of a DH system impacts many societal functions in the DH sector from regulative questions to new technologies and user's habits.

The current DH system has remained rather stable over the past decades, and it has been widely adopted in the Finnish society. DH is a centralized heating system, which provides heat for cities and districts through underground heat pipes (Mäkelä & Tuunanen, 2015, p. 11). The total length of the district heating grids in Finland is over 15 000 kilometers (Energiateollisuus, 2019B), so already the grid infrastructure itself, which every second Finn is dependent on, is huge. Municipality-owned

energy companies have provided essential quality of life by heating households (Mäkelä & Tuunanen, 2015, p. 11) and they have attained a stable monopoly position in the energy system. This position was once strengthened by land use regulation, but the regulation has later been repealed (Karjanlahti, 2012). The DH markets are coordinated by regional energy companies, who generally own the heat production systems and the DH grids. Due to their significant position, the companies are important actors in the energy transition of the DH system. (Paiho & Saastamoinen, 2018.) DH customers pay for both joining the DH grid and for using heat from the grid. DH is popular among households, because its maintenance does not require much effort and attention from a household; it is an easy option that users have become accustomed to (Werner, 2017).

Sustainable innovations face multiple challenges when they evolve and aim to contest the system. People have grown accustomed to the unsustainable system, which is resistant to change. This resistance to change hinders the development and implementation of sustainable innovations. (Geels, 2011.) Processes, such as path dependence and positive feedback mechanisms, maintain the stability of the energy system and prevent attempts to transform it (Unruh, 2000). The stability of the system, which can also be viewed as institutional inertia (Pierson, 2000), can be seen as constraining the sustainability transitions: alternative practices do not suit the current institutions, such as the accustomed ways of doing things. Because of this, the challenges the local DH niche innovation encounters can be analysed by examining the institutions that influence the niche innovation.

In this thesis I answer the following research questions with the empirical focus being on the case of Skanssi's low temperature two-way district heating system:

1. How has the strategic niche of two-way district heating innovation of Skanssi evolved?
2. How did the regulative, normative and cultural-cognitive institutions shape the emerging district heating niche?

In answering the first research question I examine the development process of the innovation by utilizing the analytical framework of strategic niche management. This research, focusing on the novel socio-technical experiment, gives valuable information of its functions and further adaptation. In my second research question I analyse the institutions that hindered the planning and implementation of the innovation by utilizing the three institutional pillars framework developed by William Richard Scott (2014).

The structure of this thesis is the following. After the introduction I present the theoretical framework of this thesis by discussing the transition literature, introducing the SNM framework and the three

pillars of institutions. The third chapter presents research methodology: I discuss the research data, its formation and I introduce how I analysed the data. In the fourth chapter I present the analysis, and in the fifth chapter the main findings of the analysis are discussed in the light of earlier research. In the last chapter I conclude this thesis by answering the research questions.

2 Theoretical framework

In this chapter, I introduce the sustainability transition literature and one of its analytical frameworks, the strategic niche management. In addition, I discuss the role of transition intermediaries in niche management. Next, I introduce the three institutional pillars framework by Scott (2014) and discuss how institutions can constrain the development and implementation of sustainable niches, thus making their management inert. I connect the theories to my research agenda throughout the chapter.

2.1 Sustainability transitions

Transition literature evolved in the 2000s' to propose solutions for complex system problems related to sustainability. It is an interdisciplinary combination of many fields, such as the social sciences, economics, engineering and environmental sciences. (Berght et al., 2011.) Complex sustainability-related problems are seen to be difficult to solve since the problems are intertwined in multiple levels of societal systems (Markard et al., 2012). For example, the transition into a sustainable transport system and the abandoning of fossil fuels is not only related to the mobility of people, but also to other systems, such as the automotive and fuel industry systems, labour systems, infrastructure systems and knowledge systems. Thus, solving a complex problem of sustainability is dependent on solving problems in other systems too, and not just those of a single system of interest.

Transition literature proposes that the solution to unsustainable complex system problems is a slow systemic change i.e. a transition. A transition renews or reshapes the old system into a new and sustainable one (Markard et al., 2012). Transitions can either be rapid, leading to quick creative destruction of the previous system (Schumpeter, 1950), or they can be slow and well-managed processes, taking approximately 50 years (Geels & Schot, 2010, p. 11). Scholars have estimated that the momentum of a transition, where the whole socio-technical system is finally transformed from an unsustainable one to a sustainable configuration, takes approximately 10 years to achieve. However, the preceding journey of the evolution of a novel socio-technical configuration takes from 20 to 30 years. (Geels & Schot, 2010, p. 11-12.)

Transition literature does not view systemic change only as the creation and adoption of new sustainable technologies, but it also takes into account the transition of people and societies. The concept of socio-technical system depicts the social aspects of a transition: transitions include both the development of new technical innovations, and their use in a societal application domain. Transitions demand the involvement of multiple actors from different fields, such as business makers,

scientific communities, companies, user groups and social movements. (Geels & Schot, 2010, p. 11.) Social aspects are not less important, since socio-technical systems are maintained by the activities of human actors. The rules, cultures and practices of people affect transitions. (Geels, 2004.). As a consequence, different actors need to be involved in a transition, since people and organizations also change with the transition (Geels, 2004; Wittmayer et al., 2017).

In this thesis, the low temperature two-way DH experiment of Skanssi is viewed as a socio-technical system. The system has its technical functions, such as the production and distribution of heat, but equally important are the social functions of the system, such as the user practices and culture of the DH system. At the core of this research is the transition of the socio-technical system of DH, where the goal is to transform an old and complex one-way DH system into a new, two-way one. The target is to introduce novel technologies, encourage their use, and start two-way DH production and consumption in the neighbourhood of Skanssi. The implementation of this target would be a major transformation in comparison to the current DH system, where the DH flows only one-way, and which is dependent on centralized DH production.

Transition research can be loosely divided into four literature strands: multi-level perspective, transition management, strategic niche management and technological innovation system. These are frequently used as theoretical frameworks. (Markard et al., 2012.) Multi-level perspective (MLP) by Frank Geels (2002) is generally considered to be the central framework in transition literature. It presents the evolutionary trajectory of a sustainability transition occurring in three different levels: the niche, the regime and the landscape (Geels, 2002).

According to MLP literature, transitions are defined as regime shifts from one regime to another (Geels, 2011). For instance, the transition from a horse-based transportation regime to a fuel-based regime is a regime shift. This transition of the transport system was a result of multiple important factors, including technological development, urbanization, and increasing wealth for instance (Geels, 2005). According to MLP, landscape level trends make the regime level prone to changes, while simultaneously new innovations from the niche level contest the regime level. The shift of regime, a transition, is caused by the combined effects of the landscape and niche level pressures. (Geels, 2011.) In this thesis, "regime" is used as a synonym with "system".

The regime level is described as a *"... semi-coherent set of rules that orient and coordinate the activities of the social groups that reproduce the various elements of socio-technical systems."* (Geels, 2011, p. 27). Examples of regime level rules are cognitive rules, shared beliefs, user practices, lifestyles and legal agreements (Geels, 2011). These rules maintain the stability of the regime, but on

the other hand, they decrease innovations and their adaptation. The regime level remains locked-in due to multiple sets of rules, which cause inertia in intentions when turning the regime into a sustainable one. (Geels, 2011.) Multiple systems have evolved due to historical and co-evolutionary processes, and because of these path-dependent trajectories, they remain locked-in and resistant to change. Path-dependent systems prevent deviation or introduction of radical innovations, such as sustainable and alternative technologies. (Unruh, 2000.)

According to Geels (2011), goal of a niche level innovation is to replace the current and unsustainable system or to de-stabilize it. Niche innovations are developed under experimental and protected circumstances, in which they have possibilities for trial and error and self-adjustment. In the MLP heuristic, the levels are more stable the higher they get: the niche level is the most sensitive to change, whereas the land-scape is the most stable. (Geels, 2011.) The land-scape level, in the MLP, is the background horizon of the action taking place in the regime and niche levels. The landscape level includes non-physical elements such as political ideologies, demographic trends and societal values, which influence niche and regime level action. (Geels, 2011.) However, in this thesis the main interest is the niche level of MLP.

2.2 Strategic niche management

René Kemp, Johan Schot and Remco Hoogma introduced the strategic niche management (SNM) approach in 1998, when it was first utilized as a policy tool to investigate sustainable transportation innovations (Kemp et al., 1998). Later on, it has been used as a theoretical framework to evaluate and investigate real life experiments (see e.g. Heiskanen et al., 2015; Ruggiero et al., 2018). In this thesis, SNM is also used as a theoretical framework to research the local DH experiment of Skanssi. SNM is connected to MLP; SNM presents the niche level processes in more detail, whereas MLP addresses the whole trajectory of the niche innovation and the regime shift.

Niches offer protected places for experiments. These are described to be the foundations of sustainability transitions (Geels, 2011). They are where experiments and innovations are created, developed and phased out (Hoogma et al., 2002). In other words, SNM does not view niche merely as a level, but as a space where sustainable innovations and pilots are developed. In this thesis, Skanssi is viewed as a protected space where a sustainable experiment of the two-way DH system is developed and nurtured.

The final target of a niche innovation is to scale up into the current system and come into use (Kemp et al., 1998). However, scaling up those innovations is difficult due multiple reasons. Regulations

might prevent the entrances of new innovations, user demand might be low due the uncertainty of a new technology, or the innovation might not fit the cultural practices of the users. In addition, the belief systems and shared knowledge of the engineers and other developers can constrain the development of an innovation already in the early phase. (Kemp et al., 1998.) Even though the innovation would have advantages over the old one, the accustomed practices and preferences steer to choose the customary, default option (Smith & Raven, 2012).

SNM literature proposes three important aspects for successful niche management. These are the articulation of expectations and visions, the building of a niche network, and learning processes in multiple dimensions (Schot & Geels. 2008, p. 540). Articulation of the expectations and their specification is most crucial for niche management. Visions and expectations clarify the common target of the innovation and the needed resources for its implementation (Schot & Geels, 2008, p. 542). The visions benefit from being supported by facts, by proposing answers to unsolved challenge, and by being specific in relation to the environment into which the innovation is implemented (Kemp & Schot, 2002). The environment of the niche innovation should be viewed broadly, taking account technological, institutional and behavioural matters among others. However, the common vision does not provide the change itself, but it is important in supporting the cognitive change both in the network and wider in the society. (Smith el al. 2005.)

A niche network is responsible for the development of the innovation. The vision of the innovation should be shared and aligned in the network, which commits the network to a common goal, thus enabling the coherent niche management (Kemp & Schot, 2002). The innovation is best managed when the network is broad and involves experts with different backgrounds from researchers to business analysts and financers. In addition, the actors of niche network should obtain enough resources for developing the innovation. (Schot & Geels, 2008.) Coenen et al. (2010) state that niche management can be harmful or inoperative when the network consists mostly of regime level actors. Regime actors seem to prefer incremental niche management trajectories over radical and more sustainable ones (Coenen et al. 2010). Therefore, a diverse niche network is important, as it enables unrestricted decision-making and change in the prevalent ways of thinking.

Learning is the last aspect in SNM framework. When visions of the sustainable experiment are proposed, learning experiences in the network advance understanding of the innovation and further its development (Hoogma et al. 2002). Learning should focus on multiple dimensions, such as cultural meanings, regulations, infrastructure and industry networks (see Schot & Geels, 2008, p. 540). Learning in multiple dimensions increases understanding of the facts and data regarding the innovation inside the network. This is called first order learning. In addition, learning guides the

development of the innovation so that the innovation can be reshaped and better embedded into the current system. This is called second order learning. (Schot & Geels, 2008.) However, the innovation should not be forced into a fixed model, since its environment, as well as understanding of it in the niche network, might change over time. Therefore, reshaping the innovation is necessary multiple times during the niche management. (Hoogma et al. 2002, p.6-7.) Reshaping also prevents the niche innovation from being locked-in.

Smith and Raven (2012) have continued to develop the SNM framework. They argue that in addition to niche internal functions, the sharing of expectations, wide network and learning, the SNM literature should pay more attention to external factors. A sustainable innovation typically has two stages of development, which demand different actions. At the first stage, the sustainable innovation is nurtured, empowered and shielded by research and development, and its competitiveness is improved. These nurturing and shielding mechanisms could not be utilized as widely in the normal market environment. After nurturing, the protection of the innovation is removed, and the development shifts to the second stage. In the second stage, the sustainable innovation competes in the general selection environment, which it has gained advantages for in the protected space. (Smith & Raven, 2012.) Niche innovation gains a momentum when the innovation has a large network, its own user group, and its own infrastructure, and when the objectives of the niche are precise and learning processes have succeeded. This leads to a replacement of the current regime, i.e. the transition of an unsustainable system to a sustainable one. (Geels, 2011.)

According to Kemp et al. (1998), a good niche innovation has four important elements. First, it has advantages over the current default option, so choosing the niche innovation is beneficial. Secondly, it gives feedback and has a learning effect. Third, it is coherent and competitive with current technology, and fourth, it is so attractive that the disadvantages of the innovation become less important. (Kemp et al., 1998, p. 187.) Smith (2007) views that niche innovations are more likely to be adopted by the regime if the regime is under a pressure. In addition, the involvement of incumbents, who obtain influential positions on the regime level, advances successful niche management (Smith, 2007). Despite the attractiveness of an innovation, their failures commonly occur for a few reasons: too little involvement of external actors in a niche management process, unembedding of the innovation with the institutional environment, too little second order learning, or insufficient resources (Schot & Geels, 2008).

I see Skanssi's DH experiment as an interesting experiment to research by utilizing the SNM framework. The DH system is a well-established part of the energy system: the first DH grid was built in Finland in 1940, and after that, the DH system has become widely adopted in the Finnish

society (Mäkelä & Tuunanen, 2015, p. 12). As a consequence, the habits and business logics of the DH system can be expected to be quite institutionalized. However, in Skanssi the DH system is intended to be disrupted by the regional energy company itself, who leads the development of the experiment. Their aim is to empower the inhabitants of Skanssi to start to produce DH with decentralized and renewable technologies. This makes the niche innovation of Skanssi slightly different in comparison to typical interests of sustainability transition literature: The object under investigation is focuses more on the sustainable practices and habits of the users of the DH system than in the sustainable technology. However, social acceptance is also one major challenge of sustainable demonstration projects (see e.g. Heiskanen et al., 2015; Raven et al., 2009), and it might pose challenges in the case of two-way DH experiment as well. This perspective, where the social dimensions of the SNM, such as habits and practices and their alignment, are emphasized, is important for my research questions and will be discussed in more detail in chapter 2.3.

As noted, sustainability transitions are slow processes, which take approximately 50 years (Geels & Schot, 2010, p. 11). Intermediaries play important roles and functions in sustainability transition processes. Intermediaries are viewed as stimulants of sustainability transitions, whose task is to facilitate and speed up the transition by various manners (See e.g. Van Lente, 2003; Kivimaa, 2014; Kivima et al., 2019; Geels & Schot, 2010). Intermediaries have been largely investigated in innovation studies (see e.g. Howells, 2006), but lately intermediaries have also become the interest of transition studies (Kivimaa, 2014).

Intermediaries are extremely important when an innovation is entering the market. Kivimaa (2014) has investigated how government-affiliated intermediaries execute multiple different functions, which speed up the niche processes. The central intermediary functions in the niche process are *articulation of expectations and visions*, *building of social networks* and *learning processes and exploration at multiple dimensions* (Kivimaa, 2014, p. 1373). Intermediaries aim to enlarge the niche network, which is essential for successful transition. The sharing of visions and expectations with multiple other actors promotes the niche, thus increasing its influence. Learning processes contribute to niche management by reshaping and shielding the niche and by improving its capabilities in its environment. All functions may speed up the diffusion and adoption of the niche innovation, thus hastening the sustainable regime-shift.

