DISTRICT HEATING PROJECT DEVELOPMENT, A FRAGILE BUSINESS

Towards new collaboration and business models

Menno Schokker

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Foreword

Thinking back about how this research came to be and asking myself what I have learned in the past ten months, I find myself struggling to find the answer. Which may be a good thing. The vast amount of knowledge I have gathered and insights I had seem to have become a part of me. Theory of education uses the term 'unconsciously competent' for this. You do not know that you know. Still, I will try to look back until the start of this graduation process and see what I have learned.

Starting in September 2015 with the graduation process, I knew I was interested in sustainability, climate change mitigation and complex urban development processes. Almost automatically, as I looked for graduation research topics, I ended up in the context of District Heating, as this is one of the few urban area scale interventions that can significantly contribute to the energy transition through the built environment. By then, I hardly knew what District Heating was. I did not know anything of the energy market and/or system. I did not know what an energy company actually did. Or a utility company. Or a business model. I had no idea; I was educated in real estate and housing, not social-technical energy systems. By now, only ten months later, I am proud to say that I have developed a broad overview of how the energy system works, how the urban energy system works and what the big challenges are towards its future. And besides this broad overview I have gained specialized knowledge of the business of District Heating, one of the main big challenges. It still amazes me how much one can learn in the course of ten months.

In addition, I have discovered and experienced a large gap between the building and energy sector. I am happy to say that one of the main results of this research is my own ignited interests and professional goal to contribute in closing this gap and so contribute in the energy transition through the built environment. In that regard, the end of this research marks the beginning of a new professional goal and a new learning process.

As to lessons learned, fulfilling this research with all the other things I was doing in the timespan that was given required the maximum of something I will call my 'society mental capabilities'. Never before (really!) have I heard myself thinking and saying to people "I have bitten off more than I can chew". During many weeks, I found myself having lost control. This research required such a large part of my society mental capabilities that I had to give in too much in all the things I did besides the research. Socializing, climbing/training in the gym, short climbing trips to the Alps to keep the 'adventure mental capabilities' up-to-date, alpine instructor education at the NKBV, work at TU Delft and the graduation internship at Arcadis. For all of those activities I signed myself up for I was unable to perform the way I like to: with a mind of commitment, proactivity, gratitude and fun. All of them to a large extent became a guilty obligation that had to be done besides the research.

Still, as I know from my own experience in mountaineering, mental capabilities can be

stretched and repaired more strongly by going out of the comfort zone. I assume that when I get back from my two months of climbing in the Alps in July and August, I have fully restored my society mental capabilities and that they will be higher than before. As a life lesson, I know that I will always leave the comfort zone quite a lot as this seems to be in my nature. Next time however, I just have to keep control so that I can still do everything with a mind of commitment, proactivity, gratitude and fun.

Speaking of gratitude, I would never have been able to learn all those things without the help and assistance of many others. First and foremost, my supervising dream team Ellen and Ilir. Many moments I was lost and low on motivation you guided me right back on track, filling me with renewed motivation and drive. Your combination of flexibility in guidance and punctuality in content was perfect, I daresay a graduation student could not wish more of its supervisors. Speaking of supervisors, I thank Marius from Arcadis for the opportunity he gave me to see inside such an organisation and his honest remarks. I also thank Agnes Franzen for the useful sparring sessions when I was searching for a research topic and the flexible working culture and method she established at SKG so I could combine the work with this research. I thank Simon Tristan from Arcadis for enabling my first case study. Alexia for the design of the cover and lay-out of this report, merci chouchou. All the interviewees, Jan Streefkerk, Joep van der Tillaart, Ton Goossens, Nico Buskens, Jan van der Meer, Rick van Diest, Simone Ploumen, Jannis van Zanten, Martin Buijck, Rob Kemmeren and Jurgen van de Laarschot, thank you for making this research possible.
Last but definitely not last, my ever supporting parents. Without any pressure I have always been able to pursue the things I wanted, with always your unconditional support. I strongly believe this stable and neutral upbringing forms the very basis for every 'success' I have achieved and will achieve. For the achievement of this education, I deeply thank you.

Menno Schokker
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Executive summary

The primary objective of this research is to investigate the role of business models and collaboration mechanisms in District Heating project development.
District Heating is 'a local network of pipes connecting the buildings in a neighborhood, district, whole city or region, so that they can be served from centralized plants as well as from a number of distributed heating and cooling producing units including individual contributions from the connected buildings. The concept District Heating or District Heating grid focusses on the integration and efficient use of potential future renewable energy sources as well as the operation of a grid structure allowing for distributed generation which may involve interaction with consumers'.
The problem requiring research can be stated as follows. Benefits of District Heating range from CO_2-emission reductions and an increased share of renewables in the energy mix to reducing reliance on energy imports and fossil fuels. Therefore, District Heating can have a significant contribution to the energy transition and in mitigating climate change. In addition, specifically for the Netherlands, the national government is planning to phase out most of the countries' gas infrastructure as of 2035. Plans are being developed to make this legally binding. District Heating is besides all-electric technologies considered the main replacement technology. Thus, the benefits of District Heating and the urgency to up-scale their development are widely acknowledged. However, as relatively few (and mostly small) District Heating grids are being developed in the Netherlands, there seem to exist critical barriers towards new District Heating project development.
District Heating, which is a decentralized energy system, is built upon a different logic compared to large-scale, centralised power plants and fuel production units as seen in the current centralized energy systems of the Netherlands. Therefore, many studies advocate research into the business models of District Heating because this decentralized nature requires new and different actors, roles, financial arrangements and risk and ownership divisions. Hence, it would be highly relevant to investigate the role of business models and collaboration mechanisms in the development of new District Heating projects in the Netherlands. Therefore, the main research question for this thesis is as follows.

What is the role of business models and collaboration mechanisms in district heating project development?

As input, the following four detailed research questions are researched.
(1) What is the current and future role of district heating in the energy system?
(2) What are the drivers and barriers towards district heating project development?
(3) How can the business model and collaboration mechanism concepts be used to study district heating project development?
(4) What are current practices of the current engagement and business model involvement of collaborators in district heating projects and what collaboration mechanisms can be identified?

Four main results came out of this research. First, (1) an overview of the drivers and barriers towards District Heating project development is provided (Figure 2-8 and Figure 2-9 on page 48/49). More importantly, also an overview of the drivers of the involved actors of DH project development is provided (Table 4-1 on page 108). Regarding the barriers, of the social, financial, sectorial and technical barriers that were categorized, it is discovered that the financial barriers are the most crucial to overcome. Regarding the drivers, it is discovered that the most important or overarching driver of District Heating is its environmental benefits and significant contribution to the energy transition. At the same time, users (business and private citizens) and private parties (energy company, energy waste company and real estate developers) are mainly financially driven to participate in DH projects, whereas public parties are mostly driven by CO_2-emission reduction and the contribution to the energy transition.
Second, (2) a generic collaboration model of the current practice of DH project development is developed (Figure 0-1). Here, a strong and essential triangular relation between the district heating owner(s), the municipality and/or higher governmental levels and the real estate developer(s) can be seen. The actors that form the 'group' of DH owners differentiates per case. Therefore, a mix of certain actors is given, that invest in and exploit the heat transportation and distribution systems. In addition, dependant of the case there are one or more heat producers who sell their heat to the DH owner(s). In turn, the energy company of the DH owner(s) sells the heat to the user. Note that there is no connection between the users and the heat producers. This shows the monopoly position of the District Heating owner(s).
Third, (3) the business model involvement per actor is extensively analysed and summarized in a simplified graphical model (Figure 5-1 on page 121). Here a highly important conflict is discovered. Most of all, the real estate developer, real estate owner and the users create and propose a high amount of value to other actors in the network, while they capture a relatively low amount of value. In other words, the successful development of a District Heating project is for a large extent dependant of the participation of the real estate developer/owner and the users, but they themselves are marginally incentivized to do so. In current practice, the municipality therefore needs a strong position to be able to oblige the actors to collaborate, see Figure 0-1.

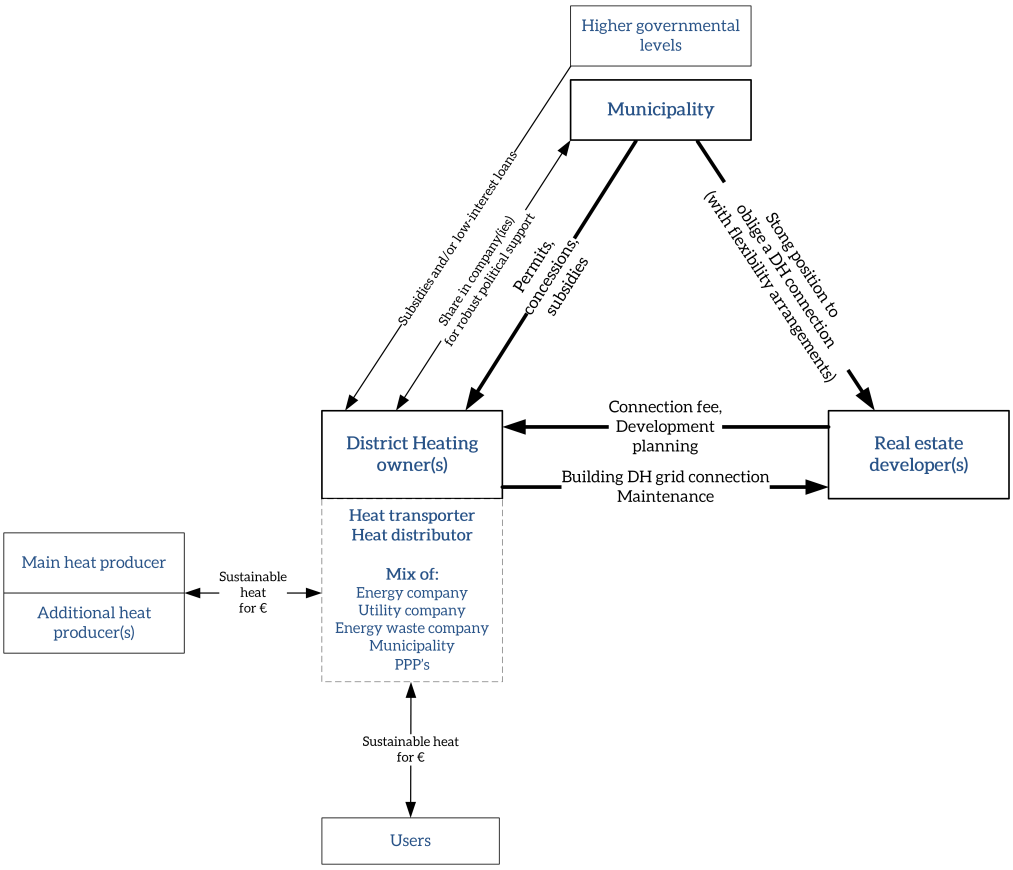


Figure 0-1: generic collaboration model in District Heating project development.

Fourth, (4) four collaboration mechanisms are identified that create important system values of which it is essential they are in place if the District Heating project is to be developed. These system values are found to be (1) financial integration and dispersion, (2) heat provision certainty, (3) heat demand certainty and (4) sustainable energy (Figure 0-2). Figure 0-2 provides a simplified graphical model; see Figure 4-17 on page 115 for a more detailed model). The first value concerns the establishment of an integral business case based on dispersed investments and revenues that is acceptable for all actors involved. The second value concerns a resilient heat provision to the system, i.e. multiple heat sources, back-up heat sources and/or long-term heat production guarantees that results in a robust supply of heat for now and in the future. The third value concerns the guarantee of a certain heat demand, which has to be created and/or quantified so as to be able to build the integral business cases. The fourth and last system value concerns the sustainability of the District Heating grid. The higher this created value is, through the connection of addition heat sources such as geothermal wells or local biomass-fired heat, the more value is captured by

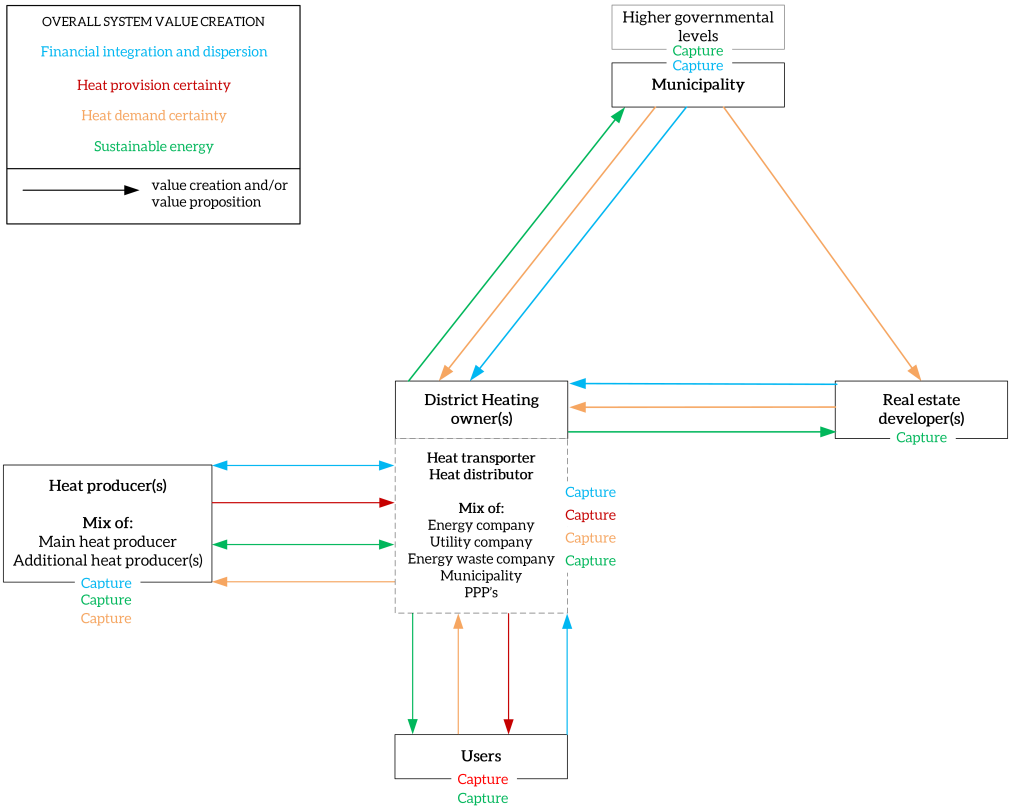


Figure 0-2: the four identified collaboration mechanisms that enable system value creation and capture. The arrows signify the value creation and/or proposition per actor. The colour of the arrow means this particular value creation is part of one of the four collaboration mechanisms and so contributes in a particular overall system value creation, which is captured by one or more of the actors.

all actors involved in various ways. For more elaboration of these mechanisms, consult paragraph 5.3, page 122.
It is important to realise that if a collaboration mechanism is to enable its system value creation, all the separate values from actor to actor have to be created. In other words, because everything is (in)directly linked to each other, when even one of the arrows of figure 0-2 is absent, the District Heating project will not be developed.

As a conclusion, it can be stated that the role of the collaboration mechanisms lies in enabling the creation of the four essential system values, and its value capturing per actor. This is therefore a highly important role in District Heating project development, as it is discovered that without these created system values, a District Heating project cannot be developed.
However, it is also discovered that the formation of these mechanisms, and therefore District

Heating project development as a whole, is dependant of the participation of real estate developers/owners and users, who in the current practice capture low value and thus are not intrinsically incentivised to participate. Hence, they have to be obliged by the municipality who then needs the power to be able to do so, which is not often the case as this depends on their land ownership and economical position. In turn, the willingness of the municipality to engage in such a process is dependant of the presence of the political will, which is also hard to come by because of the bad public image of District Heating. Then, even when this is in place, it is discovered that forming the essential collaboration mechanisms requires the presence of the rare culture of trust, openness and highly motivated high ranking people at the key actors with good personal relationships, crossing the building and energy sector.

Hence, District Heating project development in current practice is a fragile business, dependant of many conditional factors that are either highly rare and/or are otherwise highly difficult to establish. If we want to upscale its development, there is a need to stabilise the collaboration model by significantly changing the collaboration mechanisms, i.e. different value creations from certain actors involved and different value capturing for certain actors that is more aligned with their own drivers.

The main further research recommendation is then as follows. The collaboration mechanism 'financial integration and dispersion' can be greatly enhanced if the investment in and exploitation of the heat transport, which is as of now a value creation of one of the District Heating owners, is taken out of the financial-organisational set-up of the network, i.e. nationalized. By doing so, the DH owner(s) need to capture less financial value for their business case to be viable, so the real estate developers/owners and users can be offered a significant cost reduction (increased value capture) and the municipality does not need to have the power to oblige them. Thus, recommended further research is whether and how to nationalize the heat transport - for which considering the bad public image of District Heating a national scale marketing campaign may be essential - and how this will change the current financial-organization set-up of future District Heating projects.