Intermediaries have also been noted to have different ways of mediating the connections, targets, purposes and priorities of niches. Hodson et al. (2013) present four modes of intermediation: Conduit systemic, endogenous and piecemeal intermediation. Conduit intermediation refers to a situation, where externally set targets are led into regional and local spheres. These targets are pursued by a

project based and short-term actor, such as a regional energy-efficiency agency for instance, who communicates the national targets to the regional communities. Systemic intermediation also refers to externally set targets and their diffusion, but the implementation of those targets is longer term and better organized. Endogenous intermediation refers to a context-related mediation, such as communication of a local long-term sustainability plan of a municipality to local actors. This form of intermediation takes account the whole systemic level instead of concentrating only on a part of the problem. And last, piecemeal intermediation refers to a short-term and project-based facilitation, which is targeted to only a specific group or organisation. (Hodson et al., 2013.) All these modes of intermediation can be expected to influence the niche processes by different effects and amounts.

Intermediary actors and mediating functions might play a role in the niche management of the DH experiment. They might advance the implementation of the local experiment by multiple ways, by clarifying the vision or gathering knowledge of the innovation for instance. I will pay attention to the state of intermediation by utilizing the classification of Hodson et al. (2013) and to the functions introduced by Kivimaa (2014). For instance, Van Lente et al. (2003) have emphasized the need for systemic intermediaries in long-lasting and complex transition processes. Thus, intermediaries might be needed in this long-lasting area development project with an experimental DH system that deviates from the customary DH system in multiple ways.

2.3 Institutions in sustainability transitions

Institutional theories provide analytical explanations for research of social and political structures, and they have always been at the core of the research of social sciences (Lowndes & Roberts, 2013, p. 19). In this study I approach institutions by adopting the definition proposed by Douglas North. North (1990, p. 3) writes "*Institutions are the rules of the game in a society or, more formally, the humanly devised constraints that shape interaction*". In other words, institutions are rules that are created by people to guide action. Institutions create stability and reduce uncertainty, which makes collaboration and trade function (North, 1990, p. 6). However, institutions do not always function as intended: they might be inefficient, or not serve their purpose (North, 1990, p. 15–16).

According to Peters (2005), institutional theories can be divided into two strands: Old and new institutionalism. Old institutionalism has developed already by the times of Aristotle with the purpose of investigating formal institutions, such as law or political institutions. The initial questions of old institutionalism focused on of the conditions of a political institution and their appropriate and proper functioning. In the mid-20th century, theories of rational choice and behaviorism questioned the role of institutions as constraints on human action. (Peters, 2005, p. 1–6.) New institutionalism evolved

from old institutionalism, rational choice, and behaviorist theories, and it closes gaps the earlier theories left unanswered. It brought back the collective and constraining nature of institutions. New institutional scholars acknowledge that individuals make decisions, but that society, covered by multiple institutions, has influence on individual decision-making. In addition, new institutionalists study the normativity of institutions. Values and attitudes of individuals and organizations are viewed even more influential than the formal rules. (Peters, 2005, p. 43.) In this study, institutions are regarded as synonyms to rules, and they should not be confounded with political institutions.

William Scott's (2014) theory of the three institutional pillars is drawn from the earlier institution theories, and it is largely utilized as an analytical framework for investigating institutions in various trends of research. For example, the three pillars of institutions framework has been utilized to evaluate forest policy implementation (Primmer et al., 2013) and health care in the US (Caronna, 2004).

The analytical framework of three pillars of institutions constitutes of regulative, normative and cultural-cognitive institutions. All three pillars represent different kinds of institutions that constrain action and cooperation with varying mechanisms and logics. (Scott, 2014, p. 56–60.) However, while providing structure, the institutions also empower actors and organizations into activities (Scott, 2014, p. 64). For instance, some professions, such as teachers or doctors, are mandated with normative and cultural-cognitive institutions empowering them into area-specific functions. Three pillars and their main characteristics are introduced in Table 1.

	Regulative institutions	**Normative institutions**	**Cultural-cognitive institutions**
Basis of compliance	Expedience	Social obligation	Taken-for-grantedness Shared understandings
Basis of order	Regulative rules	Binding expectations	Constitutive schema
Mechanism	Coercive	Normative	Mimetic
Logic	Instrumentality	Appropriateness	Orthodoxy
Indicators	Rules Laws Sanctions	Certification Accrediation	Common beliefs Shared logics of action Isomorphism
Affect	Fear Guilt Innocence	Shame/Honor	Certainty/confusion
Basis of legitimacy	Legally sanctioned	Morally governed	Comprehensible Recognizable Culturally supported

Table 1Three pillars of institutions (Scott 2014, p.60).

The three different types of institutions constrain and empower action with different mechanisms. The regulative pillar can be viewed to reflect the old institutionalism. Regulative rules are formal and legal regulations, such as the law or official agreements. They are legitimated by legal or semi-legal requirements, and deviation from a regulative rule may lead into formal sanction. The purpose of regulative institutions is to influence future behavior by set regulations or surveillance. Regulative institutions are the clearest top-down constraining mechanism, and common elements of regulative institutions are coercion and control. (Scott, 2014, p. 59–64.) For instance, the directive of the European Union regarding near zero-energy buildings can be regarded as regulative institution, as its purpose is to constrain the construction into the set qualifications (Directive 2010/31/EU).

Normative institutions refer to norms and values, which have a prescriptive dimension in life. Values constrain the desirable behavior, and norms identify how that desirable behavior should be conducted. Normative institutions also constrain action by roles that relate to societal functions and positions. Some roles hold functions that other roles do not. Norms are performed in collective action and they uphold the functioning of the society. However, norms and roles can become burdensome to maintain, since deviation from them is often seen as undesirable. (Scott, 2014, p. 64–65.)

Cultural-cognitive rules are generated by the shared belief system of the social world. They are the "taken for granted" rules: the maintenance of cultural-cognitive rules is subconscious and their significance is seldom questioned. Roles of actors are adopted by repetition and habituation, which leads to unquestioned behavior. As a consequence, becoming aware of the cultural-cognitive constraints is not easy and it may be difficult to change them. In addition, deviation from these institutions may lead into a conflict or end of cooperation, as institutions are preserved by a collective. Cultural-cognitive institutions vary between different cultures. (Scott 2014, p. 67–69.)

Even though institutions are often seen as stable constraints, they can nevertheless change. However, institutional change is slow, and institutions tend to change incrementally rather than radically (North, 1990, p. 6–9; Scott, 2014, p. 56–60). The slowness of change is also called as institutional inertia. Institutional inertia refers to an institutional "stickiness", where an institution is resistant or unwilling to change, and hence, is not changing (Pierson, 2004).

Fuenfschilling (2014 p. 20) views that much of the sustainability transition literature can be seen as discussion about institutions, even though the vocabulary is partly different. The regime level stability, which is preserved by user preferences, policies, and science for instance, can also be considered as institutional stability (Fuenfschilling, 2014, p. 20). As noted, institutions, such as values

and cultural practices, change slowly. Institutions bias the decision-making processes of people, because they guide to choose products and paths that people are already accustomed to choosing (Geels, 2004). Thus, institutional inertia can be seen to prevent the diffusion of niche level innovations and to maintain the unsustainable system (Geels, 2011).

In this thesis, I view the regime level stability as institutional stability[1]. I argue that the regulative, normative and cultural-cognitive institutions maintain the stability of the DH system by different mechanisms and logics. For instance, the values and habits of people might prevent the diffusion of the DH innovation in Skanssi. People might be unwilling to start decentralized DH production and participate to the two-way DH experiment, because they can be accustomed to such habits of living that do not include the habit of producing heat. In addition, the norms of the building sector might dampen the implementation of the experiment.

Path-dependence and lock-in are phenomena of institutional change, which have been noted as hindrances of sustainability transitions (see e.g. Van Lente, 2003; Unruh, 2000). Path-dependence refers to situations where decisions that are made earlier constrain future options. It makes radical decision-making difficult, since deviation from the constrained path demands a lot of effort. (Pierson, 2000.) Lock-in is a result of path-dependence: Locked-in systems cannot be changed radically without changing other parts of the system too (Vergne & Durand, 2010). For instance, the evolution of the energy system has made its parts dependent on others, making the system locked-in (Unruh, 2000). The DH system can also be regarded as a locked-in system. The grid infrastructure has been designed for high DH water temperatures and for technologies that enable one-way flow of the DH water. Therefore, the diffusion of low temperature DH grids and large-scale two-way DH production would need adjustments on or replacements of the current DH grids. (Schmidt et al., 2017.) This poses major challenges for the sustainability transition of the DH system.

Smith et al. (2005) view that the actors who hold the power, the incumbents, are the most influential in changing the regime level rules, since they have leverage on the institutions of the system. However, incumbents may be reluctant to change their habits or use their power if they do not see the alternative supportive for their business (Smith et al., 2005). Furthermore, if the innovation is planned among the old regime level norms and practices, the innovation might turn into an incremental improvement of the current system (Kern, 2011). Turku Energia, who can be viewed as an incumbent, is strongly coordinating the DH niche management of Skanssi. This makes the DH experiment an interesting case, as the energy company itself has power in changing the rules of the DH system.

[1] I acknowledge that the regime level stability is also maintained by technological lock-in for instance.

However, the niche management of the DH experiment might lead only to incremental improvements, if the actors with power are not willing to make radical decisions concerning the niche innovation. Furthermore, if the regime level actor Turku Energia reproduces the regime level institutions in the niche management, the experiment might also lead into an incremental and easily achievable result.

Because the regime level institutions influence the niche management in multiple different ways, Smith (2007) argues that the learning experiences in the niche management should also focus on institutions. By learning about the institutions, the innovation can be reshaped to better diffuse in to the regime. Sustainability transition can also be facilitated by supporting institutional change by nurturing the change of norms and cultures. However, this process has been noted to demand a lot of power and resources. (Fuenfscilling & Truffer, 2016.) Finally, the lack of institutions can cause inertia for sustainable innovations, but formation of a new institution empowers the niche innovation to diffuse into the regime (Fang et al., 2012). Therefore, new institutions and shaping of the old ones need to be pursued within the niche management. Skanssi's DH experiment is a novelty, and it might be that there are no institutions reducing the uncertainties of the two-way DH.

Transition literature and its frameworks have attained a lot of critique. For example Wittmayer et al. (2017) view that the questions of agency and the role of actors in a transition process have been underestimated in the transition literature. Greater attention to the different roles and their change is needed, and the scholars introduced agency in the context of transition literature (Wittmayer et al., 2017). I see this critique to be highly important, since roles are regarded as a normative institution in this thesis. Thus, the question of roles and their transition is taken into account in researching the DH experiment of Skanssi.

In addition, MLP has been viewed as too simplified, as a transition does not always initiate from evolving niche innovation. Geels and Schot (2007) have thus proposed four different transition types: a transformation, de-alignment and re-alignment, technological substitution, and reconfiguration. For instance, a de-alignment transition evolves from a confused regime level, where sudden changes in the regime have led into the evolution of multiple innovations which compete for the regime level attention and resources. As time passes, one of them becomes dominant and the regime level stabilises again. (Geels & Schot, 2007.) Furthermore, Smith & Raven (2012) discuss the conditions of the protected space in more detail. The scholars view that there are two different kind of niches that empower and protect the innovation by different mechanisms. "Fit and conform" refers to a niche that conforms the innovation into the current institutional environment of the regime level. This innovation is not radical, but developed to suit into the stable regime level without major changes. In

turn, innovation that is developed in "stretch and transform" niche demands radical changes from the stable regime level. These radical changes empower and embed the niche innovation in to the regime. (Smith & Raven, 2012.)

Svensson & Nikoleris (2018) also claim that the MLP framework offers insufficient ontological foundations for transition, and its origin, pattern and dynamics. However, it is important to remember that transition literature and its widely used frameworks such as SNM are yet not described as theories, but literature strands. I argue that the frameworks are not institutionalized into the canon of grand theories, as the frameworks are still actively researched and developed. However, the critique of Svensson & Nikoleris (2018) should not be underestimated. Sustainability transition research has also focused largely on the issues of the western societies, and thus the literature has represented only some parts of the planet. However, recently the frameworks have been utilized in analysing cases such as the solar power diffusion of a developing country (Elmustapha et al., 2018) thus extending the scope of sustainability transition literature over only western societies.

To summarize the theoretical framework of this study, I investigate the development and implementation process of the Skanssi's DH experiment by utilizing the strategic niche management framework. In addition, I examine the role of intermediaries in participating in and managing the niche innovation. Furthermore, I examine how regulative, normative and cultural-cognitive institutions influenced the development and implementation of the innovation. I argue that institutions shape the niche management internally by the niche network, who develop the innovation. In addition institutions influence the niche innovation externally from the regime level, which makes the diffusion and adoption of the innovation inert. Both internal and external constraints prevent the diffusion of the niche innovation, if the institutions do not change.

Adapting the image of the sustainability transition by Schot and Geels (2007), the institutions are seen as part of the socio-technical regime. Figure 2 pictures these as science, culture, policy, etc. In addition, the regime-level actors are seen as the carriers of the regime-level institutions, which may constrain the niche management via expectations and networks of the niches.

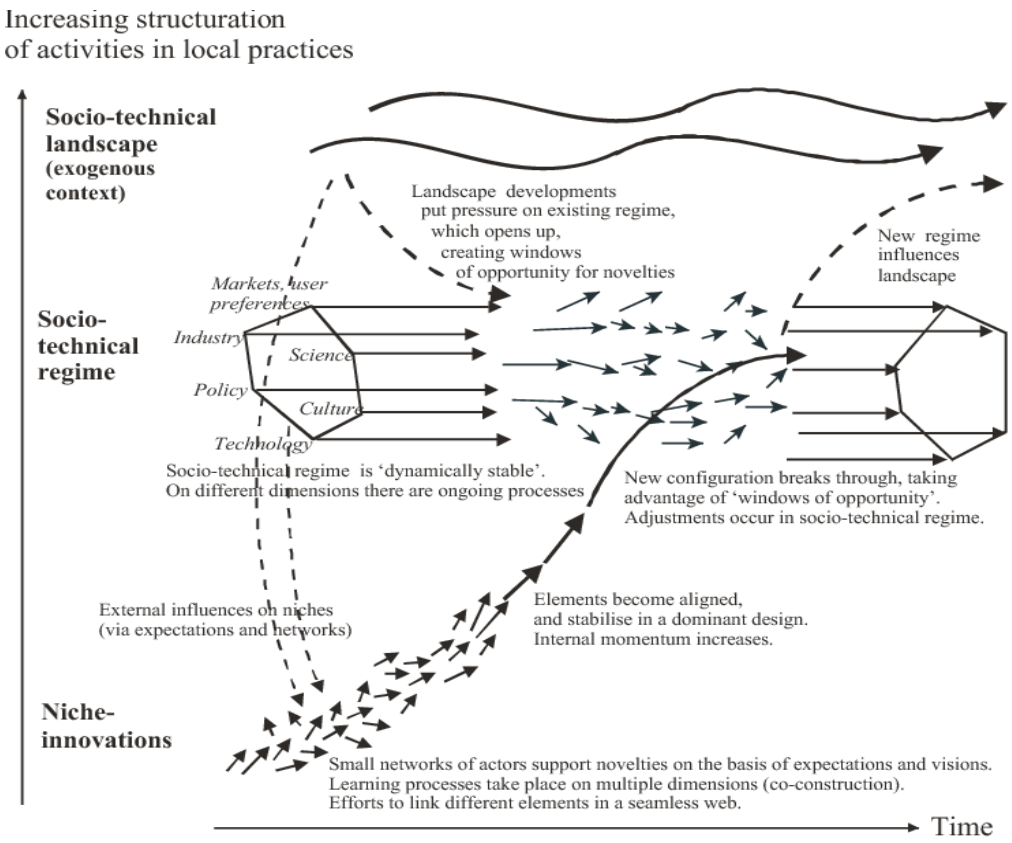

Figure 2 The multi-level perspective on sustainability transitions. Source: Geels & Schot, 2007.