As to research methods, three District Heating cases are studied, namely Paleiskwartier 's Hertogenbosch, Warmtenet Nijmegen and Westpoortwarmte Amsterdam. Besides case documentation studies, in total eleven semi-structured interviews are conducted at six different actors. The case study and interview structure is based on a developed conceptual framework, which in turn stems from an extensive literature research into (1) drivers and barriers of District Heating and (2) business models.

Content

CHAPTER
01

Introduction

This chapter will shortly introduce the topic of this research, why this is chosen and its objective.

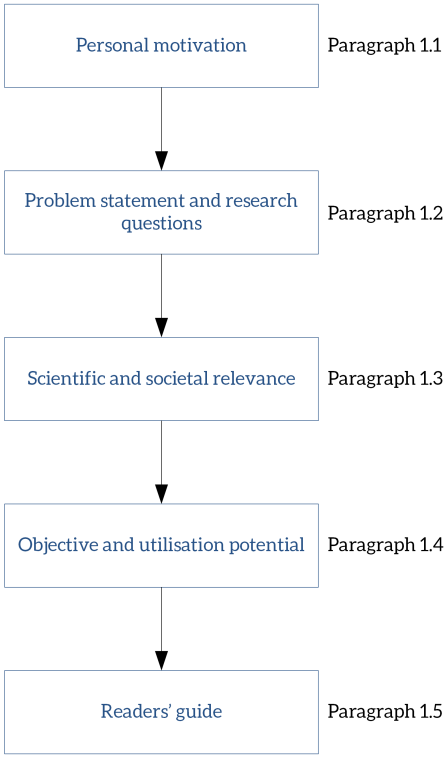


Figure 1-1: readers' guide chapter 1

1.1 Personal motivation

Studying at the faculty of Architecture and the Built Environment of TU Delft implies studying subjects that cross technical, social and economic domains. Relieved from the hassle of day-to-day business in practice, this broadens the mind for those who are able. It can ignite interests, passions and an independent mind leading to different paths of life than one is originally nurtured in. For myself I discovered an interest for the global societal trends and how the built environment can use the related possibilities and tackle the related challenges. Digitalisation and globalisation has led to the realisation that while living in a wealthy part of one of the wealthiest countries in the world, we morally cannot ignore what is happening 'out there'. Be it gender or income inequality, food or energy poverty or permanent climate change, during the course of my study I am ignited to contribute in tackling these global challenges. Being a fanatic mountaineer and outdoor adventurer led to a special interest for the issue of climate change. Besides realising its disastrous implications for certain countries and islands, having walked and climbed upon many (receding) glaciers and experienced nature in its most pure form, I have grown sincerely aware of the urgency.

Meanwhile, I also grew interested in the organisational processes within the built environment. Especially on the urban and city scale of which challenges are characterised by a complex nature. It has led me to an exploration for ways to contribute to mitigating climate change through the built environment. First, one arrives at two options: a focus on existing or newly built stock. As newly built stock only represents about one percent of the total building stock, the name of the game is the existing stock. Next choice is scale: regional, city, district/neighbourhood or building level? As said before, the complex nature of bigger scale challenges is of

bigger interest for me, crossing out the building scale. Regional and city scale quickly becomes a policy or top-down governance question, being both important and interesting, but my preference goes to bottom-up, project related questions. Leaving only the district and neighbourhood level. From here it quickly became clear that the possible solution as of now are the District Energy Systems, representing a diversity of technologies that seek to develop synergies between the production and supply of heat, cooling, domestic hot water and electricity. Diving into this energy system, it became clear that this highly relevant and controversial technology obliges many different sectors that have never collaborated before to initiate, design, construct and maintain projects together. New actors, new business models, new roles, new integrated projects. At the forefront of the new economic paradigm shift due to the digitalisation. In other words, this innovative subject is a concrete example of the transition towards a new economic paradigm that we need so as to address the global societal challenges. This is what motivates me.

Of course, one can not only be driven by idealism and moralism. Eventually, one of the goals of studying is securing a future in one's own business life. In this regard profiling oneself within this subject seems to be adequate as well.

1. 2 Problem statement and research questions

It is generally accepted that district heating can have a significant contribution to the energy transition and in mitigating climate change (Booth, Hammond, Lamond, & Proverbs, 2012); (UNEP, 2015); Van den Dobbelsteen, Wisse, Doepel, & Tillie, 2013). District heating is part of a District Energy System (DES), together with the electricity grid. In many studies, the term DES is used to indicate a diversity of technologies that seek to develop synergies between the production and supply of heat, cooling, domestic hot water and electricity. The term District is used because DES require heat and/or electricity infrastructure (pipes with warm or cold water and cables) which can only be applied on a district or larger scale. Synergies are created when e.g. a Combined Heat and Power Plant (CHP) produces more heat when electricity prices are low and vice versa. Thus DES is an overarching term to indicate energy systems on a district or city scale, with a large set of renewable energy sources that are connected to buildings through heat and/or electricity infrastructure. This research focusses on the heating grid part of DES and will use the term 'District Heating' (DH) and sometimes 'District Heating grid'.

Benefits of district heating range from CO2-emission reductions and an increased share of renewables in the energy mix to reducing reliance on energy imports and fossil fuels (UNEP, 2015). Without these systems, many untapped renewable energy sources, such as geothermal heat, deep water cooling and waste heat, will remain unused as only these systems can make their utilization economically viable through economies of scale (CEDelft, 2015); (Koch, Girard, & McKoen, 2012); (Lund et al., 2014); (Woods & Overgaard, 2016). Given the future resource scarcity and the fact that in the Netherlands the coming decade a large part of the incumbent energy infrastructure (gas) are coming to the end of their technical life-span, it is essential to study the development of new District Heating grids. If this window of opportunity is missed, a locking-in of district heating development for another forty years is expected (Brown, Chandler, Lapsa, & Sovacool, 2008); (Szendrei & Spijker, 2015b). While their high potential and urgency is globally recognised, implemented district heating can still be seen as niche innovations; they are not mainstreamed. Among others, in the Netherlands only 12 % of all heating of the building stock is achieved by district heating (Haffner, Van Til, De Jong, Mans, & De Graaf, 2016). There are many barriers towards its development and implementation. In the Netherlands, most of these barriers arise not due to the district heating technical issues, but due to its decentralized nature, increasing complexity, having an immature heat market and a bad public image (Engelken, Römer, Drescher, Welpe, & Picot, 2016; Haffner et al., 2016; Hellström, Tsvetkova, Gustafsson, & Wikström, 2015; Lund et al., 2014; RVO, 2012; Szendrei & Spijker, 2015a, 2015b). A

decentralized energy system is built upon a different logic compared to large-scale, centralised power plants and fuel production units. This requires new and different types of business models (Hellström et al., 2015). Therefore, many studies advocate research into the business models of DES because this decentralized nature requires new and different actors, roles, financial arrangements and risk and ownership division. However, almost all studies into business models of DES concern the electrical grid part of DES, not the heating grid part (Engelken et al., 2016). Research into business models of district heating is therefore unexplored grounds.

Research into the concept business model showed that this concept should be used to analyse and describe markets. This knowledge can then be used to coordinate (and maybe also create new) actors and relationships, eventually shaping new markets (Palo, 2014). More specifically for DES (and thus district heating), other recent studies state that business models should be seen as mere elements of more fundamental collaboration mechanisms. It is said the analysis of one business model in isolation is not able to explain the way towards increased value creation. However, it is a crucial concept for grasping the value capture of each individual company, which in the end is the main incentive for engaging in collaboration. It is suggested to add 'collaboration mechanisms' in the business model design just like value drivers. Collaboration mechanisms are vehicles of business model innovation that enable new business models and business by connecting elements that previously were not primary parts of the business models. In essence, a collaboration mechanism reflects the part of overall value creation for each company, i.e. its role or function in the system, and value capturing for each company (Hellström et al., 2015).