3 Research methodology

In this chapter I report how this research was conducted. I begin by telling how I became acquainted with Skanssi, what role the sustainability transition literature posed in this study and why I considered qualitative research interviews as the most appropriate method for answering my research questions. Next, I discuss the choice of research interviewees and the course of the interviews. After that I explain how I coded and analyzed the research data by using content analysis as an analytical tool. Reliability and validity of this study are discussed through the chapter by utilizing the views of Tuomi and Sarajärvi (2009, p. 138–141) for the evaluation.

3.1 Qualitative case study research

I wanted to gain more research experience, which guided me to do my thesis in a research project at the Finnish Environment Centre (SYKE). A professor at SYKE arranged an internship position for me to do my thesis in a research project called TRIPOD – *Intermediaries in the energy transition: The invisible work of creating markets for sustainable energy solutions*. The personnel at SYKE were interested in Skanssi, and after planning my role in TRIPOD at Fall 2017, we decided with colleagues that I would research Skanssi and its energy experiments in my master's thesis. After exploring Skanssi, the low temperature two-way DH system appeared to be its most exciting energy experiment, and I decided to make it the object of my study.

Case study research explores the object under investigation by utilizing multiple data sources, aiming to create a comprehensive understanding of the case (see e.g. Hamel et al., 1993). Frequently, the research questions of a case study aim to understand how and why something has occurred, and in a what context (Thomas & Myers, 2015). The low temperature two-way DH experiment of Skanssi formed the empirical case of this study. The aim of this research was to become acquainted with the origin of the experiment and with the different phases in the development and implementation of the experiment. To be more precise, the case of this research can be viewed as a process. The aim is to find out how the experiment evolved from an idea to where it stood in spring 2018, when the data of this study was collected. Furthermore, the aim was to understand the background and environment of the experiment and the future expectations.

Initial theory is the methodological strategy that forms a researcher's perception of the object of the study (Hamel et al., 1993, p. 44). The role of theory is to guide the research setting, method and interpretation of the data, but the way theory is applied, depends on the researcher and the research

question (Tuomi & Sarajärvi, 2009, p. 18–22). While I got acquainted with Skanssi, I also familiarized myself with the sustainability transition literature: I studied the analytical frameworks, such as the MLP and SNM, and read multiple case study articles about sustainable innovations and experiments. Transition literature formed the initial theory of this study. It affected the manner I perceived the case and it had an impact on the decisions I made through this research project. For instance, the case was approached *ex ante* as a niche innovation that aims to advance an energy transition. The utilization of transition literature was a conscious choice, and I feel that the study was in balance with the choices made in the beginning.

3.2 Data collection

As case studies aim for an in-depth analysis of the case, they usually comprise of a large amount of empirical data (Hamel et al., 1993, p. 45). The data collection of this study began from internet searches as I got acquainted with the area of Skanssi and with the low temperature two-way DH experiment. The internet material was central in increasing my understanding of the origin and context of the case. I began by reading the city of Turku's and Turku Energia's internet-based material about Skanssi in fall 2017. In addition, I read the official records of the city government, city council and city board concerning Skanssi and the DH experiment. I also made Google searches of Skanssi, the low temperature two-way DH system, Turku city's climate and environment targets, and other city development projects relating to energy and climate in Turku. These interned-based materials are listed in appendix 1 and their role as research data is discussed later in this chapter.

Ultimately, the amount of internet-based material was meager and the content of this data was general. I found it difficult to be used to investigate the development and implementation process of the experiment. In addition, the internet-based material did not discuss the challenges of the experiment, which I was particularly interested in. Thus, I could not have answered the research questions by utilizing the internet-based material only and deeper knowledge of the case had to be sought from the local level in Turku. Therefore, I decided that the best method for researching the case in more depth would be to interview people who had been working with the case. They had experiences and opinions of the development and implementation process that I was interested in.

The method of selecting interview informants should be well justified in qualitative research (Tuomi & Sarajärvi, 2009, p. 85). Alastalo & Åkerman (2010, p. 373–374) recommend using specialist interviews when the object under investigation is a case or a historical process. In a specialist interview, the interviewee is selected based on the knowledge of the process she or he is assumed to have. Specialists, as in my case, are irreplaceable, since only they hold the knowledge of the researched case. (Alastalo & Åkerman, 2010, p.373–374.) While I collected the internet-based

material of the case, I also made a list of approximately 20 names that appeared in the documents concerning Skanssi. I considered them to be the case specialists of the development and implementation process of the experiment. I planned to contact people from this list and ask if they were interested in taking part in my research. In contacting informants, I prioritized names that had appeared more frequently in my pre-research. I also expected some informants to decline an interview, so the initial list comprised of more names than I intended to interview.

The interview questions were written in cooperation with two colleagues from SYKE. I formulated a first draft of the question template, which was then refined with the colleagues. The question template was divided into four themes: the first questions concerned Skanssi in general and the informant's relation to it, the second theme included questions about the two-way district heating experiment, the third theme concerned the anticipated challenges encountered during the experiment, and the last section included questions about the future of Skanssi, also addressing plans to overcome the challenges. Some of the questions were general, while others were based on the theoretical framework. The interview template was later translated into English. This translation can be found in appendix 2.

I sent the first interview inquiries to four different people in January 2018. Three people agreed to take part in the research. One person rejected my inquiry and later I understood that his role was not a case specialist. During the next two months I sent eight more interview inquiries. Six out of the eight recipients accepted to participate in the research. One person denied my interview inquiry but forwarded my message to a person whom she considered to know more about the experiment. The name of that person was already on my specialist list of 20 people. A person whom I thought would be important for my research rejected to participate. However, this person told to me he could not contribute new information in addition to the interviews I had already conducted with his colleagues. The first nine interviews were conducted in February and March 2018. The last research interview inquiry was sent in April 2018 and the interview was held in May 2018.

Although I had prepared the list of specialists based on pre-research, I asked most of the interviewed people whom they thought I should interview for my research. By asking the specialists I wanted to guarantee that no important informant relating to the case would be overlooked. However, the informants mostly mentioned names that I had already contacted or planned to contact. One informant mentioned a few names that were not on my specialist list. However, since their work in relation to the experiment was only marginal, I did not interview them. Furthermore, as my understanding of the case deepened during the interviews, it became apparent who the case specialists were. As a consequence, I did not end up interviewing all the people in my list. It should be noted that the people

from the list I did not interview were not mentioned by the interviewed informants. Finally, in May 2018, I felt I had interviewed all the relevant case specialists, as I had acquired sufficient data for answering my research questions. The informants and their employer organization are introduced in Table 2.

Organization	Number of informants
City of Turku	4 informants
Turku Energia	2 informants
Business Finland	1 informant
Housing developer	1 informant
VTT	1 informant
Sustecon Oy	1 informant

Table 2 List of informant's employer organizations and their amount.

All the people I interviewed had been somehow involved with the development or implementation of the DH experiment. Four of the interviewees represented the city of Turku, but one of them was no longer employed by the city. Two informants worked at Turku Energia, the regional energy company responsible for the experiment. An informant representing the housing developer's view was selected to the specialist group because I wanted to interview a party that was expected to realize the decentralized heat production. No inhabitants were living in Skanssi during my interviews, so experiences of the inhabitants of Skanssi could not be heard. The informants from VTT and Sustecon Oy had been involved as external researchers commissioned by Turku Energia. The informant from Business Finland represented the case financer's point of view. All the interviews were recorded with a mobile phone or with a recorder. Nine interviews took place at the informant's place of work and one was conducted by phone.

Before starting the actual research interviews, I notified the informants of the ethical research guidelines proposed by the Finnish Social Science Data Archive (Tutkittavien informointi, 2018). I reiterated the focus of the TRIPOD research group and the purpose of my research. In addition, I informed the interviewees of the anonymisation of the data and the use of interview quotations that would be utilized in the thesis. I let the interviewees ask possible questions about my research and reminded them they could end the interview at any time if they wanted. All the central information of the research and the ethical questions had already been given to the informants with the interview inquiry.

I tried to create a confidential and relaxed atmosphere in which the informants would feel free to share their views and experiences of the DH experiment. Most interviews resembled conversations rather than interviews, which I felt made the discussions less formal and more relaxed. All the interviews were conducted in Finnish and they lasted from 35 minutes to 1 hour and 20 minutes. All interviews except one were individual interviews. One interview I conducted with a colleague from SYKE, who continued the discussion following my interview questions. I transcribed all the interviews expect for the one conducted with a colleague. However, I revised this transcription by comparing the audio to the written transcript. I started to transcribe the interview material within a week after interview. The final number of the interview data was 93 paper sheets.

The ten interview transcriptions collected via thematic research interviews formed the primary data source of this study. The interned-based material was used as a secondary data source. It was used for forming an accurate picture of the case, since all the phases in the development were not discussed in detail with the informants. Secondary data sources were mostly utilized in chapter 4.1 for verifying and adding years of events, for instance. Thus, the primary data source formed the main data of this study. In addition to the specialist interviews, I also conducted a follow-up interview by telephone with one informant in May 2018, which I recorded. This phone call, lasting only 10 minutes, was complementary to the actual thematic interview conducted earlier, since I only asked some short questions to clarify the case. I did not transcribe this call.

Interview quotations presented in the text are considered to strengthen the made arguments of the interpretations for the reader, increasing the validity of the study (Sakki & Pirttilä-Backman, 2011, p. 15; Mason, 2004). The author is responsible for the translations of the quotations, and the quotations in the original language are listed in appendix 3.

3.3 Data coding and content analysis

One common method for analysing texts or documents is content analysis. Content analysis can either be understood as a method or as a loose theoretical framework, and the way in which content analysis is applied varies between different disciplines and research traditions (Tuomi & Sarajärvi, 2009, p. 91). Hsieh and Shannon (2005, p. 1278) describe content analysis as follows, "…*content analysis is defined as a research method for the subjective interpretations of the content of text data through systemic classification process of coding and identifying themes and patterns*". The interpretations made from the text are subjective, because they represent my understanding of the case. To ensure the systematicity of content analysis, I coded all the interview data collected.

Since my research approach leaned towards the sustainability transition literature already from the beginning, I utilized the theory also in the coding of the data and in the analysis of the data. Tuomi and Sarajärvi (2009, p.117–118) view that when a theory guides content analysis, the major concepts of the study are known before the analysis, and those concepts guide the interpretation of the data. Similarly, Hsieh & Shannon (2005) introduce directed content analysis to investigate textual data. They (2005) recommend directed content analysis when the interest is to approach the phenomena of the research with an established theory, or to validate or extend it. Selected theories help to focus on the research questions, and they guide the researcher to the relevant matters in the data (Hsieh & Shannon, 2005). I see the approaches of Tuomi & Sarajärvi (2009) and Hsieh & Shannon (2005) similar with the manner I utilized content analysis.

I began to code the data with the text analysis program Atlas-Ti one and half weeks after the first interviews. Saldaña (2009, p. 4) describes coding as a "transitional process" between the collection of data and its in-depth analysis. Coding summarizes and reduces the amount of data, and it becomes easier to handle and analyze (Saldaña, 2009, p. 4). As recommended by Tuomi & Sarajärvi (2009, p.117–118) and Krippendorff (2004, p. 352) the codes were formed from the concepts of the theory, since they often picture the phenomena in the data more precisely, when self-made codes might be too simplistic. I developed eight codes in the Atlas-Ti program before I began the actual coding. Three of the codes were formulated from the strategic niche management literature and five represented the potential causes of institutional inertia.

After coding the first two interview transcripts, I noticed that my inertia codes were too narrow. Examples of these predeveloped inertia codes were for instance "Inertia: citizens or groups" and "Inertia: Law and regulations". By utilizing the inertia codes I had forced the findings to fit into the predeveloped code description. In addition, some of the relevant findings had not been coded with the predeveloped codes, because they did not fir the code description. Therefore, I abandoned the predeveloped inertia codes and continued the coding with only four predeveloped codes: "Expectations", "Network", "Learning" and "Inertia".

The decision to abandon the preformulated inertia codes was important. I think they had biased my research and by reducing the codes I was able to catch the multiple forms of inertia. This decision also increased the validity of the method. Mason (2002, p. 151) has also noted that some parts of text can be impossible to code by only one code, since texts content could suit into multiple categories. I acknowledged this issue during my coding, and some parts of the text were coded into two categories. In sum, I was aware of the disadvantages of the coding while I coded the data, nonetheless, it made easier to handle large amounts of text data. I interpreted the data with my coding mechanism, but the

coding was not the same as analysis. Picture 1 shows the coding and analysis process of the study. Even though the process seems linear in the picture, I would describe it as iterative. I coded, interpreted the results and then coded again, thus moving back and forth multiple times.

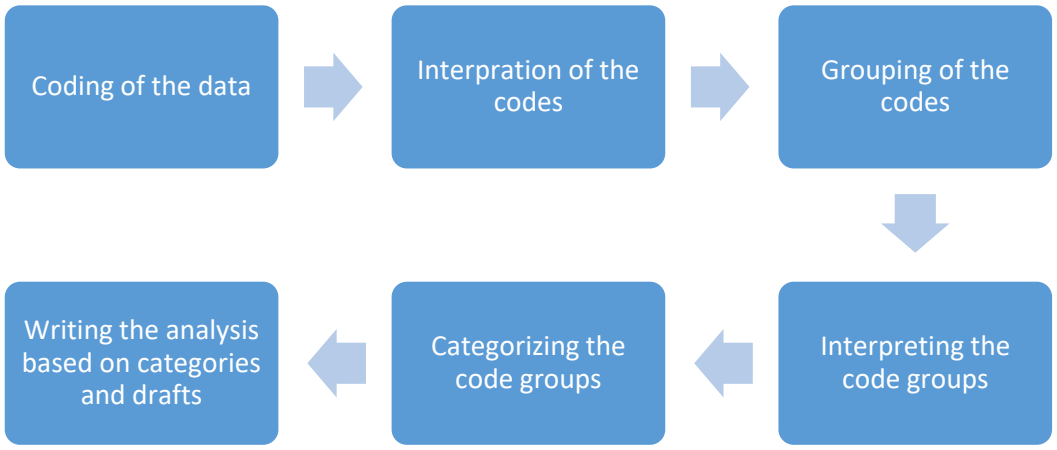

Figure 3 Coding and analysis process of this study.

The four predeveloped codes were used to indicate the parts in a text which discussed the content of the code. I used a colon to clarify the content of the code more accurate and precise, since sometimes codes might end up being too broad and inaccurate and therefore useless (Mason, 2002, p. 151). I first coded the quotations with a predeveloped category and then I wrote a more detailed definition of the coded quotation, which I separated from the code with the colon. I also created a few codes based on the data. For example, I also coded the parts of transcriptions where some things were not seen as a cause of inertia. Table 3 shows examples of my predeveloped and text-based codes. This coding technique made the later grouping of the codes easier, and overall the codes where more useful and informative with the use of colon. The coding and grouping of codes were done in Finnish. Codes and quotations in the original language are available from the author upon request.

Predetermined code /Text based code	Example of a code	Quotation
Predetermined code: Expectations	Expectation: separation of heat transmission and production	*It might be needed at some phase*
Predetermined code: Network	Network: Developer	*The developer party, who will take the connection in time, is the most important party*
Predetermined code: Learning	Learning: Doesn't know	*I can't answer to that*
Predetermined code: Inertia	Inertia: Questions of responsibility	*Maybe it is more the questions of responsibility*
Text based code	Inertia: NO: Administration	*" And have there been any challenges in the implementation arising from the city administration or its operations?"* *"I think not"*
Text based code	Niche: Background	*We thought we could pilot that in Skanssi and we have been involved in the project for the DH grid*

Table 2 Examples of predeveloped and text-based codes with quotations.

After coding the interview data, I began to interpret the content of the codes. This interpretation of codes led me to recode some parts and to code some quotations that were left uncoded in the first round. After reading the transcripts multiple times and reading the codes, I printed them on paper. I wanted to get away from the computer for a while and just look at the codes and think, what is the meaning of these codes in relation to my research question. Next, I grouped the codes with Atlas TI. I brought the codes with similar content into a same code group (such as code group "interests", see Table 4). I investigated the groups and the quotations in them and weighted their meanings in relation to the theoretical framework. At the same time, I drafted my interpretations of the code groups on a computer in Finnish and began to list the findings in text format. I categorized these texts into parent categories and contemplated the texts in the light of the theory. I worked with Atlas-Ti and drafts of the interpretation until I felt that I did not find anything new and that my interpretations were

sufficient and comprehensive. After that I wrote the analysis. The aforementioned way is the practice of how I used content analysis in this thesis.

Parent category	Code group	Code	Quotation
Normative institutions	Interests	Inertia: Inhabitants are not interested	*But if it is a kind of plus minus zero issue which demands extra effort then it is little experienced difficult*

Table 3 Examples of the interpretation made from the data.

Even though the reasoning utilized in the analysis might appear rather theory-based, I also utilized text-based analysis. For instance, I returned to read the interview material, which was not coded, about ten times during the analysis. I wanted to guarantee that I had not missed anything important from the data. Sometimes this led into important findings and formation of new codes.

3.4 Reliability and validity of this study

There is no consensus for measuring the reliability and validity of qualitative study in the academia, and different research trends have formed their own indicators for measuring reliability (Tuomi & Sarajärvi, 2009, p.134–137). However, in general the question of research validity refers to the question of whether you are conducting research on what you say you are conducting research on (Mason, 2004, p. 188). Reliability often refers to replicability, or the question of whether the results would be the same if the research would be repeated. However, often the aim of qualitative research is not to generalize research findings, but to increase understanding of the case (Tuomi & Sarajärvi, 2009, p.22, 85), even though there are also alternative views (see e.g. Flyvbjerg, 2006) stating the opposite. I have sought to increase reliability by providing detailed information of the progress of this research project in this chapter.

In the beginning of my research project I did not know exactly what was happening in Skanssi, and at what stage the experiment was. I thought that the two-way DH production was about to start soon, and my research would focus on the first experiences of the experiment. However, while I was conducting the first interview, I understood that the implementation of the two-way district heating was still in an early phase and I should adjust my research questions. As a consequence, the focus of my research shifted from the actual implementation, which was the focus in the beginning of the study, to the challenges and institutions in the niche management. I did not consider this problematic

for this case study. On the contrary, shifting the course of the study made me aware of my preconceived notions and sharpened the understanding of the research object.

It is also important to note that the development and implementation of the energy experiment was in operation while I collected the research data in early 2018. In September 2019, the experiment still exists and, according to the websites, the implementation of a two-way DH system is still a common target. Thus, the development and implementation process of the experiment is still in progress. Thus, the results of this study reflect the situation of the experiment in early 2018. As the process continues to develop, the situation in the experiment may have changed from the data collection.

The data of this study was generated by interviewing the people who were then or had been involved in the experiment. The informants had different roles in the development and implementation process, so the understanding of the DH experiment probably varied between them. However, all interview data was considered equally important, and was treated similarly. Later, after having already collected the interview data I thought it might be interesting to interview representatives from the Finnish energy union Energiateollisuus ry and from the future fund Sitra. They had been promoting the two-way DH system, and had also commissioned research from a consult company Pöyry concerning the two-way business models. However, because I had initially decided to concentrate only on the actors who directly participated in the local experiment of Skanssi, I decided not to interview people from those organisations.

The interpretations made from the data reflect the reality of the researcher, and as Hsieh and Shannon (2005) remind, the result of content analysis is always based on subjective perspective. It is possible that the results of this study were different had someone else had conducted the same research. In my view, I researched the things that I meant to research and the analysis answers the research questions proposed in the beginning. I do not claim that the understanding of the case presented here is infallible, although I have done my best to describe the case and answer the research questions. The results of this research are not meant to be generalized to all similar experiments in the future, but future cases might possess similarities with this study.

4 Analysis

This chapter introduces the results of the research. They are discussed in more detail in chapter 5. First, I introduce the history of Skanssi and the visions and expectations of the DH experiment. After that I examine the challenges that the area development had encountered. Then I discuss the institutions that influenced and shaped the niche management. In the last section I analyze the learning experiences in the niche management.

4.1 Case overview and the great expectations

Before 2012, the area of Skanssi did not differ significantly from other area development projects in the city of Turku. In the component master plan from 2000, Skanssi had been planned to be a typical neighborhood for around 2,500 inhabitants. Before 2012, there were two construction companies, henceforth referred to as A and B, operating in Skanssi. Company A had won the first plot assignment competition (in Finnish "Tontinluovutuskilpailu") of Skanssi in 2004. The company was responsible for the construction of a shopping mall in the area called "Skanssi", which was completed in 2009. The same company also developed the first apartment buildings of Skanssi, the first of which were completed in 2012. In comparison to company A, construction company B had not begun construction in Skanssi before 2012; it had a pre-contract for purchasing a plot of land from a private land owner in the area in 2011-2012. In other words, the construction plans that the company B had were at an earlier stage at the turn of the 2010s. The company had decided on the plot purchase and construction, even though the plans were incomplete.

2012 was a significant year for the development of Skanssi, because the plans for the area changed radically. In November 2012, the city government of Turku introduced a plan of a smart and sustainable Skanssi and nominated it as a city government flagship project. In the city government's declaration, Skanssi was envisioned to become an ecologically, socially and economically sustainable neighborhood for 5,000 to 8,000 inhabitants. In addition, smart technology solutions would be widely utilized in the overall development of the area. The idea of the novel neighborhood was based on the Turku city's budget proposal from 2010. In November 2010, the city council had decided on preparing a new concept of a sustainable neighborhood, of which Skanssi would become the first case example. The city government was responsible for the implementation of this decision, announcing their implementation plan in November 2012. Prior to this announcement no information was

available concerning what the new area concept would be in practice. Hence these development plans brought the ideas to the public and kicked off a more active phase in the development of the area.

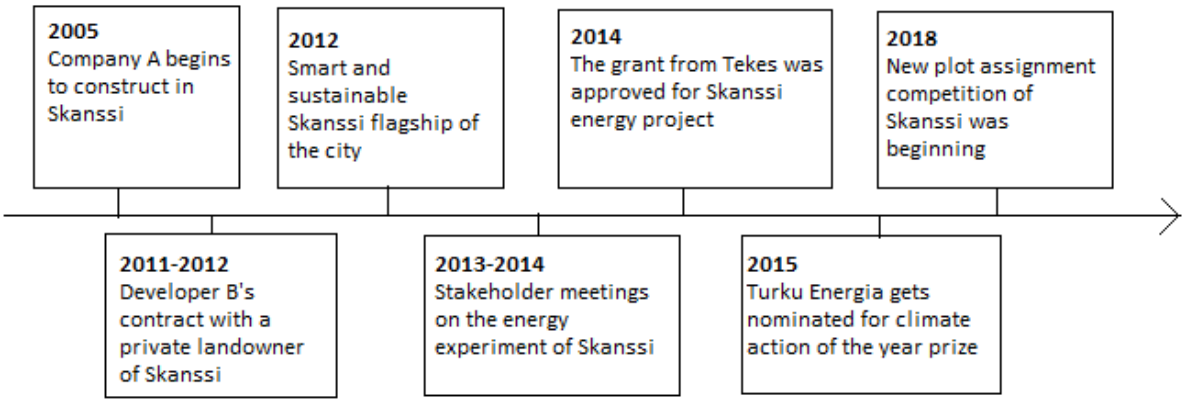

Figure 4 Timeline of the major events in the development of Skanssi.

In November 2012, the city government also adopted a list of themes and targets, which were planned to guide the overall development of Skanssi. The list included more specific objectives about the area development, regarding, for instance, sustainable transportation and energy. The declaration also stated that the implementation of a smart and sustainable Skanssi would require an update of the city's component master plan. For example, to meet the targets related to public transport, the population of the area should be more than the 2,500 inhabitants that had been envisioned in the initial city master plan of 2000. At this point, a low temperature two-way DH experiment was not yet mentioned as a goal of Skanssi.

In the city government's announcement, Skanssi was mentioned as a means for the city of Turku to realize their own sustainability targets. For example, in 2009, renewable energy was stated to become the major energy resource in Turku by 2020. In 2015, the city aimed for carbon neutrality by 2040. Ambitious climate policy was also pursued through area development. The city had participated in various city development projects in the 2000's and had already sought for sustainable solutions to climate and energy questions in them. For example, plans for sustainable transport were developed with the German multinational company Siemens. The informants viewed that the best ideas from previous projects were attempted to be adopted in the development of Skanssi. The unbuilt area of Skanssi offered favorable conditions for designing and implementing new alternatives. In general, the overall approach in the development of Skanssi was experienced to be more elaborate and participatory than in earlier area development projects. One informant described the novel development area as follows:

It [Skanssi] *has given us a concept we didn't have before, that a neighborhood, like, can be created sustainably, and it can be set with targets that have to do with city development and communications and image and all of things more broadly, that the implementation and development of a neighborhood can be an interactive and joint development project.* (City of Turku 1)

In the early 2010s', a project group was formed to plan and implement the ideas of a smart and sustainable Skanssi. The project group had consisted mostly of civil servants, but also of other stakeholders, such as the regional energy company Turku Energia. The informants recalled that initially the intention was to develop a smart electricity grid with decentralized electricity production. However, the electricity regulations of that time had constrained profitability, and therefore the idea was abandoned. In the project group, the regional energy company had suggested experimenting with the DH system that the regional energy company would construct. The project group supported the idea, shifting the focus at Skanssi from a smart electricity grid to a smart DH grid. As a consequence, a low temperature two-way DH system became the central energy experiment of the area.

The informants viewed the local DH experiment as a solution to multiple challenges. Various regulations and policies required cutting greenhouse gas emissions, which entailed the transformation of the energy system. Therefore, the regional energy company and its owner, the city of Turku, were under pressure to find ways to reach emission targets. In addition, changes in the energy sector had altered the earlier stable position of DH in regional heating markets. Current and future potential DH consumers were considered increasingly interested in alternative heating technologies, such as ground heat pumps. These technologies typically had advantages over DH, such as a more competitive price. Furthermore, the diversifying supply of heating technologies increased competition in the heat markets. DH experimentation was intended to renew the system and make it more attractive.

Some informants argued that the low temperature DH experiment was also a response to demand. Local actors, such as heat technology suppliers, had shown interest in supplying heat into the DH grid if it were made possible. Lower water temperature in the DH grid of Skanssi would enable more efficient decentralized heat production. Therefore, Skanssi was expected to attract the eager heat producers. In addition, citizens were seen to be familiar with DH, and since the experiment would not endanger energy security of households, it was considered to meet the need of the inhabitants. One interviewee emphasized that the enthusiasm of one individual expert in the energy company probably influenced the decision to experiment with DH. Furthermore, the city of Turku and Turku Energia had successfully cooperated in the past and so the collaboration the experiment would require was considered to likely be smooth. Consequently, the mutual understanding of the benefits of the system

between the energy company and the city allowed the plan to proceed. In general, all informants had positive attitudes towards the DH experiment:

My expectations were that it's really great to develop new technology and, like, I saw the future potential rather significant that it could be a big change in thinking about energy. (City of Turku 2)

Viewing the innovation at a practical level, lower water temperature in the DH grid was envisioned to reduce both heat loss and the resources required in heat production. The greenhouse gas emissions of the DH system would also be reduced by the two-way, decentralized DH production. The vision, also introduced on the Skanssi website, was that the buildings in Skanssi would produce heat by decentralized and renewable heat production units, such as ground heat pumps or solar thermal collectors. The produced surplus heat would be sold back to the local DH grid and distributed to other apartments inside the grid. In addition, some informants viewed that the decentralized DH system with smart metering technology would enable efficient control of supply and demand during peak hours. The demand for centrally produced heat was expected continue, but the decentralized production was expected to decrease the overall demand. Some informants noted that the initial target was to import a successful two-way heat model to the whole of Turku.

Also, Skanssi's DH system was expected to produce new knowledge about the low temperature decentralized DH system. The vision of a low temperature two-way DH system in Skanssi was a first of its kind experiment for a local systemic change in the DH sector. Low temperature DH grids had never been built in Finland before, and two-way DH contracts were highly uncommon. In addition to the heating grid, a cooling grid was planned to be built into Skanssi, which was unconventional in residential areas at the time. According to one informant, visions of transforming DH systems had existed in energy research for over ten years, but only individual small-scale DH experiments had been carried through globally. The DH system in Skanssi had been long-awaited, and the visions from research would finally materialize in Finland:

I'm really excited that somebody finally took this on, was interested in investigating this more thoroughly […] *and all the benefits it could bring, and the challenges and so on.* (Sustecon Oy)

From the beginning, the city of Turku and Turku Energia were the key players developing the low temperature two-way DH system. Before the construction of the grid began, the visions for Skanssi's DH system were also shared with citizens. The intention was to enlarge the network, get more stakeholders, and to hear the views of locals concerning the project. For example, during 2013-2014, Skanssi's project group invited local construction and technology companies to discuss the planned

energy solutions of Skanssi. In this dialogue, it was stated that the development of Skanssi's energy solutions needed a leader to take responsibility of the implementation of the vision. As a consequence, the local energy company Turku Energia took the lead, and the city was responsible for the other dimensions in the area development. Other actors did not get involved in the project to develop the DH innovation.

Turku Energia applied for funding for the development of Skanssi's energy project from the Finnish research and development fund Tekes (now Business Finland), which promotes the development of innovations. The grant was approved and given to the company at the end of 2014, and the development of the DH experiment started to take shape as part of Tekes's Smart city program. Even though Skanssi's energy project included other innovative energy solutions, the low temperature two-way DH system was considered as the most ambitious one. A draft of the energy vision of Skanssi was published in 2014. This introduced the local DH system in operation in year 2030. In the vision, locally produced heat and cool would be sold from the apartments to the local grid and then distributed to other apartments. It was also envisioned that billing heat and cool would be based on hourly rates. Buildings would have automated smart DH systems that would take into account the weather forecast.

With the funding from Tekes, Turku Energia was able to assign employees to work on Skanssi. In addition, the energy company ordered several studies concerning the low temperature two-way DH system. For example, in spring 2015, Turku Energia commissioned the Technical Research Center of Finland (VTT) to investigate the technical and economic conditions of Skanssi's DH experiment. The researchers investigated the functioning of the different heat production technologies and different heat volumes in a low temperature two-way DH grid. The informants saw that this research clarified the vision of the innovation.

VTT was also involved in formulating the plot assignment stipulations of Skanssi, which were written in collaboration with the city of Turku, Turku Energia and VTT. Plot assignment stipulations are a policy tool used by municipalities for providing more detailed building instructions for the developers in addition to the customary land use regulations. Every construction company operating in Skanssi was expected to approve the stipulations in order to receive a plot on which to construct. One informant described that the purpose of the plot assignment stipulations was to guide construction with the goal of attaining the sustainability targets of the area and the DH experiment:

We want to ascertain with the assignments and contracts that the district heating grid is possible to implement so in that sense we have expectations that we can include them in the assignments, and commit the housing developers to these stipulations. (City of Turku 3)

Finnish Innovation Fund Sitra and an energy union Energiateollisuus ry also had a share in Skanssi indirectly. Low temperature and two-way DH systems had gathered interest more widely in the energy sector and the aforementioned parties had commissioned a consulting firm Pöyry Oy to investigate potential business models for the two-way DH. Their research also conducted a small case investigation of the DH system in Skanssi. Some informants told that intention was to utilize the results of the study in the development of Skanssi's heat contracts. In addition, two university theses were written for Turku Energia about Skanssi's DH system, one concerning the developers' views of the system and other the technical installation. However, the grant received from Tekes was seen as the most important factor for the development of the innovation, and the informants viewed that the experiment could not had been realized without it. In addition to the financial aid, Tekes also provided networks, visibility and ideas.