Concluding, the benefits of district heating and the urgency to up-scale their development are widely acknowledged. As relatively few district heating grids are being implemented in the Netherlands, there seem to exist critical barriers towards new heating grid project development. At the same time, a collaborative business model research approach is said to be key (Engelken et al., 2016; Hellström et al., 2015; Sepponen & Heimonen, 2015), which is as of now unexplored grounds. Hence, it would be highly relevant to investigate the role of business models and collaboration mechanisms in the development of new District Heating projects in the Netherlands. Therefore, the main research question for this thesis will be:

what is the role of business models and collaboration mechanisms in district heating project development?

To be able to provide input for answering the main research question, the following four detailed research questions are proposed.

(1) What is the current and future role of district heating in the energy system?
(2) What are the drivers and barriers towards district heating project development
(3) How can the business model and collaboration mechanism concepts be used to study district heating project development?
(4) What are current practices of the current engagement and business model involvement of collaborators in district heating projects and what collaboration mechanisms can be identified?

1. 3 Scientific and societal relevance

This paragraph is divided into the scientific and societal relevance of this research.

Scientific relevance

One of the research programmes of the Faculty Architecture and the Built Environment is called 'Innovation in the Management of the Built Environment'. "The programme considers the performance of building stock both in isolation and in its (usually urban) context, making explicit the roles, constraints and relationships of different actors and stressing the need for consistent, structural solutions that are based on policy and strategy and are substantiated by scientific means. This involves extensive knowledge and technology transfer from various disciplines, followed by adaptation to the conditions of AEC and integration into a coherent whole that applies continuously to the lifecycle of the built environment. The results are comprehensive methods and techniques that are usually geared towards specific issues, such as new business models for sustainability or post-credit crunch architectural practice, supply chain evaluation tools in construction and renovation, indicators of post-occupancy evaluation success and approaches to the adaptive reuse of existing building stock." (n.d., 2015). This research will address many concepts as outlined above, such as roles, constraints and relationships of different actors and business models for sustainability. Also, the same website says "research is oriented to the construction of utilities, dwellings and urban infrastructure". The topic of this research connects all these.
In addition, cross-overs with among others the energy and transportation sector needs to be made as the built environment is responsible for about 70 % of global anthropogenic greenhouse gas emissions. This research will contribute to both the energy and real estate sector research in starting a cross-over.

As to topicality, many of the (scientific) sources used are published in the year 2016 and the second half of 2015. Many introductions of the sources mention the emerging research on both business models and District Energy Systems or the combination of both, which this research is focusses on. Many studies recommend further studies, among other case studies (Hellström et al., 2015; Späth & Rohracher, 2015; Summerfield & Lowe, 2012). Thus the added value of this research will be added relevant knowledge to an emerging research topic and starting a much needed cross-over of the building and energy sector.

Societal relevance

The last climate summit in Paris marked the end of the fossil economy, so we hope. The popular economist Jeremy Rifkin shows the road towards a new economic paradigm: a distributed and digitised economy. A future economic system of which smart grids, be it electrical or heat, are a vital part. In addition, resource scarcity, energy independence of contested oil and gas economies and climate change drives a need for a transition towards a local renewable energy system. It is generally accepted that these grids can have a significant contribution to the energy transition and in mitigating climate change (Booth et al., 2012; UNEP, 2015; Van den Dobbelsteen, Wisse, Doepel, & Tillie, 2013). The European Commission has made a Heat Roadmap so as to decarbonise the EU energy system (Connolly et al., 2014). With many platforms, studies and subsidies made available in the past years and for coming years, they made it clear this technology needs implementation. National and local governments need to fulfil emission targets, especially in Europe.

An extensive research summarises the development of energy neutral urban areas into five steps. The steps are (1) reduce energy demand, (2) maximise usage of renewable sources, (3) energy exchange in energy grids, (4) buffering the energy demand & supply and (5) imported energy and fuels. All steps are equally important (RVO, 2012). DH seems to facilitate steps 2, 3 and 4. Also, it is generally accepted that the existing stock plays a central role because newly built stock represents a mere 1 % of the total building stock. This leads to another notion: the coming decade a large part of the incumbent energy infrastructure (gas & electricity) in the Netherlands is coming to the end of their technical life-span (Szendrei & Spijker, 2015b). This situation can be seen as a window of opportunity to replace the incumbent energy infrastructure to DH infrastructure, contributing to both unlocking the energy lock-in and energy neutral urban area development. Moreover, when this window is missed, a locking-in of DH development for another forty years is expected (Brown et al., 2008; Szendrei & Spijker, 2015b). A research into the development of this technology is then highly relevant for all actors and users involved.

1. 4 Objective and utilisation potential

The main goal of this research is to investigate the role of business models and collaboration mechanisms in DH project development. To be able to reach this goal, an analysis of the drivers, barriers and development process of DH project development is needed, which can be seen as the secondary objective.
The result will be an overview of the drivers and barriers towards DH project development, a generic model that explains how each actor is involved business model wise and another generic model that explains the identified collaboration mechanisms. This will inherently result in knowledge about new roles and business models of the involved actors, how they collaborate with each other and how this creates and captures value for themselves and the project. In turn, this will lead to much needed, well-argued further study recommendations.

1. 5 Readers' guide

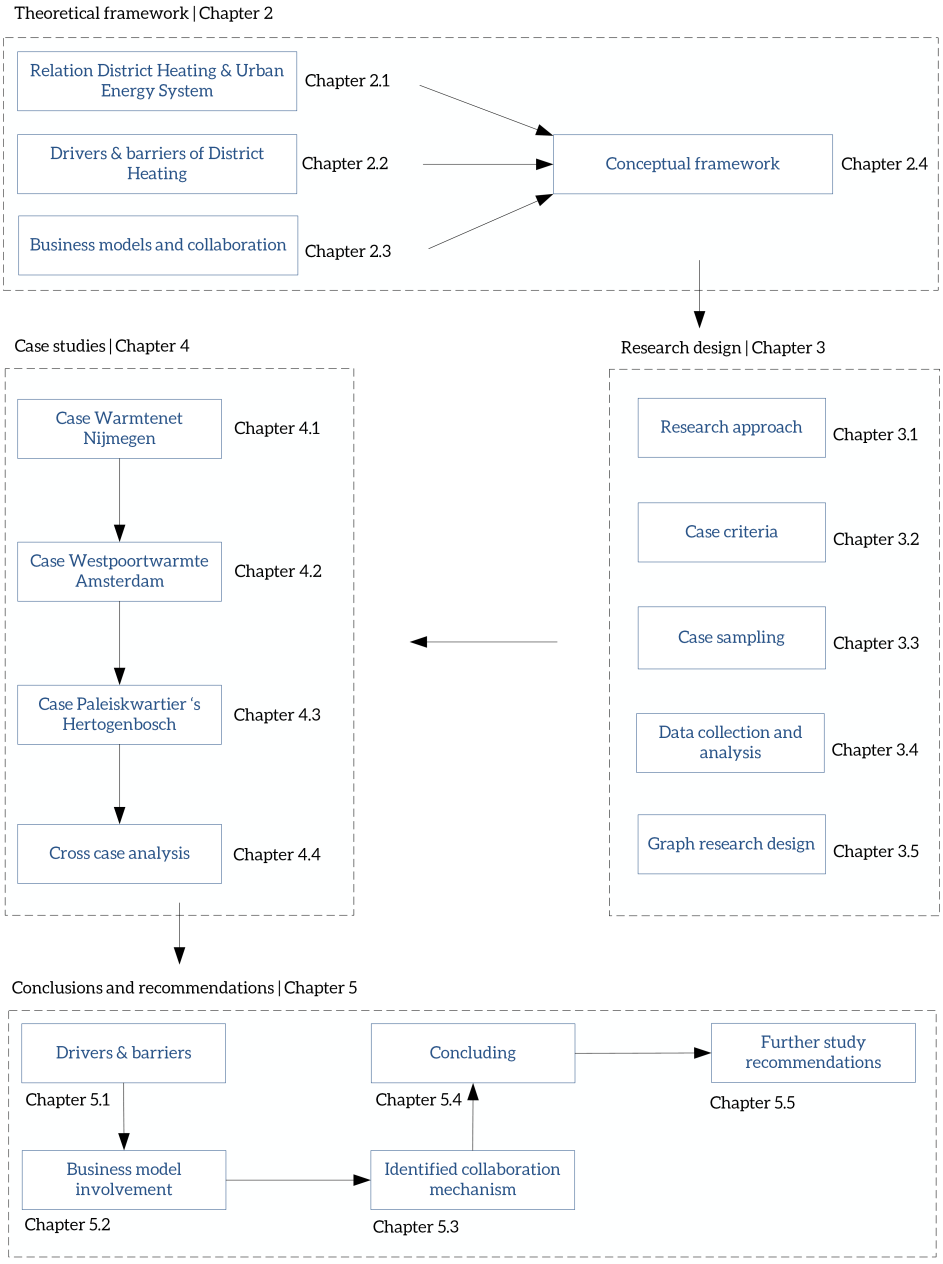


Figure 1-2: graphical overview of this thesis' structure

CHAPTER
02

Theoretical framework

This chapter will elaborate on the three topics as depicted in Figure 2-1, so as to form the conceptual framework.