The technical implementation of the low temperature DH grid was realized by conveying the DH water from the general grid through a heat exchanger into the local grid of Skanssi. The system in Skanssi deviated from conventional DH systems only by having larger water pipes. Basic technology for constructing the system was already available and one informant emphasized that the plan was to not construct a system that would be dependent on future innovations. In general, technology was not seen as a challenge in implementing the low temperature two-way DH system.

Visions of Skanssi's DH system were featured in local and national media. Moreover, representatives of the energy company had been promoting the DH innovation of Skanssi all over Finland. The visibility of the project was exceptional, and one interviewee assumed that there was no actor in the Finnish energy sector not aware of Turku Energia's plans in Skanssi. On top of the positive hype, Turku Energia was nominated with a "climate action of the year" prize in 2015. They gained the nomination for their three sustainability projects, of which Skanssi's DH experiment was seen as the most ambitious one. The climate action nomination further improved public awareness of Turku Energia and Skanssi.

By 2018, however, the positive hype had not materialized. Decentralized DH production or two-way DH contracts had not been implemented. Area development of Skanssi continued as usual, even though the construction of Skanssi had been delayed. Actors from the city and energy company met several times a year and communicated actively on the topical issues of Skanssi. The initial project group had dissolved over the years, possibly due to employee changes in the city. However, the city of Turku continued the development of Skanssi in a city development project "6-aika", in which civil servants organized open events introducing themes of Skanssi to citizens and stakeholders. The aim

was to increase cooperation of various actors in Skanssi. In 2018, the city of Turku was going to implement a new plot assignment competition.

The collaboration between Turku Energia and Tekes was most active in the beginning of Skanssi's energy project, but by 2018 it consisted mostly occasional communication. Although Tekes had financed the project, it did not participate in the project much. This may have been due to major changes within the organization. The energy company acted alone in implementing the two-way DH experiment and no new collaborations had been formed. The funding from Tekes was going to end during 2018, and in early 2018 the informants did not know how the DH innovation was going to be developed after that.

4.2 The postponement of the experiment and contradictory visions

The area development of Skanssi did not commence as rapidly as anticipated. As a result, the implementation of the low temperature two-way DH experiment was delayed. The regional energy company had approached potential heat producers of Skanssi, but no local heat production had been established. The involvement of citizens, the future inhabitants of Skanssi, was considered important for the development of the two-way DH system. However, it was experienced to be difficult before the inhabitants actually moved into the apartments.

In spring 2018 there were only two developers constructing in Skanssi. They were the same two, company A and B, who had operated in Skanssi before 2012. The first plot assignment competition with the plot assignment stipulations attached was arranged at the turn of 2015-2016. This competition received only one tender, which was later rejected. In 2018 no new construction companies had come to Skanssi, and as a consequence, construction of the area was delayed. This, in turn, impacted the implementation of the two-way DH system. In general, the development of the two-way DH system was experienced to be more challenging and slow than expected. One of the interviewees described the challenges of realizing the vision in the following way:

*This is kind of an experiment platform and there are all kinds of hopes for it, but to be honest not a lot of new things or innovations have emerged there but hopefully in the future. (*Turku Energia 2)

The informants saw that there were multiple reasons for the postponement of Skanssi's construction. The city had received feedback from the developers that the plot assignment stipulations were too complicated, and the overall construction would become too expensive with the stipulations. The use of plot assignment stipulations was unconventional, and the informants considered them as one reason for developers' lack of interest towards Skanssi. Some informants also thought that the economic

recession had reduced developers' capabilities to construct in general. Also, some companies were viewed to be too busy with their current projects, and therefore they did not have time to construct in Skanssi. Other challenges that the informants noted were the large plot sizes, difficult soil conditions, and Skanssi's somewhat remote geographical location.

The role of construction company B was essential, since the experimental nature of the area and the plot assignment stipulations were presented to them after the company had already decided to construct in Skanssi. Company A's construction was not guided by the plot assignment stipulations, since they were written after developer A had already began construction. Furthermore, the idea of a low temperature two-way DH grid was launched after construction had begun, and the plots of the construction company A were situated within the conventional DH grid. Decentralized heat production was not expected to be arranged into apartment buildings built by company A. Therefore, the roles of these two companies differed significantly in relation to the decentralized DH production, even though they both constructed in the Skanssi area.

However, company B needed to hire a consultant to investigate how the plot assignment stipulations would be implemented and what it would cost. The company did not have the needed expertise to implement the stipulations in-house and no public help was available. Later, company B negotiated the realization of the stipulations with representatives from both the city and energy company, agreeing not to implement some of them.

Collaboration between the city of Turku, Turku Energia, and construction company B was intensive, since there was a will to implement decentralized heat production in the first apartment buildings and participate into innovative area development. However, a common vision for arranging the two-way DH was not found, and company B decided that decentralized heat production would not be built into the first apartment buildings. Nonetheless, the developer was going to experiment with heat storage technology in one of their apartments in collaboration with a local polytechnic, and the company installed solar panels on the first apartment buildings. The first buildings inside the low temperature DH grid were finished in the summer 2018.

The city of Turku was going to arrange a second competition for plot purchase in Skanssi in 2018. Before that, they were going to reshape and clarify the plot assignment stipulations, in which the two-way DH was going to be included. It was anticipated that the plots would get more tenders this time, since the economic situation was considered to have improved and the stipulations had been rewritten.

In addition, the technical implementation of the low temperature grid did not proceed as was expected. In the beginning of the project it was considered whether alternative and cheaper materials for the

construction of DH pipes with lower water temperature could be utilized. The use of alternative grid materials would have brought savings and brought new experience of a novel piping system. However, the DH grid was decided to be built with the same pipe material as the ordinary ones, because the familiar materials were considered to be more reliable.

Even though the interviewees supported the vision of a novel two-way DH system, some of the views for implementing it were contradictory. Some informants saw that Skanssi's two-way DH grid would not function if only apartment buildings produce heat. All the heat that apartment buildings could produce with their own production units would sink into their own use and no extra heat to sell to the grid would be found. Furthermore, some argued that a producer with greater surplus heat quantities was needed to bring more heat volume to the grid. Additionally, some viewed that supply and demand would not meet in a decentralized DH system where the surplus heat was produced by apartment buildings, since the heat usage was expected to be too similar between users. Thus, some emphasized the need to have heat storage technology in order to execute the vision of the two-way DH system, even though it was still seen as too expensive. One informant described the difficulty of households as heat producers in the following manner:

We did notice that it doesn't work as such if there are only apartment buildings that it probably is not enough to get much utility of the system, because they are so similar as users in sharing energy between themselves. (City of Turku 2)

One informant doubted whether it was reasonable that the first apartments of Skanssi would produce heat. Since there were only few apartments inside low temperature DH grid, the first properties should not invest on heating technology and the execution of the vision should be postponed until there were more apartments and inhabitants in Skanssi.

In 2018, Skanssi had failed to attract heat producers and local companies remained uninvolved in the project. The energy company had intended to realize two-way DH contract with a nearby industrial building and shopping mall, but the intentions had not succeeded. The new shopping mall already had such an efficient energy utilization system that no extra heat was available in the mall, and discussion with the nearby industrial building had not led into two-way DH contract. Furthermore, the energy company intended to utilize cool from a nearby wastewater stream in the district cooling grid. However, the local construction companies had stated that inhabitants were not willing to pay for district cooling, since its construction would increase the price of apartments. As a consequence, the vision of Skanssi's cooling grid was cut, along with the plans to utilize the wastewater stream.

There was also a plan to install heat production technology into the future school building of Skanssi. No other larger heat sources had been found in Skanssi.

In summary, the development of the Skanssi neighborhood had delayed in 2018. This was seen as a consequence of multiple reasons, such as the utilization of plot assignment stipulations, the economic recession, and Skanssi's less attractive location. The slow development of the neighborhood had also complicated the implementation of the two-way DH system. The informant's views of the implementation of the two-way DH system were contradictory; some argued that the two-way DH system needs other than only apartment buildings connected, but options for those buildings did not exist, at least in 2018. Hence, the implementation of the system still appeared complicated and unclear. The next chapter moves to discuss institutions in the niche management of Skanssi's DH.

4.3 Institutional constraints in the development and implementation of the DH innovation

The next sub-sections analyze the institutions which constrained the development and implementation of the innovation. The institutions are divided into regulative, normative and cultural-cognitive institutions according to William Scott's (2014) classification.

4.3.1 Regulative institutions

The two-way low temperature DH system of Skanssi was the first experiment of its kind during the time of research. Therefore, there were no preconceived regulations or laws about the implementation of the system. In general, the laws concerning DH were not considered to be as advanced as electricity laws. This was partly seen by the informants as a consequence of the DH sector being led primarily by municipalities and energy companies, whereas the electricity sector was a more national level issue. Since information about the regulation of a two-way low temperature DH system was limited in the beginning of the project, the actors noticed that much development work on the system was needed to be done locally in Turku. This was seen as a challenge and an opportunity at the same time by one informant:

District heating is more free and wild since there the actors have mainly been cities and the development work has been more inside the city community than with a legislator, but on the other hand it gives more possibilities for developing the activities, but then, with the contract affairs we were left penniless since nothing actually regulates them. (City of Turku 2)

The uncertainty of the formal institutions for two-way DH was also noted in other related regulations. For example, two-way DH was not recognized in taxation or energy performance certificates. In addition, one informant noted that they did not yet know what data the smart metering of decentralized

DH would produce and how that data would be handled. Two-way DH regulation and its compatibility with current regulation was going to be formed locally in Turku, since regulations, such as laws or policies, did not exist.

Since no specific rules for arranging the two-way DH contracts were available, the informants suggested two different logics for implementing the rules. Some took the position that the rules and conditions for the two-way DH would be negotiated between the regional energy company and the first heat producers. The perspective represented the implementation of two-way DH from an experimental and local point of view, since complete models for two-way DH trade contracts were not believed to exist yet. Fixed regulation was seen as undesirable, since it was thought to limit the freedom to experiment. There was a perception that the most beneficial contract would be found by negotiating about its conditions together. Based on the results of short-term, experimental DH contracts, generalized models for the two-way DH trade could be formed. This logic was seen to be flexible, as both the energy company and the heat producer could influence contract regulations. However, the two-way DH contracts had not yet been negotiated, and the pricing of heat was raised as a central challenge by one informant:

Only the price should be there for everyone, in a way, put together a final list with the partner that 'these are the things we need, we will meet at the halfway, you pay this much and we this much, and there are the costs we have to share together', and in a way, it is what it [two-way DH] *needs.* (Turku Energia 1)

Contrary opinions for establishing the two-way DH's regulations were expressed. Some viewed that since there were no prices for the two-way DH, developers and inhabitants were unable to estimate the price of the decentralized heating system, and thus they were unwilling to experiment. Some informants expected a top-down logic for setting the rules, in which an established regulative environment would alleviate uncertainty, reduce risks and thus enable to begin the decentralized heat production. Profitability of the two-way DH system was seen to be important for most informants, but it was also questioned of whether a two-way DH trade model, which would share profits for all, could be found:

Are they able to form the price in a way that it would be profitable among these actors and housing cooperatives or not, I can't even say, is it possible with the chips they currently hold. (Housing developer)

In 2018, no one had knowledge of the final terms and conditions of the heat trade contracts. However, discussions of the contracts' conditions were seen as unimportant by some before there was any practical experience of the two-way DH. The implementation of first two-way pilot contracts was seen to be crucial by most informants, but slow area development of Skanssi postponed it. The pilot would bring more experience and knowledge of the functioning of the two-way DH, its profitability and regulations, and thus it would further the development of the two-way DH. However, the first pilot had not been able to be arranged in 2018 even though it was acknowledged as a central milestone by one informant:

Probably we should find a temporary business model for the first projects in which it would be really rewarding […] so that we could test the technical system in the first place, because the business model does not matter if there is no technical capability. (City of Turku 4)

Other regulative institutions that could be observed from the data were the plot assignment stipulations, which the city of Turku utilized in the land rule of Skanssi. The stipulations were divided into required, conciliatory and recommended conditions. By utilizing the stipulations, the city administration could attach instructions to the developers and bind them to implement the sustainable targets of the area, in exchange for the land. The stipulations also included parts of the implementation of the DH system. However, the stipulations did not coerce into decentralized heat production or to connect houses to the DH grid. In addition, they did not describe how the decentralized heat production would be organized. This was not given even as a recommended condition in the stipulations.

Even though the land rule did not force participation in DH, the plot stipulations could be seen as coercing into the DH indirectly. For instance, one required condition of the stipulations stated that all apartment buildings of Skanssi had to be equipped with a DH connection technology which enabled the two-way flow of heat. Another condition stated that a space for the possible installation of solar thermal collectors has to be left into the structures of the house. Hence, the stipulations could be seen as coercing into DH by implication, even though participation in it had not been explicitly written. Coercion into heat production was acknowledged as an enabler of the two-way system by some informants, even though coercion was not used.

The plot assignment stipulations were not seen as perfectly effective. One informant argued that the city administration did not have a formal body to supervise the materialization of the stipulations. In other words, the city could set conditions for the developers, but they could not monitor whether the conditions were met or not. In addition, the developers had thought that the stipulations were too

demanding and ambiguous. The first construction company, whose construction was altered by the content of the stipulations, had decided in mutual understanding with the city and energy company to not to implement some rules stated in the plot assignment stipulations. Thus, some of the set targets had been abandoned before the construction of the first apartment buildings inside the low temperature DH grid had even begun. Also, the ambiguity related to the implementation of decentralized heat production had left some informants confused of how it would be arranged:

There is no exact or binding entry in the plot assignment stipulation of the practice of how the local production will be arranged... How would I put it, in that respect it is in the gray area and has been left as an issue which will become more precise in the future. (Housing developer)

Most of the informants did not consider that law or regulations constrained or empowered the two-way DH experiment. Only one informant mentioned the EU commission's target to open the DH networks in the future but did not consider it as an influencer of Skanssi's DH experiment. Though, further adaptation of EU legislation at the national level was seen as a possibility to advance the development of DH in the future. In addition, one informant stated that the Finnish government had only offered tax credit for the households energy renovation expenditures, which could be used to advance the two-way DH in households. No other policy tools or regulations were mentioned enabling the two-way DH, but neither constraining. However, some informants noted that all regulations that might constrain the local experiment had not necessarily yet been encountered due the early phase of the experiment.

In addition to the EU and national level politics, actions from local political sphere were viewed inadequate to empower the two-way DH system. For instance, neither the city of Turku nor the energy company had provided any incentives, such as grants, to realize decentralized heat production. However, there were no sanctions set for the housing cooperatives of not producing heat either. Some informants argued that at the beginning the two-way DH would need an incentive to proceed and to overcome the inert situation. Nonetheless, incentives were considered to be most beneficial to start the decentralized production, and then they should fade away. One informant emphasized the importance of financial support in the implementation of first pilots:

Probably in a pilot area it could be nice that there were small reliefs in order to start it, it would benefit other representatives of the sector too, who would see that how the pilot functions in Finland and what experiences would be collected in it, it is a value in itself. There comes new information of its function and then if there are some challenges that what the challenges are then that the others could learn from them. (VTT)

In summary, regulative inertia stemmed mostly from the absence of the pre-existing specific regulation. The absence of regulation caused uncertainty for the implementation of two-way DH, since no clear models for arranging it existed. Some wanted a top-down rules setting for the two-way heat trade, when others supported the bottom-up experimental approach. In 2018, there were no incentives for the implementation of the two-way DH trade, which existence probably had empowered the experiment. In addition, no pilot contract had been arranged where the regulations of a two-way DH had been experimented. The plot assignment stipulations constrained into DH and decentralized heat production indirectly, but unclearly, and this caused confusion. No higher level political authority was viewed to advance or constrain the local DH experiment. Some informants reminded that all the challenges two-way DH system might face had not yet been encountered and the future might bring new regulative challenges.