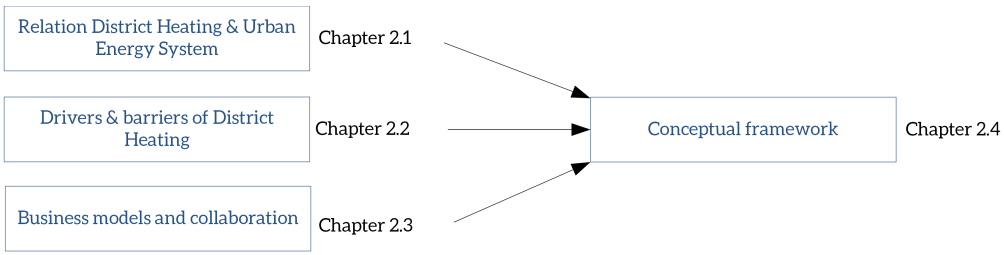


Figure 2-1: readers' guide chapter 2

2. 1 The role of district heating in the urban energy system

This paragraph will answer research question one: what is the current and future role of district heating in the energy system?

2.1.1 Urban energy systems and District Heating

As explained in the problem statement (paragraph 1.2), district heating is a part of a DES. In Figure 2-2, an overview of the concepts and terminology is provided. Many studies use the term District Energy Systems (DES), which represents a diversity of technologies that seek to develop synergies between the production and supply of heat, cooling, domestic hot water and electricity. Some studies use Energy Hubs, categorizing it in e.g. 'all-electric', 'geo-hubs' or 'solar-hubs'. Other studies use the term Distributed Energy System, to indicate its decentralized nature. This research will use the term District Energy System (DES) as an overarching concept that includes both the electricity and heating grid. This research focusses on the heating grid part of DES and will use the term 'District Heating' (DH) and sometimes 'District Heating grid'. District Heating is often also referred to as a thermal grid, a heating grid, a heating and cooling system or a Smart Thermal Grid.
It is to be noted that district heating as urban intervention spans all urban scales: building, block/neighbourhood, district and city-level. Next paragraphs will further elaborate on that.

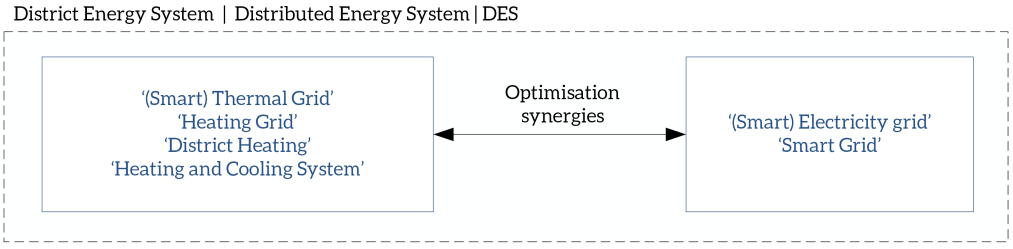


Figure 2-2: an overview of the different concepts with their different terminology, based on the thesis of Dronkers (2015) with some simplification adaptations.

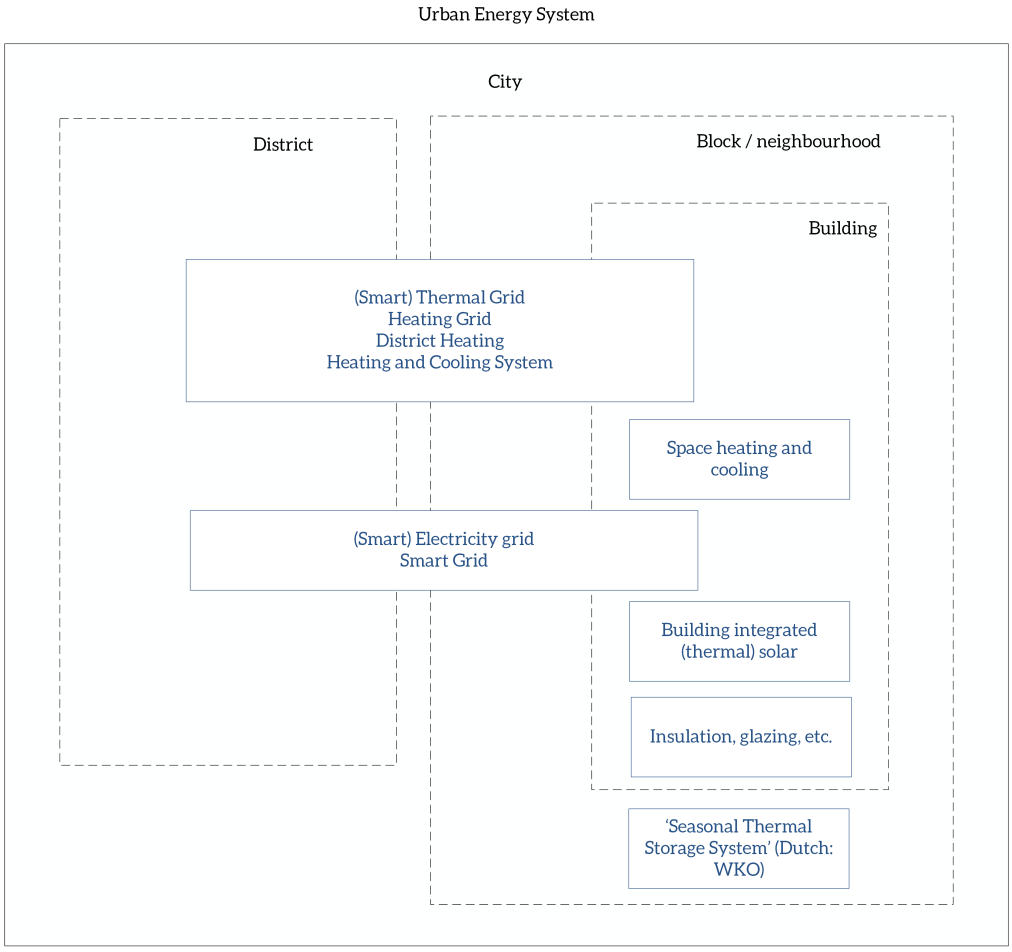


Figure 2-2 continued: an overview of the different concepts with their different terminology, based on the thesis of Dronkers (2015) with some simplification adaptations.

2.1.2 Definition District Heating

District Heating exists since about 1880. In time, as technology evolved, the concept of District Heating changed as well. As of now, it seems to be generally accepted that a fourth generation of District Heating is about to be implemented globally (Lund et al., 2014; Sandoff & Williamsson, 2016; UNEP, 2015). See Figure 2-3 for an overview of the four District Heating generations. This fourth generation is defined as follows: "a network of pipes connecting the buildings in a neighbourhood, town centre or whole city, so that they can be served from centralised plants as well as from a number of distributed heating and cooling producing units including individual contributions from the connected buildings. The concept of Smart Thermal Grids

(the 4th generation District Heating) can be regarded as being parallel to smart electricity grids. Both concepts focus on the integration and efficient use of potential future renewable energy sources as well as the operation of a grid structure allowing for distributed generation which may involve interaction with consumers." (Lund et al., 2014)