4.3.2 Normative institutions

The DH experiment of Skanssi was based on the interests of the regional energy company. They, in cooperation with the city, started to push the idea in Skanssi. The experiment was a means to achieve goals related to greenhouse gas emission cuts and improve the competitiveness of the DH. These targets were in the interest of both the city and the energy company. Thus, there were normative expectations regarding the experiment for whose realization the developers and inhabitants were responsible for. In other words, the development of the DH experiment did not begin with their ideas, but they were nonetheless responsible for certain normative expectations regarding its construction. This system-push approach had not advanced easily, which was also acknowledged by an energy company representative:

At Skanssi the starting point is a little bit different that we are kind of trying to lift up this two-way system and find the right partner, but it would succeed so much agile if you already had an existing cooperation who kindles that 'we would like to try, will you cooperate'. (Turku Energia 1)

Even though the citizens were seen to value sustainability and not oppose the two-way DH experiment, they were not considered to be interested in participating in experiments. In general, they were seen as hardly interested in questions related to energy, most of which were viewed to be rather unfamiliar to the everyday life of ordinary citizens. It was uncertain how the support for sustainability would turn out into decentralized heat production. One informant highlighted the challenge of translating the vision of the experiment into the actual changes of living practices:

We had this sparring group with whom we went through these ideas, and all of these ideas got really positive feedback, but then when people praised that these are good solutions and we have to develop

these, but then, on the other hand they are still so far from the everyday life of people that the ordinary consumer does not know or understand that what is actually the question. (City of Turku 2)

Also the construction companies were seen to be uninterested in experiments. Experiments were seen as abnormal to developers' business operations, which would only cause undesirable risks and increase their expenses. One-way DH had been an easy option which had not demanded much involvement or technical knowledge of energy systems from the developers. The two-way DH demanded more expertise from the housing developers, which they did not usually have. Lack of energy expertise inside the construction companies was acknowledged during the project, and the aim was to provide more guidance and advice for the future developers of Skanssi. This was considered to empower the two-way DH in the future. One informant viewed the norms of the building sector as the following:

The understanding of profitability of things seems to be quite central for developers and that normal construction company, who then sells the apartments and wants to keep things simple and avoid problems and manage the project and sell and move on to next project. (City of Turku 1)

The normative institutions were also related to the different roles the actors would have in the vision of the two-way DH system. The role that developers' and inhabitants were considered to play differed greatly in comparison to their roles in the conventional DH system. Developers were expected to construct the apartments in a way articulated in the plot assignment stipulations and to invest in DH production technologies in the constructed apartment buildings. In addition, they were expected to participate in the development of the two-way DH system of Skanssi. The future heat suppliers and buyers would mainly be the future housing cooperatives.

Inhabitants in the housing cooperatives of Skanssi were envisioned to change their living habits by investing in heating technology and participating in decentralized heat production through collaboration in the housing cooperatives. Inhabitants' and developers' new, transformed roles were crucial for the implementation of the two-way DH, even though they deviated greatly from the current roles of the one-way DH system. However, there was no information on how the roles would be realized, and some informants were skeptical towards the transition of the roles:

I would assume that in the decision making of the housing cooperation you would probably face the mainstream 'couldn't care less'. (VTT)

The roles of the regional energy company and city were easily compatible with their roles in the conventional DH system. These actors also formed the core of the niche network. The role of the

energy company was seen as the operator of Skanssi's DH grid. The company would solve the two-way DH trade contracts with the heat producer and take care of the stable functioning of the grid. The city, on the other hand, would steer the apartments into the two-way DH system with the plot assignment stipulations. They would also coordinate the general area development. When apartment buildings would be finished, the city would participate in Skanssi's DH only indirectly as the owner of the energy company or as a heat trade partner. The city and the energy company probably had been able to articulate the easy-to-adopt roles for themselves, since they had been deeply involved in the vision making. However, some informants argued that the implementation of the two-way DH system would demand more radical reforms, such as unbundling of the DH grid's ownership. This would also change the roles of the energy company, but in 2018, these disruptive changes had not been done.

Profitability of the two-way DH system seemed to be a central value for most informants, though even a first pilot contract had not been arranged. An important, but unsolved question was: Who was obliged to pay for the investment of two-way DH system? No one, not the future inhabitants, developers, the city nor the energy company seemed to be willing to pay for the heat production technologies and the costs of the alternative, low temperature and two-way DH system, even though it was a key objective of Skanssi. The uncertainty of the monetary benefits was seen to only increase the difficulties in getting people involved. One informant also stressed the long payback period of the investment, which increased the complexity of the implementation of the system:

Who pays for the costs of the energy efficient construction, or the costs of the energy efficient house, and in what time frame, that if it is more profitable in a 20 years' time frame, how we can get the benefit to the inhabitant. (City of Turku 1)

Turku Energia, as a leader of the Skanssi energy project and the owner of the heat grid, answered for the DH contracts. The energy company was going to continue searching for potential heat producers by the same means as earlier: by being easily available, participating to the events of Skanssi and communicating about their aims actively. They were not going to change their practices, even though earlier proposals had not produced the desired results. Some informants suggested that the local energy company could propose lower expectations of profits or create an hourly or real time DH pricing in Skanssi. In 2018, Turku Energia had changed the DH pricing from a fixed price to seasonal pricing. One informant viewed that the pricing model of the DH was not going to be changed:

Why advance [hourly pricing] *when we don't have any customers, why do something like that, we don't have anyone who would like so sell us.* (Turku Energia 2)

Most informants highlighted the strong organizational support the two-way DH experiment had from both the city administration as well as from Turku Energia. Advancing the low temperature two-way DH experiment inside the city was considered easy, since the organizations, employers and politicians did not oppose it. On the other hand, some thought that even though the experiment was not opposed, it was not given enough resources to proceed well. Some informants viewed that decentralized DH production in a public building would encourage others to get involved in it too, and there was a vision to arrange heat production into a future school in Skanssi.

Some suspected whether the city was really interested in promoting the two-way DH, as they had vested interests in the project. If realized, the two-way DH production could decrease the profits of the local energy company, whose owner with the largest share was city of Turku. Even though the city intended to make the energy system more sustainable, one interviewee pointed out that the city of Turku might have contradictory interests:

If there is an energy company owned by the municipality, and the municipality wants that it is a good business and it produces capital for the municipality, then of course the politicians reflect it… that is this smart, that does this harm the profit-making and so on. (Sustecon Oy)

Some informants mentioned that since Skanssi was a green field, experimenting with DH was expected to be easier. The construction companies were expected to agree to the alternative land use rules with plot assignment stipulations more willingly at a new and experimental area than at the infilling development area. Even though there were multiple reasons for the delay of the area development, developers were seen to prefer plots without plot assignment stipulations. One interviewee doubted whether the company B would have decided to construct in Skanssi at all if it had been aware of the plot assignment stipulations beforehand. The use of plot assignment stipulations was not a norm in land use rules, which perhaps made developers shun the plots of Skanssi.

Lastly, the realization of the two-way DH in the particular case of Skanssi was seen as a challenge by some informants. Some informants acknowledged that heat producers could be found more easily in other areas in Turku. On the other hand, Skanssi was the particular location that had been pointed out as an area where the two-way DH was expected.

In sum, actors' different values, roles and the lack of information of the two-way DH system were the main causes of the normative inertia relating to the implementation of Skanssi's two-way DH. The energy company and the city wanted to implement the two-way DH in Skanssi. This wish was not generated by the inhabitants or developers. Inhabitants and developers had central positions in

empowering the two-way DH system, but there was no clarified view of how these new roles would be adopted. Operative practices also caused inertia for the development and implementation of the experiment: no radical decisions were made in the project, possibly due to vested interests of central actors.

4.3.3 Cultural-cognitive institutions

The greatest challenge for realizing the DH system was probably to develop the culture and frames of the novel, two-way DH system. The regulative, normative and cultural-cognitive institutions all intertwine in the development and implementation of a novel system. Inhabitants and housing developers had never been influenced by such institutions which the realization of the decentralized DH system of Skanssi demanded. The DH experiment was uncommon in its functions in comparison to the one-way system that people had grown accustomed to. The informants viewed that the creation of the new socio-technical system with all its new functions was the most difficult thing in Skanssi:

In general, as usually with all these new issues at the heating sector, the technology is not a problem, but maybe all the other things around it. (Turku Energia 1)

Probably the biggest problem will be that how a single housing cooperative gets excited of it, or how to attract some actors there who, perhaps, that hey someone wants to build a larger ground heat pump there or to do heat recovery of a store so then it wants to sell it forward, so what is the business logic there, so generating a business environment is probably the biggest challenge. (VTT)

Decentralized heat production was not seen as a cultural convention in the housing and energy sector. Even though Skanssi's energy plans had been on display in the media, it had not attracted the interests of the inhabitants. The constitutive schema of the inhabitants about the DH system seemed to support the traditional DH system, in which inhabitants were not active participants in the energy system. Few informants also questioned the faith in inhabitant's behavioral change to actually change to a more sustainable mode of life in Skanssi. For example, one requirement in the plot assignment stipulations required the housing developers to connect the houses to the two-way DH system with smart housing technology. By utilizing the smart services, inhabitants were expected to pay more attention to their DH usage and get accustomed to controlling its demand and supply. However, the behavioral change and customer demand was not seen as a driver of two-way DH according to one informant:

No one of these buyers has lifted up these energy issues to us in a way that they had asked that how we are going to implement these energy issues in here, and no one has actively brought up that they

were the reason for their purchase… The reasons for selling a house are price, quality, appearance of the buildings, things like these. (Housing developer)

The cultural schemas in the housing and energy sectors had already began to change, since some companies were having more experimental and sustainable projects. Despite of this small observed cultural change, Skanssi's two-way DH had not gained interest. The common shared understanding in the housing sector seemed to support conventional building projects, in which buildings were quickly constructed and then sold away. Turku Energia had been searching for new practices, and started to implement a novel energy system, even though research and experimenting had not been a customary interest of the municipality owned energy companies. This had created new practices and operative culture in the company. The new practices of the energy company also involved actors from the housing sector, where the energy company earlier had not operated. The slowness in implementing of the two-way DH system may have been the result of new practices that the experiment brought along. For instance, the collaboration between the housing developers and the energy company had not been as close in the past as the two-way DH experiment demanded.

In addition, the already repealed old land rule regulations seemed to still constrain the thoughts of some developers. Previously, municipalities had coerced inhabitants and developers to connect their apartments into the local DH by the land rule regulations. Informants argued that they had abandoned this coercive institution, since coercion was viewed as strengthening the monopoly of the regional energy company. However, one informant pondered that the old regulation could still have an influence on the belief systems at the construction sector, which inhibited the implementation:

It is probably an old echo at the developers' side that 'nonetheless you will coerce us into this' that 'we don't wan't to join anything that's forced on us' but then at Skanssi in order to realize, there isn't much alternatives but to participate into district heating grid, that it is kind of an obligation. (Turku Energia 1)

One informant mentioned that the intention was to form a system that would demand only small participation from the inhabitant. Nevertheless, some kind of interface between the inhabitants and energy company was needed, but it was uncertain how their relations would finally be realized. One idea for increasing citizens' familiarity with the DH system was to install electric screens to the street scene of Skanssi. Screens would provide a space which could be used for communicating with the citizens about the DH system, but no structures for building and maintaining the novel relationship between energy company and inhabitant were proposed by the informants.

Some informants argued that the operative culture in the project would also need to be improvement. All the actors did not have the same knowledge of the technical preconditions than the technical experts, and therefore the formulation of the common vision inside the project was sometimes experienced to be difficult. On the other hand, experiments were considered to always be uncertain to some degree. For example, no one seemed to know how the two-way DH system would be finally realized in the housing cooperatives, but the experiment was still continued, and the challenges were going to be solved within the project's development.

In sum, reconfiguration of the cultural schemas of the one-way DH system into a two-way and decentralized DH system were not advanced. A two-way DH system like in Skanssi had never existed before and this shaped the social construction. The inhabitants had not shown an interest in participating in the DH experiment; neither was energy experimentation a cultural convention in the developers' operations. The cultural schemas seemed to support the passive agency of the inhabitant and developer in a DH system. In addition, the experiment had brought along new practices, such as more extensive cooperation, in which all the actors were not yet accustomed to. Some informants argued that if someone, somewhere, had succeeded in Finland in what they were doing in Skanssi, the project would probably have proceeded much quicker.

4.4 Learning experiences from the experiment

All interviewees noted that they had learned new things during the development and implementation of the Skanssi's DH. What was learned varied among the informants, and it probably depended on their preceding expertise. Most interviewees mentioned having learned about renewable energy technologies and energy production and some saw that their views regarding city planning and decision-making processes in the city had widened. Especially the formulation of the plot assignment stipulations was seen to generate new knowledge. The informants felt this formulation challenging but important and useful in the future's projects. However, in 2018 plot assignment stipulations had not yet been applied to other areas in Turku.

Interviewees mentioned also having learned about other actors' and organizations' work and working culture. The development of the DH had formed new networks that were considered beneficial for future projects. However, since the DH innovation of Skanssi was only one of the innovations and experiments in the area, the informants were uncertain whether the two-way DH was the thing that led people together. Still, the collaboration between the city of Turku and Turku Energia was considered to have extended during the development of the DH experiment. The energy company and city had not participated in planning the city together as closely before. Writing of plot assignment

stipulations was a good example. One informant viewed that Skanssi had already led into nascent changes in the organization culture:

When we have seen a little bit closer how the city plans new areas and in a sense how the building project develops in there, then we have changed our operations and asked more proactively that 'how is it going' and 'do you have something going on in which we could join'. (Turku Energia 1)

The DH niche was reshaped after the events where Skanssi's energy vision was shared with the local companies. Because the companies wished that one party were accountable for the development of the niche, the ownership of Skanssi's energy project was nominated to Turku Energia. The nomination contributed into path-dependency that emphasized the project ownership of the regional energy company. In addition, based on the collaboration, the vision of the district cooling network of Skanssi was abandoned. The construction companies did not consider Finnish households to be ready to pay for district cooling, and therefore, the DH of Skanssi was reshaped to consist of only of the heating grid. This reshaping decreased the possibilities of the housing cooperatives to produce energy, since the decentralized heating technologies would have produced energy more efficiently to the cooling grid than to the heating grid. However, the vision to implement two-way DH production into Skanssi persisted.

Turku Energia ordered commissioned research about the two-way DH system from the research organization VTT, but the results of the study were not shared outside company. Therefore, it is difficult to say what the impact of the study was and how it shaped the expectations inside Turku Energia. However, the intermediary organization generated essential knowledge of the functioning of the local DH grid. VTT articulated the vision of the experiment more precise by investigating the scenarios of the two-way DH system and by clarifying the requirements and resources of the system.

Skanssi and the DH experiment were viewed to be widely known in the energy sector. Skanssi had already attracted visitors, and the area itself was viewed to be a place in which new knowledge was generated and shared. In 2015, Turku Energia and Skanssi's energy project was nominated for the climate action prize of the year. The prize was experienced as lifting the spiritual goals positively and motivating for the informants. They felt they were doing the right and necessary thing. However, one informant described that the prize also increased pressure:

When we got the climate action prize of the year it raised our targets that we got fame, and then we maybe thought we have to raise our own targets that we would be worth of the prize. (City of Turku 2)

One informant stressed the inert situation of the DH experiment in 2018. Since the implementation of the two-way DH was halting, major changes in the management of the project would be required. These changes would improve the implementation and make it more attractive for other actors to get involved. The informant emphasized the need for clarification of the unsolved economic questions:

Now we are in a state of mind that the mechanism of the cost structure of the two-way DH, what does the purchase and selling cost, it is an acknowledged question in which we would need a solution to. (Housing developer)

In 2018, no two-way DH contracts had been formed. In addition, the development of the Skanssi neighborhood was still very much in the beginning, since the first apartment building inside the low temperature DH grid was ready in summer 2018. Experience about the low temperature DH was gained after that. This can lead into new learning experiences and shaping of the niche.

5 Discussion

The aim of the study has been to investigate how the sustainable DH niche of Skanssi evolved and how institutions shaped the development and implementation of the innovation. The analytical framework was formed by utilizing strategic niche management literature and the three institutional pillars by Scott (2014). This chapter discusses the main findings of the study in the light of earlier research. I begin by examining the different sustainability visions of the experiment, after which I discuss the institutions in the niche management. I then scrutinize the role of the niche network and the intermediation in guiding the niche management process. Finally, I discuss the learning experiences and the future path of the two-way DH experiment.

First, regarding the visions of the experiment, the major target of the low temperature two-way DH system was to renew the DH system by creating a sustainable alternative. The experiment can thus be viewed as a niche innovation aiming to transform the current locked-in and unsustainable system (Hoogma et al., 2002, p. 8). However, in addition to sustainability, there were many other expectations for the experiment. For instance, some envisioned that the experiment would increase the competitiveness of the DH, and others expected that it would empower the inhabitants of the area to produce heat and sell it to the grid. In 2018, the two-way DH system had not been implemented and the whole project seemed to be in an inert state. According to my empirical analysis, the quantity of various expectations was hindering the implementation: the actors had not been able to shape the experiment in a way that would have fulfilled all the expectations in the niche network. A common vision of the experiment, which has been stated to be a precondition of strategic niche management (Schot & Geels, 2008), was missing.

SNM literature defines seven essential dimensions of niche management, in which learning and vision building are needed. These are technology and design, market and user preferences, cultural meanings, infrastructure and maintenance, industry and production networks, regulations and policies and societal and environmental effects. (Schot & Geels, 2008, p. 540.) In the case of Skanssi the visions of the local experiment were most defined in relation to the technology and infrastructure of the innovation. These themes had been researched before the implementation of the experiment, which had clarified the resources needed for the niche management (Schot & Geels, 2008). However, the vision of the two-way DH had become clearer for the energy company whereas the housing developers were still having difficulties in understanding and adopting the new technologies. In addition, vision building concerning regulations and societal effects for instance, were much

unknown. Two-way DH is still a novelty in the energy sector, and due to this, vision building and learning in all dimensions is still imperfect. Unclarity of the vision hampers the implementation of a niche innovation (Schot & Kempn 2002) and thus, specification of the visions advances the DH experiment.

Some informants did not think that the vision would be executed if only apartment buildings would produce DH to the local grid. They saw that at least one industrial heat producer was necessary for implementing the two-way DH, but that producer had not been found. Contradictory visions hamper the niche management (Kemp & Schot, 2002) and they could have influenced the implementation of the DH experiment too. An investigation concerning third party DH producers by Pöyry (2018) states that currently the only competitive DH sources are produced by data centers or industrial sources. Since all the informants do not see the vision to be relevant, and the investigation states it is not cost-effective, it seems unclear whether or not the vision can be realized. The experiment would benefit from rearticulating the common vision as it clarifies the target of the niche network (Kemp & Schot, 2002). Furthermore, my findings stress the need to disrupt the current DH system and its institutions. The vision of the two-way DH system of Skanssi is locked-in with the target of bringing economic profit to everyone, and simultaneously aiming to provide profitable business for the energy company. Disruption of the institutions of the DH system has been noted to be essential for the implementation of a two-way DH system (Auvinen, 2017).

Institutions, such as norms and regulations, bring stability and empower action, although simultaneously they can constrain action (Scott, 2014). Institutional change is a slow process, and institutions are noted to be resistant to change (Pierson, 2004). This change resistance and stability prevents the entrance of sustainable innovations and hinders their diffusion (Geels, 2011). For instance, institutions bias the decision making of people. This bias makes them avoid a new product or service, which prevents the diffusion of an innovation in the regime level. (Geels, 2004.) In addition, institutions shape niche management at the niche level because of the vested interests of incumbents for instance (Smith et al., 2005). Similarly, in Skanssi, multiple regulative, normative and cultural-cognitive institutions hindered the local experiment at the regime and niche levels. Institutions that shaped the niche management of Skanssi are listed in Table 5.

	Regulative institutions	Normative institutions	Cultural-cognitive institutions
Regime level institutions	Not acknowledged in the current energy regulation	Not an interest of citizens and developers	No shared understanding of the two-way DH innovation
	No political constraint or pressure (from the EU or national level policy)	Vested interests of Turku Energia and city of Turku impact niche management	Housing developers do not experiment
			Old memory of constraining into DH hinders developers
			Active communication between energy company and citizens or housing developers is not cultural convention
Niche level institutions	Absence of regulation caused uncertainty	Use of plot assignment stipulations is not a norm	No shared understanding of the two-way DH innovation
	Energy company's incumbent power in the niche management	Innovation fits with the accustomed roles of energy company and city, but not with the roles of inhabitants and developers	Niche network does not believe in the cultural change of inhabitants of producing DH
	Ambiguous plot assignment stipulations	Value of profitability among niche network	Adoption of new cooperative culture in the implementation of the innovation was inert
		Maintenance of regime-level practices in the niche management	
		Interests of different parties do not align to empower the innovation	

Table 4 Institutions that shaped the development and implementation of the local DH experiment.

The nonexistence of regulation concerning the two-way DH production and distribution hindered the niche management. The experiment was difficult to implement because there were no regulations or standards concerning two-way DH. It has been noted in multiple previous cases that the development and diffusion of alternative technologies remains insufficient if the legislation does not acknowledge the systemic alternatives (see e.g. Fang et al., 2012; Kainiemi et al., 2013; Smith, 2007). Therefore,

current regulation could be shaped to empower two-way DH, for instance by identifying it in the energy performance certificates of buildings or energy taxation. Regulation concerning two-way DH would decrease its institutional uncertainty (North, 1990). Regulation could empower participation in the local experiment and empower the diffusion of two-way DH outside of Skanssi, thus increasing the stability of two-way DH as a part of the energy system.

In Skanssi, the regional energy company Turku Energia owned the local grid and acted as a coordinator of the two-way DH trade contracts. No external DH producers had been found, and the experiment was mainly managed by the energy company. As a consequence, the energy company had a natural monopoly in Skanssi, being able to set the conditions of the experiment. Due to the influential position of the energy company the niche innovation was developed by incremental solutions, which maintained the powerful position of the energy company. These habits of incumbents have also been noted by Coenen et al. (2010) and Smith et al. (2005). Incumbents are unwilling to execute actions that might hamper their conventional business operations (Smith et al., 2005). Similarly, in Skanssi, this regime level energy incumbent maintained its influential regime level position in the local niche management. It would be interesting to investigate different practices for organizing governance of the DH system. The experiment of Skanssi could also provide an alternative setting to arrange a DH system, in which decentralization could also include decentralized grid ownership for example. This would advance the disruption of the institutions of the DH system.

Institutional inertia in the implementation of the two-way DH also relates to the roles of different actors. The current one-way DH system has been formed through a historical path-dependent process which has maintained the roles of different actors for years. In the vision of the DH experiment, the role of the regional energy company remained similar to its conventional role in the current DH system. In contrast, the roles of construction companies, inhabitants and housing cooperatives differed significantly in comparison to their current roles in the one-way DH system. In the vision, the role of developers was to invest into energy production units and the role of inhabitants was to be willing to pay for the DH investment and organize heat production in the housing cooperatives. This is a radical shift from the current roles in the DH system, which do not empower such activities as envisioned in Skanssi. However, the adoption of these new roles is central for the successful implementation of the two-way DH system in Skanssi. Roles become adopted by repetition and habituation, which are slow processes (Scott 2014, p.67-69). The nurturing of roles has been stated to empower institutional change and thus advance the diffusion of the niche innovation (Wittmayer et al. 2017). Therefore, the developers and inhabitants of Skanssi would presumably need support in this radical change.

In addition, the misalignment of interests hinders the adoption and diffusion of the DH innovation. Developers and inhabitants were viewed to be interested in neither experimenting nor energy questions, which delayed the adoption of the DH innovation. In previous studies it has been noted that households prefer technologies which are competitive, easy and convenient (Klobut et al., 2014), and ordinary citizens are not interested in energy experiments (Heiskanen et al., 2015). Even though no one opposed the DH experiment of Skanssi, transforming habits to correspond with ideological values is a challenge in implementing sustainable innovations (see e.g. Raven et al., 2009). However, the involvement of citizens and housing developers is essential for the implementation of the two-way DH system, especially if the system is to be constructed so that they are active participants in it. Since the current centralized energy system does not demand much involvement from citizens and developers, this institutional change can be expected to be slow.

The niche innovation was managed to align with the interests of Turku Energia and City of Turku. However, in 2018 the niche management had led into a situation where no one else had not gotten involved to the project. The "technology push" approach of niche management with a narrow network is a challenge, and such project tend to fail easily (Schot & Geels 2008, p. 541). Unclarity and uncertainty about the benefits of an innovation also increases difficulties to implement it (Kemp et al., 1998, p. 187). The niche innovation on Skanssi would benefit from development that would make it attractive to all crucial parties, especially for those who are expected to join the project, such as housing developers and inhabitants. Economic questions, such as profitability of the innovation, were a key concern of the informants. Addressing these issues is central to further development of the innovation.

Even though there is a vision of a novel low temperature and two-way DH configuration, the vision needs to be continuously repeated. The two-way DH system is a huge change in the mindset of an ordinary housing developer and this shift will take time. Scott (2014, p. 68) emphasizes the role of cultural-cognitive institutions being the constitutive dimension of social reality. Their influence should not be underestimated. The informants felt that the experiment was problematic already at an early stage, since even the implementation process had proved to be far more complex than anticipated. Institutions change slowly (Pierson, 2004) and shifting the constitutive schema from a one-way and centralized DH system into a two-way and decentralized one is probably a long process. Therefore, it is particularly important to continue the experiment, share the vision and enlarge the network. Transitions are slow processes, but niche experiments are essential in leading sustainability transitions (Geels & Schot, 2010, p. 11-12).

Energy companies have noted to become increasingly important players in shaping the energy regime (Apajalahti et al., 2017). When examining the network of the DH innovation, a pivotal element is that Turku Energia, the regional energy incumbent, formed the core of the network. They were managing the development of the local experiment, which was also attended to by officials of the city of Turku. Turku Energia had changed its operative practices in Skanssi and actively pursued to implement two-way DH contracts, without succeeding with it. A construction company that was active in the area had been involved, but its participation was fading as a result of a misaligned vision and their decision of not experimenting. Other actors, such as citizens, project financer Tekes, or local technology companies did not participate in the development or implementation on a permanent basis. Further development of the two-way DH innovation will show whether the niche network enlarges and how Turku Energia will continue its operations.

Actors and organizations can possess intermediary roles (Hodson et al., 2013) or mediate various intermediary functions (Kivimaa, 2014). Intermediaries aim to speed up the transition and create links between different contexts, such as regional experiments and national energy systems (Hodson et al., 2013). VTT and Tekes can be seen as niche intermediaries who hastened the local energy experimentation and participated in its development. The function of VTT was to build a more concrete vision of the experiment by investigating the production scenarios in the grid. The innovation centre Tekes provided the finances that initially made the Skanssi energy project and the two-way DH experiment possible. The roles can be seen to align with the typology of the roles of intermediaries in niche internal processes by Kivimaa (2014). However, their role in the niche management was piece-meal intermediation, which is described as short-term and focused on a specific issue (Hodson et al., 2013). The intermediaries participated in the niche development process only partially, and with context-related priorities. VTT approached the case from the conditions set and with the questions commissioned by Turku Energia, and for instance questions related to user acceptance or regulation were left not investigated. However, a potentially important actor in sustainability transition, a process intermediary, who had participated into the experiment from beginning to the end, approaching the experiment as a socio-technical entity (see e.g. Van Lente et al., 2003) and executing the daily actions of a niche process (Kivimaa et al., 2019), could not be observed in the case. A process intermediary would advance the implementation of the niche as a neutral actor, because incumbent actors do not develop innovation with the most sustainable and optimal decisions due their vested interests (Bakker et al., 2015).

Lastly, shielding and nurturing of the local DH innovation were scarce or absent. For instance, no financial grants or knowledge for the implementation of the novel socio-technical configuration was

available. The development of the DH innovation can be viewed as “fit and conform empowerment”, in which the niche is intended to be diffused into the current regime without changes (Smith & Raven, 2012, p. 1030). However, this empowerment seems insufficient, which was also indicated by the inert situation in 2018. The DH innovation did not fit the institutions, and current institutions did not empower it. Sustainability niche innovations, such as the two-way DH system, cannot compete in the normal market environment due this institutional mismatch (Geels & Schot, 2008). The two-way DH innovation will not become widely adopted without niche protection and nurturing.

Second order learning refers to niche reshaping, in which a niche innovation is shaped to better align with its environment (Schot & Geels, 2008). Even though the DH innovation of Skanssi had been shaped a few times due to these second order learning experiences, I see the inert situation of 2018 as a new moment of second order learning. Smith and Raven (2012, p. 1030) discuss “stretch and transform” empowerment, in which the innovation is reshaped to better succeed in its institutional environment. “Strect and transform” also aims to disrupt the current institutions, which hinder the diffusion of the innovation (Smith and Raven, 2012, p. 1030). Reshaping the DH innovation would help to tackle the institutions that constrain the niche management and overcome them. In addition, reshaping would advance the diffusion of the innovation, regardless of whether the goal is only to improve the business of the energy company or to actually create a vision of a scalable and sustainable DH system. Increasing number of inhabitants and developers of Skanssi will reinforce the possibilities to implement the experiment in the future, and therefore, experimentation should be continued.

6 Conclusions

This final chapter presents the conclusions of this master's thesis. This qualitative case study research has analyzed the development and implementation of a local DH experiment and the institutions which caused inertia for this experiment. This research has targeted to answer the following two research questions: 1) How has the strategic niche of two-way district heating innovation of Skanssi evolved, and 2) How did the regulative, normative and cultural-cognitive institutions shape the emerging district heating niche?

The DH innovation evolved from the need to find ways to reduce greenhouse gas emissions in the city of Turku. Renewal of the energy system was noted to be central in achieving climate targets. Experimenting with the DH system had been in the interest of the regional energy company, and the DH experiment of Skanssi began from their initiative. This local experiment was simultaneously addressing multiple challenges, including the reduction of carbon emissions, but it was also creating new opportunities, such as developing the business of the regional energy company. The DH project of Skanssi was active from the year 2013 onwards, but in 2018, the development seemed to have stopped. Slow construction of buildings in Skanssi had a significant impact on the implementation of the two-way DH experiment, as it was dependent on the participation of the developers and inhabitants of the area.

The implementation of the two-way DH was actively pursued with the first housing developer of the area. However, a common vision of the experiment was not found and the attempts to implement the experiment ended. In 2018, there were no two-way DH contracts in Skanssi, and the energy company was expecting new housing developers to begin construction in Skanssi, which would further advance the implementation of the DH experiment.

The regional energy company formed the core of the niche network and was influential in managing the niche innovation. In addition to them, only officials from the city of Turku were involved in the niche network. Small networks are a challenge for niche innovations, and the involvement of a wider array of actors could improve the niche management of Skanssi. Networks need to be wide so that all who are impacted by the energy transition can be involved in visioning and shaping it. However, other parties had not become involved in the niche management of Skanssi. The innovation was not attractive enough due its multiple uncertainties, such as the uncertainty of economic profits and the difficulty of understanding the technology involved. In addition, the powerful position of the energy company in the niche network might have decreased the interest to participate. In 2018, the

implementation of the two-way DH system of Skanssi was still a common target. Two-way DH pilots in the region are essential in implementing the experimental DH system.

The findings of this study stress the novelty of a two-way DH system. The implementation was inert due to high uncertainty of the innovation. This uncertainty indicates that there were no institutions concerning the two-way DH system, nor did it fit the current institutions of the DH system. There was no specific regulation concerning two-way DH in Finland. Furthermore, two-way DH was neither a norm in the socio-technical DH system, nor compatible with the accustomed roles in it. In addition, there was no shared understanding of the DH system. Due to its radicality, the current institutions of the DH system need to be disrupted in order to empower the two-way DH.