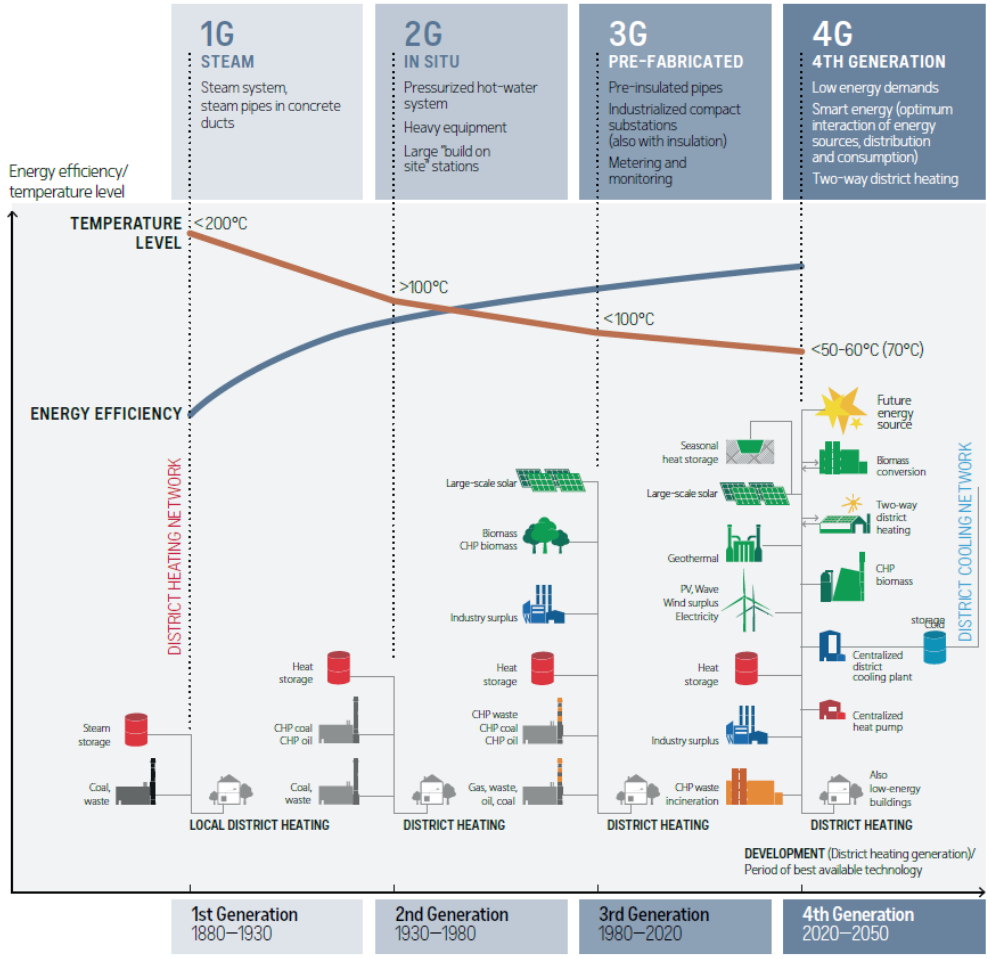


Figure 2-3: overview of the four District Heating generations (UNEP, 2015).

Currently, on a global scale mainly the 3rd generation District Heating is operational, with some District Heating grids transitioning to the 4th (Woods & Overgaard, 2016). That is so because certain District Heating grids use for instance a high temperature of the 3rd generation (60 – 100), while using geothermal heat as energy source which is a characteristic of the 4th generation. This research will focus on District Heating, be it a 3rd or (semi) 4th generation. Here it should be noted that it is accepted that the more characteristics a heating grid has of the 4th generation, the better. This generation is most energy efficient and has the highest amount

of renewable energy. As a first preview of some research results, it can be seen that in general, for profitability purposes, first a 3rd generation DH has to be implemented. Then, when the customer base is high enough, certain 4th generation elements such as geothermal heat or seasonal heat storage can be attached. The essence is that District Heating, be it 3rd of 4th generation, is:

a local network of pipes connecting the buildings in a neighbourhood, district, whole city or region, so that they can be served from centralised plants as well as from a number of distributed heating and cooling producing units including individual contributions from the connected buildings. The concept District Heating or District Heating grid focusses on the integration and efficient use of potential future renewable energy sources as well as the operation of a grid structure allowing for distributed generation which may involve interaction with consumers.

The definition is an adapted and combined quote from Lund et. al. (2014) and Haffner et al. (2016). What is meant with 'interaction with consumers' will be elaborated in the next paragraph as this section will explain the elements and their technicalities of DH.

2.1.3 Technical elements of District Heating

DH can be described along the elements 'building heating systems', 'building connections', 'heat transportation and distribution' and 'heat sources'. See Figure 2-4.

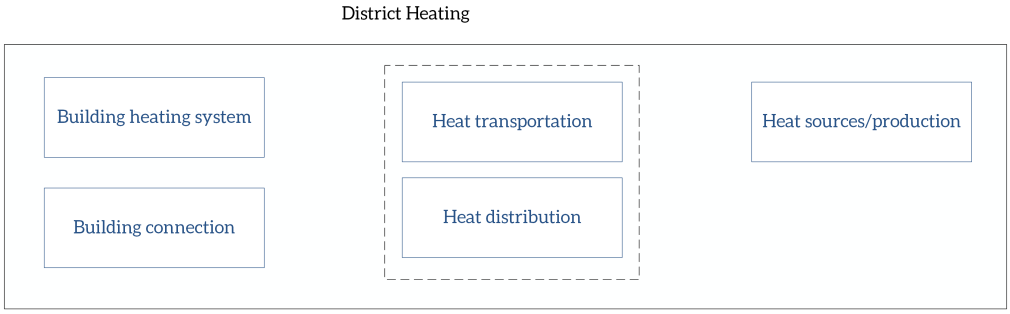


Figure 2-4: the elements of District Heating (DH)

Building heating system

For the building heating systems, the operating temperatures are important. Often the building heating system has not changed since installation even though the building may have been upgraded and lower flow temperatures can thus be used (Woods & Overgaard, 2016).

Building connection

Regarding the building connections there are two types, namely an indirect and direct connection to the grid. For a direct connection the building heating systems needs to be able to accept the grid pressure but has the least low space requirements in the building and lower maintenance costs as it is much simpler (Woods & Overgaard, 2016). Research has shown that this is much appreciated by the user ("De waarde van Nuon Warmte," 2016). Indirect connections have the benefit of a clearer contractual boundary of responsibility but requires a heat exchanger. Furthermore, the controls of the building connection need to achieve two primary functions, namely (1) to limit the maximum flow rate that the building takes from the grid to prevent system failure during peak demands and (2) for indirect connection to control the grid flow on a variable basis to reduce losses and required pumping energy. Lastly, the connection goes with a heat meter and isolation valves and filters (Woods & Overgaard, 2016). With regard to the heat meter, Lund et. al. (2014) here describe 'intelligent control and metering of the network performance' as a wireless gathering of heat meter readings (thus at every connected building) over short time intervals that makes it possible there is a close link between heat production and usage. It can also be used for continuous commissioning, the payments and metering the sale of surplus heat from e.g. solar thermal from the individual building to the grid (Lund et al., 2014). This seems to be about the 'involving and interacting with consumers' as stated in the previous definition of DH grids. One other study call this Demand Side Management (DSM), which will need to be done by existing (thus a new activity in their business models) or entirely new organisations (Niesten & Alkemade, 2016). In this research it will be seen that in one of the cases they are developing such an organisation (case Warmtenet Nijmegen).

Heat transportation and distribution

The heat transportation and distribution is comprised of a pair of pipes, flow and return, with high levels of insulation. The carrier pipe itself (i.e. of the warm water) can be of steel or plastic (Woods & Overgaard, 2016). Both have many dis- and advantages, which is being studied extensively (Gudmundsson, Brand, & Thorsen, 2015). In the Netherlands there is as of now no market model. This results in that in certain District Heating grids transport (carrier pipe from heat source to neighbourhood) and distribution (carriers pipes from transport pipe to the buildings) is owned by one actor (an integrated energy company) and sometimes by two different actors (a utility company and an energy company).

Heat sources

Regarding heat sources, this is said to underpin the financial viability of the heating system by having heat sources that are low cost and deliver carbon savings to achieve acceptance (Woods & Overgaard, 2016). This research will show that this is indeed one of the important factors, when for instance an energy company purchases relatively cheap heat (warm water measured in Gigajoules) from a waste incinerator. Figure 2-3 shows the available heat sources per DH

generation.
Going back to the historical development of DH as seen in Figure 2-3, in essence from 1880 till 1930 the first generation was implemented, with heat production based on coal, waste and a usage of steam storage. The second generation, from 1930 till 1980, added coal- and oil-fired CHP's as heat production. They also started to use heat storage. The third generation, from 1980 till (expected) 2020, adds gas- and biomass-fired CHP's, waste heat from industry and large scale solar heating as heat production. The fourth generation, expected to be implemented from 2020 till 2050, only uses biomass-fired CHP's and adds heat production from waste incineration, centralized heat pumps, geothermal, biomass conversion, locally produced heat from buildings, surplus electricity from wind and solar and seasonal heat storage.