Energy companies are constrained by the current institutions of the energy system, and the regime level role of Turku Energia influenced the implementation of the DH innovation. Even though the interest of the incumbent was to transform their operations more sustainable, their interest was also to maintain the profitability of their business. These vested interests of the energy company shaped the niche management of the two-way DH experiment. Due to the inert situation in Skanssi in 2018, the niche management of the two-way DH innovation would benefit from rearticulating the vision. Contradictory visions need to be resolved and the institutional inertia overcome in order to advance implementation.

The results of this research emphasize the fact that transitions are slow processes. Local experiments are important in advancing the energy transition by proposing visions, but already the implementation of a novel DH system poses multiple challenges. However, sustainable niche innovations propose multiple learning experiences that further advance the facilitation of the energy transition in different contexts and areas. When experiences of local experiments are shared outside the communities, others can learn from the forerunners and obtain the best practices. Skanssi has already raised interest from outside the Turku region and time will tell if the local DH innovation further advances the diffusion of the two-way DH.

If the implementation of the two-way DH system becomes a widely supported vision in the Finnish society, the energy system needs to be disrupted (Auvinen, 2017). Currently the energy companies hold the power in the energy regime and their target is to conduct profitable business. It may be that these power structures need to be reorganized if there really is a will to create a decentralized heating system. It is uncertain whether a future two-way DH system could share profits between both the energy company and the producers of the heat, although this was an expectation in Skanssi. In the future, energy transition research needs to tackle new emerging topics: How can a fair shift from a

centralized energy system to a decentralized one be organized? Do energy companies lose in the energy transition when ambitious climate policy is sought? Do the companies need to be compensated for this loss or does the market fix itself? Energy transition has begun, and new interesting research topics will emerge. For instance, the preparation of sector-specific low-carbon roadmaps has begun this fall (TEM, 2019) and the results of these roadmaps will clarify concrete ways of reducing emissions in different industries. It will be interesting to see if the government takes a stand on the role of the DH system in its forthcoming policy mix.

After the research data was collected in spring 2018, the conditions in the case of Skanssi have probably changed. Further research on the implementation process of the DH innovation could produce a characteristic longitudinal case study for sustainability transition research. In addition, general discussion concerning two-way DH has expanded since spring 2018. Some energy companies, such as Fortum in Espoo and Helen in Helsinki, have opened their DH networks for decentralized DH production and introduced prices for the DH they purchase form the public. These changes will slowly begin to change the energy regime and the institutional environment of the DH system. These changes might also influence the decisions made in Skanssi.

For society this research has produced more information about the development and implementation process of the low temperature two-way DH experiment of Skanssi. The results of this research propose learning experiences, which may advance the implementation of the local experiment in Skanssi. Equally, the results of this case study may be useful in the implementation of a similar socio-technical configuration in Finland as well as abroad. Furthermore, the results emphasize the socio-technical character of innovations: the DH experiment includes novel technologies, but it also brings along new users' practices and regulations. These social dimensions should be taken into account when innovations of sustainability transition are implemented.

The novelty of two-way DH, the institutional inertia of the experiment and the lack of niche intermediaries raises questions concerning motives and common pool resources. In whose interests is it to advance two-way DH? Transition of the energy system is needed in order to slow down climate change and achieve political climate targets. These demands are also widely supported in society. Even though the diffusion of the two-way DH system would serve climate targets, the case of Skanssi shows that diffusion is inert. Transition of the DH system could be investigated as a common pool resource problem: Is the DH system a commons in which the environmental costs are not taken into account and cheap energy is produced until the resources run out? The DH system is the source of a large portion of greenhouse gas emissions, but due to its institutional stability, calculating and distributing the environmental costs might be difficult. The diffusion of two-way DH production

would reduce greenhouse gas emissions, but institutions of the DH system need to be disrupted to empower it. It would be important to investigate how the current DH system could be reorganized to increase two-way production and consumption. Transition of the energy system is inevitable and this locked-in energy system needs to be resolved. The energy transition remains a relatively young phenomenon, and will undoubtedly continue to inspire new topics of research in the near future.

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Appendix

Appendix 1: Secondary data sources

Websites

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Documents

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Appendix 2: Interview questions and complement questions and notes

1. Would you describe what you/your organization does in Skanssi?	
2. How is the work related to the local two-way DH system?	
3. Would you describe the actor-network around Skanssi's DH system?	

Expectations and opportunities

4. What kind of expectations do you have towards the DH experiment?	Why this innovation? What does it affect?
5. Do you think your expectations are shared by other actors?	b) n.n., n.n. and n.n. work with the two-way grid. Do you all share the same expectations relating to the project? How do the expectations differ?
6. Where did the idea of a two-way DH system come from?	How? Where was the information sourced from?
7. Which actors significantly influenced the DH innovation?	
8. Have environmental or sustainable approaches impacted the experiment?	

Implementation and challenges

9. How are the two-way DH grid and heat production implemented in practice?	Two-way DH and relations with - Technology - Politics and regulation - Culture - Demand - Local production - Infrastructure

10. Have you had any challenges or obstacles in relation to the development and implementation of the two-way DH system? If you have had, what sort of? Were the challenges related to: - Law or regulation - Authorities - Politics - Citizens or groups - Technology - Something else - (Cooperation?)	Who governs heat trade? Have you established a new organization? Who supplies the heat production technologies? Are they rented? What kind of contract is used? How are the inhabitants informed? Are the inhabitants obligated to produce and sell heat? Will the laws be changed?
11. How have you overcome these challenges?	Have regulations been altered? Has communication improved? Has previous technology been replaced? Have new practices developed? etc.
Has some actor been pivotal in resolving these challenges?	How? In what ways? What did he/she do?

Changes in organizational practices

12. Have your or other organizations changed their practices/operations after the project? If yes, how?	Has the project and the work associated with it changed your practices, e.g. to acquire heat pumps, to increase thinking about sustainability, broadened ways to operate, opened doors to future collaborations?
13. Has the culture of construction/city planning/ zoning changed in Turku?	Will the use of plot assignment stipulations be continued in projects outside of Skanssi?

Final questions: Learning and future possibilities

14. What have you learned form the two-way DH experiment, and how will you apply what you've learnt now and in the future?	a) Technology and design b) Societal and environmental effects c) Regulation and politics d) Users e) Culture and symbols f) Infrastructure Have participants in the project learned in the aforementioned dimensions (a-f) and has this learning been applied to the development of the two-way DH grid?
15. What would be the best way to advance two-way DH production?	Are you intending to apply this in other areas in Turku? What practices have been successful in Turku, and how could this be applied to other cities?

Appendix 3

Quotations in original language

se on tuonu meille semmosen konseptin mitä meillä ei aikasemmin ollu että kaupunginosa niinku voidaan tehdä kestävästi ja sille voidaan asettaa tavotteita jotka liittyy kaupungin kehittämiseen ja viestintään ja imagoon ja kaikkeen tämmöseen laajemminkin, et se kaupunginosan toteuttaminen ja kehittäminen voi olla semmonen vuorovaikutus ja yhteiskehittelyhanke. (City of Turku 1)

mulla odotukset oli et tosi hienoa kehittää uutta tekniikkaa ja näin kyllä niinku tulevaisuuden potentiaalin ihan merkittävänä että se vois olla iso muutos siihen energia-ajatteluun. (City of Turku 2)

mä olen tosi innoissaan et joku vihdoin otti tän, oli kiinnostunut selvittämään tätä tarkemmin […] Ja et mitä kaikkee hyötyjä se vois tuoda ja, haasteet ja niin poispäin. (Sustecon oy)

me halutaan varmistaa niillä luovutuksilla ja sopimuksilla että se kaukolämpöverkko on siellä mahdollista toteuttaa niin siinä mielessä meillä on odotuksia että me saadaan ne sisällytettyä niihin luovutuksiin ja ne rakennuttajat sitoutettua niihin ehtoihin. (City of Turku 3)

tää on tämmönen kokeilualusta johon toivottas kaikenlaista ei nyt vielä ainakaan kauheena jos rehellisesti sanotaan niin oo voimakkaasti tullu mitään uutta tai innovatiivista mut toivotaan et jatkossa. (Turku Energia 2)

me huomattiin kyllä että se ei sellasenaan toimi että jos siinä on pelkkiä asuinkiinteistöjä niin se ei varmaan niinku riitä siihen että siitä järjestelmästä tulis paljon hyötyjä kun ne on sitten käyttäjinä niin samanlaisia jakamaan siinä energiaa keskenään. (City of Turku 2)

kaukolämpöasia on paljon semmonen vapaampi ja villimpi siinä ne toimijat on pääasiassa ollu kaupunkeja ja se kehittämistyö on ollu paljo enemmän kaupunkiyhteistyössä kuin lainsäätäjällä mut toisaalta jättää enemmän mahdollisuuksia toiminnan kehittämiseen mutta sitte näissä sopimusasioissa oltiin vähän niiinkun tyhjän päällä että mikään ei oikein säätele sitten sitä. (City of Turku 2)

kaikille pitäs vaan saada se hinta sit sinne, tavallaan koota se yhdessä sen kumppanin kanssa tavallaan se lopullinen lista, et nämä asiat me tarvitaan ja te tuutte vastaan tän verran ja me tän verran ja tämmönen kustannus meidän pitää jakaa yhdessä et tavallaan sen tekemistähän se vaan vaatis. (Turku Energia 1)

pystyykö he määrittelee sen hinnottelun sillä tavalla että se on oikeesti näitten toimijoitten ja talonyhtiöiden kannalta kannattavaa vaiko eikö enkä mä osaa edes sanoa onks se mahdollista niinku niillä pelimerkeillä mitä heillä on käytössä. (Housing developer)

varmaan pitäis joku väliaikanen liiketoimintamalli niille ekoille kohteille missä se ois tosi palkitsevaa … jotta sitä ylipäätänsä päästäisiin testaamaan sitä teknistä järjestelmää koska sillä liiketoimintamallilla ei oo kuitenkaan sitte väliä jos ei oo sitä teknistä valmiutta. (City of Turku 4)

se miten se paikallinen tuotanto järjestetään, niin siihen ei oo mitään ekstaktia tai sitovaa kirjausta siellä tontinluovutusehdoissa kuitenkaan oo eli… miten sen nyt sanois niiltä osin se on vähä siellä

harmaalla alueella ja jääny sellaseks asiaksi että tämä tulee täsmentymään jatkossa. (Housing developer)

varmaan tämmöses pilottialueessa vois olla ihan kiva että siinä ois semmosia pikkusia avustuksia et se lähtis käyntiin sitten tota siitä ois niinku hyötyä muillekki toimialan edustajille jotka näkis miten se pilotti toimii suomessa ja mitä kokemuksia siitä kerättäis siitä on arvo itsessään että siitä tulee jotain uutta informaatiota sen toimivuudesta ja sit jos siellä on jotain haasteita niin mitä ne haasteet sitte on toiset pystyy sitte oppimaan niistä (VTT)

skanssissahan tavallaan lähtökohta on vähän toinen, että me ollaan, tavallaan yritetään saada tätä kakssuuntasta järjestelmää pystyyn ja haaliin sitä oikeeta kumppania et tollaihan se onnistuu paljo ketterämmin että sulla on jo olemassa oleva yhtiö jolla lamppu syttyy että me haluutais kokeilla että lähetteks te mukaan. (Turku Energia 1)

meillähän oli semmonen sparrausryhmäki tässä jonka kanssa käytiin näitä ideoita läpi ja kaikki nää ideat oikeestaan sai todella positiivista vastakaikua mutta toisaalta myöskin niin kun ihmiset kehu että nää on hyviä ratkasuja ja tämmösiä pitää kehittää niin toisaalta nää on sit sen verran kaukana ihmisten arjesta että ei se tavallinen kuluttaja niinku ymmärrä tai tiedä että mistä tässä on kysymyskään. (City of Turku 2)

mä olettaisin että sen talonyhtiön päätöksenteossa todennäköisemmin törmättäs kuitenki siihen mainstreamiin että ei vois vähempää kiinnostaa. (VTT)

se taitaa olla aika keskeistä rakennuttajalla se käsitys siitä että miten tuottosaa joku on ja sitte se että tommonen niinku normaali rakennus-, hankerakennusyhtiö joka myydään sitte ne kiinteistöt ne haluaa ehkä pitää asiat yksinkertaisina ja välttää niinku ongelmia ja hoitaa sen projektin ja myydä ja siirtyä seuraavaan projektii. (City of Turku 1)

kuka maksaa sit sen niinku kestävemmän rakentamisen kustannukset tai sen energiatehokkaamman talon kustannukset ja millä aikavälillä et jos se on edullisempi 20 vuoden aikavälillä niin miten se saadaan asiakkaalle se hyöty siitä. (City of Turku 1)

miks viedä eteenpäin ku ei meil oo yhtään asiakasta miks tehdä semmosta ei meil oo yhtään joka haluais meille myydä. (Turku Energia 2)

jos kunnan omistama energiayhtiö, kunta haluu et se tekee hyvää bisnestä ja tuo sitten rahoja kunnalle. Niin tietenki se varmaan mietityttää poliitikkojakin et.. Et onks tää järkevää et haittaaks tää nyt sitä kannattavuutta ja niin poispäin. (Sustecon oy)

No siis ylipäätään, niinku aika usein tämmösissä lämpöalan uusissa asioissa niin ei se teknologia oo se ongelma, vaan se on ehkä ne muut asiat siellä ympärillä. (Turku Energia 1)

suurin ongelma tulee ehkä siinä että millä tavalla niinku miten vaikka yksittäinen talonyhtiö innostuu siihen asiaan tai tai millä houkutellaan sinne alueelle vaikka jotakin toimijoita vaikkapa et hei joku haluaa rakentaa isomman maalämpöpumpun sinne tai tai kaupan lauhdelämmön talteenoton niin sitte se haluaaki myydä sen sinne päin eteenpäin niin mikä se liiketoimintalogiikka siinä on et se bisnesympäristön syntyminen on siinä ehkä se isoin haaste. (VTT)

näistä ostajista kukaan oo mitenkään tuonu näitä energia-asioista meille et ois kysytty että miten me näitä energia-asioita meinataan täällä toteuttaa tai niin että kukaan ois aktiivisesti tuonu esille että ne ois ollu ostopäätöksen perusteena... et kyl ne perusteet millä asunnot myydään niin on hinta, laadulliset tekijät, rakennusten ulkonäkö siis tällaset tekijät. (Housing developer)

se on ehkä semmonen vanha kaiku joka tolla rakennuttajaosapuolella on että ’te kuitenkin pakotatte meidät tähän’ etme ei haluta mihinkään pakkopullaan mukaan mut sitte taas skanssin alueella jotta se homma toteutuu nii ei oo kauheesti vaihtoehtoja muutaku liittyy siihen kaukolämpöön, et se on vähän niinku velvote kuitenki. (Turku Energia 1)

ku ollaan vähä nähty lähempää että sitä miten kaupunki suunnittelee uusia alueita ja miten se tavallaan se rakennusprojekti siellä sisällä menee niin niin me ollaan muutettu meidän toimintatapoja ja aktiivisemmin kysytty että miten teillä menee ja onko teillä jotain uutta menossa missä me voitais olla mukana. (Turku Energia 1)

Kun me saatiin se vuoden ympäristötekopalkinto niin se varmaan nosti aika paljon meidän rimaa et me saatiin julkisuutta ja sit ehkä ajateltiin et omia tavotteitaki pitäis nostaa että me oltais sitten sen palkinnon arvoisia. (Turku Energia 2)

nyt ollaan semmosessa tilanteessa että se mekaniikka siihen kakssuuntasen kaukolämmön kustannusrakenteeseen, mitä se osto ja myynti siinä maksaa niin se on se tiedostettu ratkaseva kysymys mihin pitäs vastaus saada. (Housing developer)