2.1.4 Role of District Heating in (future) urban energy system

This paragraph will firstly elaborate the current situation and role of DH in the urban energy system of the Netherlands, then what will be the expected future role.

Current situation

In the Netherlands heat demand is about 1224 PJ, which is about 59 % of the total energy demand (Haffner et al., 2016). This heat is mostly used for space heating, domestic hot-water, greenhouses and industrial processes. About 88 % of this heat is produced at the same location of utilization, e.g. with individual gas-boilers. Of the remaining 12 %, about 75 % is transported steam for industrial processes. This leaves about 25 % of the original 12 % to be provided by District Heating for greenhouses, space heating and domestic hot-water (Haffner et al., 2016). Thus, district heating as of now provides for about 3 % of the total heat demand, while the total heat demand is about 59 % of the total energy demand.

Recently, the national government of the Netherlands has announced that the gas infrastructure will have to be phased out. Interviewees for this research told that, although this is not yet publicly stated, the government will be aiming for 2035 in this regard. As stated above, 59 % of the total energy demand in the Netherlands is heat. Only 3 % of that is provided by District Heating, the rest from individual gas-boilers and transported steam for industrial processes. Although hard figures about what portion of that is provided by gas-boilers are lacking, one can clearly see that when gas will no longer be available there will be a large gap. Here lies a huge potential for DH.

Future role and challenges

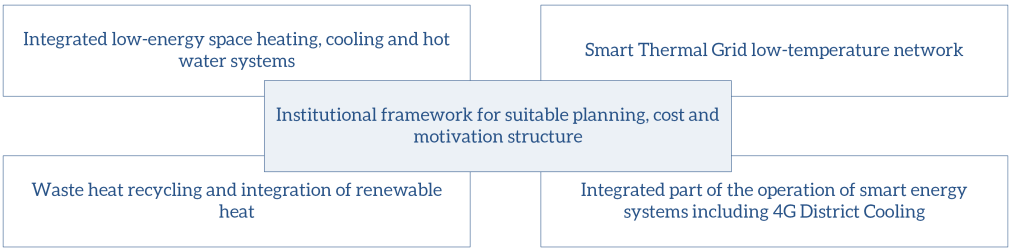


Figure 2-5: The five challenges of District Heating for fulfilling its role in the future sustainable energy systems (Lund et al., 2014).

Figure 2-5 shows the five challenges towards the future role of District Heating in the urban energy system as defined by Lund et. al (2014). The first (1) is a supply of low-temperature district heating for space heating and domestic hot water to existing buildings, energy-renovated existing buildings and new low-energy buildings. This underlines the importance of combining the implementation of DH with energy-renovated existing buildings and new low-energy buildings so that low-temperatures for space heating and domestic hot water become sufficient (Lund et al., 2014). Here, conflicts can arise which will be discussed in paragraph 2.2.2 about the connection of DH with the urban sector.

The second (2) concerns distributing heat in networks with low grid losses by using low-temperatures. It builds upon the fact that low temperatures (30-60 degrees Celsius) paves the way for a better utilisation of low-temperature renewable heat (e.g. geothermal) and increases the efficiency of CHP sources and large-scale heat pumps (Lund et al., 2014).

The third (3) is to recycle heat from low-temperature sources and integrate renewable heat sources such as solar and geothermal heat. It concerns the challenge of utilising waste heat from incineration, industry, commercial buildings, geothermal heat and central or local solar heating with seasonal and temporal storage (Lund et al., 2014). For example, due to the high cost of the borehole for deep geothermal heat, it may not produce heat at a cost low enough to finance a new heating network, but it can have valuable role as baseload heat supply for the more established network (Woods & Overgaard, 2016). Also, solar thermal at a large scale can be seen in many district heating grids in Denmark. The capital cost large scale solar thermal is much lower than on individual scale, and together with inter-seasonal thermal storage this has a high potential. However, it requires significant land areas (Woods & Overgaard, 2016), which poses a problem in the Netherlands. Thus, each and every different renewable heat sources poses specific challenges to be addressed.

The fourth (4) concerns being an integrated part of smart energy systems (i.e. integrated smart electricity, gas, fluid and thermal grids). An important characteristic of the (future) electrical grid is the use of fluctuating and intermittent renewable sources such as wind and solar. Lund

et. al. advocate to combine and coordinate electricity grids as well as heating grids and gas grids to identify synergies between them in order to achieve an optimal solution for each individual sector as well as for the overall energy system. An example is an active regulation of CHP's by use of thermal heat storage. In essence, when electricity production is high (sunny and windy days), these plants should produce less, but should still produce enough energy to maintain economic viability. The solution then is thermal storage, to be later on used as source for district heating. Electrical storage is said to be not possible for a wide range of reasons (Lund et al., 2014). This is very much underlined by the study of Woods & Overgaard (2016). Thus to reach a smart energy system, electrical grids needs to interact and create optimisation synergies with district heating grids and vice versa.
The fifth (5), which will be the focus of this research, concerns ensuring suitable planning, cost and motivation structures in relation to the operation as well as to strategic investments related to the transformation into futures sustainable energy systems (Lund et al., 2014).

2.1.5 The policy framework

Although much attention has been paid to low carbon energy transitions in cities, there is surprisingly little attention to the dimension of governance, policy and politics in the scholarly literature. A proposed research agenda is among others a further understanding of strategic action fields and lines of conflicts between (coalitions of) actors and identifying workable governance frameworks and policies supporting community-led energy initiatives (Hoppe & van Bueren, 2015). As with other aspects of the energy transition, a key factor in the successful development of DH is the establishment of an appropriate policy framework (UNEP, 2015). Although many of the specific decisions and measures associated with the establishment of a given system can and must be made at a local level, coherent and coordinated multi-level governance is key to achieving optimal results (UNEP, 2015). The energy market in a country and the degree of liberalization, privatization and regulation shape the business model for district energy. DH is for instance negatively affected by market distortions (e.g., fossil fuel subsidies). The long-term nature of district energy investment can mean that it is ignored over simpler, short-term energy solutions that can, in the long term, be the less beneficial option. DH needs fiscal or policy support to bring them on to an even playing field with other technologies (UNEP, 2015).

The heat market and required policy framework in the Netherlands is currently maturing (Haffner et al., 2016). Global studies are done (UNEP, 2015) to compare best practices. However, this study from UNEP made it clear that every country requires an own policy framework. In the Netherlands, the heat market and the Heat Act are being studied intensively so as to improve the policy framework. This paragraph will elaborate on the current situation in the

Netherlands by categorizing it into (1) incentives regarding (a) energy rating policies, (b) taxes and (c) heat producers and users, (2) multi-level governance, (3) the market model and (4) tariff regulation.

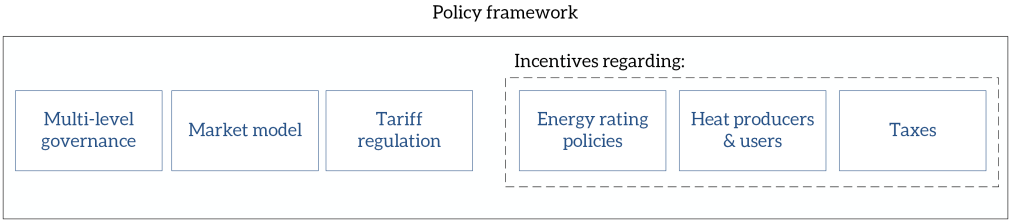


Figure 2-6: categorization of the policy framework.

Incentives

Rating policies and certificate systems such as LEED and BREAMM often do not acknowledge the full benefits or contribution of district energy and tend to give preference to on-site solutions. An important issue is the calculation of energy efficiency for new buildings and the energy labels for existing buildings. Considering new buildings, the EPC-norm (energy performance coefficient) however does take energy efficiency of DH grids into account. This can be an incentive for real estate developers to apply a DH grid as a means to meet the EPC-norm (Haffner et al., 2016). Considering the existing stock, in the Netherlands being connected to a DH grid does not upgrade the energy label, thus it has no added value for customers to connect. Also, the EPV (energy performance compensation) does not take a DH grid into account. This means that real estate owners cannot raise the rent when they have made investments to connect to a DH grid (Haffner et al., 2016). This is however quite logical because in practice the heating costs for consumers from a DH grid is as high or higher than conventional means. Thus there are no energy cost savings to utilise by the real estate owner.

Considering national taxes, Szendrei and Spijker (2015b) explored a number of national policy options such as CO_2-tax, a residual heat obligation, direct subsidy of heat suppliers and green taxation. They conclude with "the perfect solution is unlikely to be available, and it is expected that a mix of options is needed to achieve a certain acceptable economic profile of the DH value chain" (Szendrei & Spijker, 2015b). Currently the national government of the Netherlands provides two subsidies applicable for DH grids, namely the SDE+ program and the EIA (Energy Investment Deduction). The former stimulates exploiting renewable energy projects by closing the gap between renewable and fossil energy prices. The latter stimulates investing in renewable energy project by giving investors the possibility to deduct 58 % (for the year 2016) of the investment from their taxable income (Haffner et al., 2016). It remains unclear however whether the amount of subsidy per case is appropriate. The study from UNEP (2015) advocates

subsidy programs helping to finance the development costs (e.g. feasibility study costs, programme structuring and business or financial plans). The Netherlands currently has no such programs.
Considering incentives for heat producers and users, industrial companies with waste heat can be obliged on the basis of the Heat Act to perform a societal cost and benefit analysis for utilising this heat. However, a clear framework for this study is lacking. Also, when the study is found positive, companies cannot be obliged to actually perform the next step (Haffner et al., 2016). Furthermore, there is no 'sense of urgency' due to reasons such as a lack of knowledge and financial means. Opportunities for DH development arise by improving the current instruments and designing new instruments to incentivise industrial companies with waste heat to utilise its heat (Haffner et al., 2016).
Regarding incentives for users, as of now, the only drivers for a company to upgrade its energy performance are an improved image and financial gain due to energy cost savings (Haffner et al., 2016). Therefore, studies are done to see if instruments can be made to incentivise companies to upgrade their energy performance. Opportunities are instruments such as the EEP (Energy-efficiency plan), which obliges companies from a certain size to meet certain energy-efficiency demands. This could in turn be an incentive for a company to connect its office to a DH (Haffner et al., 2016). Regarding home-owners it was already mentioned that the lack of DH acknowledgement in the energy labelling is an issue to address.

To conclude, there is not enough 'sense of urgency' from both heat producers and users to connect to a new of incumbent DH grids. Incentives by means of energy ratings, national taxes and policy instruments are under development, but still far from adequate. Most of all there is no incentive for actors within the existing stock to upgrade the energy performance, let alone commit to a DH grid. Lastly, a study into whether the current subsidy programs are appropriate for DH development is lacking.

Multi-level governance

As cities become increasingly important for achieving national goals, they are playing a growing role in the design and development of 'vertically integrated' state and national policies (UNEP, 2015). Examples are the newly launched LoCal initiative, a subnational public-private organisation raised to fund climate change mitigation efforts (Burgers, 2015). Or the recent initiative in the Netherlands from several provinces, municipalities and companies that underline this importance of multi-level governance for among other the interconnections of local DH grids ("Groeiplan voor warmte," 2015). They advocate that multiple relatively small DH grids will have to be connected with other small DH grids so as to enhance synergies (e.g. a local DH grid in Rotterdam to a local DH grid in The Hague leading a regional DH grid). A connection will have to be made, which requires a high investment. This can only be realised by multi-level governance and collaboration ("Groeiplan voor warmte," 2015).

National heat maps and energy visions are increasingly acknowledged as important. Based on a national heat plan, municipalities should be obliged to formulate a more detailed heat plan for their city. This will take away demand uncertainty as it will be clear which (future) urban areas are designated for DH (Haffner et al., 2016; UNEP, 2015). Formulating such an extensive 'heat transition plan' is a complex project involving stakeholders such as ministries, municipalities, utility companies, project developers, heating companies, consumer organisations, energy companies, etc. The upcoming Energy dialogue this year in the Netherlands should include such a process (Haffner et al., 2016).

A problem here could be that multi-level governance adds more stakeholders in the process, thus increasing complexity while the DH projects are already considered complex. It is however crucial for finance (e.g. grants and demand certainty) and optimal tuning of the available heating and cooling technologies (e.g. gas, all-electric, heat/cold) per municipality and/or region.

Market organisation or market model

The current structure of finance and support for DH is generally found to be inadequate for all relevant actors in the value chain (Szendrei & Spijker, 2015a). Dervis and Nierop (2015) concluded that there is no perfect solution for possible market models. However, the most promising market model is one in which one integrated network owner and supplier, buys heat (single buyer) from multiple heat producers (Dervis & Nierop, 2015). This single buyer is responsible for heat delivery to its customers and uses its network to transport the heat. Production of heat is ensured using long-term heat production agreements between producer and the single-buyer. As of now, in the Netherlands this is done on free will of both producer(s) and single-buyer. However, it will be more promising for DH implementation when the single-buyer is obliged (by policy) to negotiate with heat producers. They cannot just refuse heat producers anymore; he can also be obliged to tender new producers or when in case of a disagreement between the single buyer and possible heat producer, an independent third party can decide whether the single buyer has to provide access to the heating network and on what conditions the heat will have to be taken. See below for a graphical representation of the model (in Dutch). Other models exist, but they seem to be less promising (Dervis & Nierop, 2015).

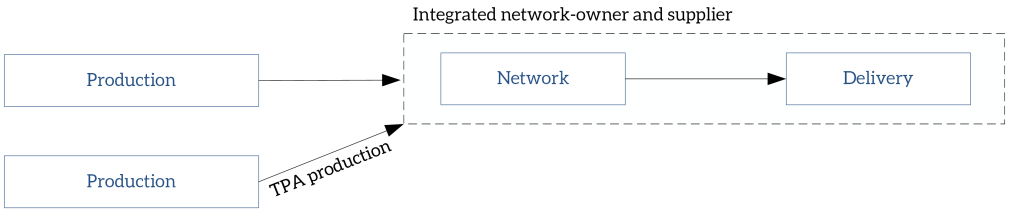


Figure 2-7: the most promising network model (Dervis & Nierop, 2015).

The most recent (and very extensive) study into the Dutch policy framework for the heating market (used as input for adapting the Heat Act this year) recommended that no national market model should be designed (Haffner et al., 2016). This because for every DH grid the organisational model needs to be custom-made, depending on many local characteristics. A whole thesis could be focused on the (dis)advantages of different market models for the heat market; considering the focus of this thesis it will suffice to know that freedom to design the organisational model per case is considered more appropriate than a national market model. Haffner et. al. (2016) do recommend to study to what extent requirements can be forced upon district heating owners for how they deal with access requests from heat producers.

To conclude, this could be an interesting aspect to research in the case studies. Does the absence of a fixed market model impede the development of DH grids? Or, as Haffner et. al. concludes, was this freedom necessary because no generic market model would have been appropriate for both this particular situation and for others? And, now that this organisational model seems to be successful, should this be the generic organisational model to be included in the future policy framework?

Heat Act and tariff regulation

In the Netherlands, the first Heat Act was enacted as of January 2014. Its motive was the need to protect small users (up to 100 kW, about four times the average heat consumption of a single household in the Netherlands) against high prices and securing a reliable delivery of heat. Thus the main goal of the Heat Act is consumer protection. This is achieved through clauses that are aimed at tariff protection and delivery security for consumers and the introduction of an independent supervisor (Haffner et al., 2016). Before elaborating on tariff regulation, a brief overview of the most important instruments of the current Heat Act will be provided for contextual knowledge purposes. Haffner et. al. (2016) summarised the following instruments.

1. Definitions clause. Here definitions are provided such as user, supplier, heat, etcetera so as to clearly demarcate roles, tasks and responsibilities.
2. Requirements of suppliers to users (< 100 kW). These are requirements such as ensuring a reliable delivery of heat, of a certain defined quality or that they at least once a year provide the consumer a detailed note regarding costs and provided services.
3. Maximum price (NMTO-principle). This will be elaborated later on.
4. Financial return monitor. This will be elaborated later on.
5. Requirements concerning heat metering. A heat supplier has to provide a heat meter, to be rented out to the consumer. These prices are based on average metering costs of gas systems.
6. Permit requirements 'large' suppliers. It is illegal for suppliers to deliver heat without a permit, unless there are no more than 10 consumers, per year they use no more than 10 MJ or the supplier is owner of the building the heat is supplied to. Then, there are several requirements

that can be demanded with a permit, which for now will not be elaborated.
7. Regulation regarding emergency supply. When suppliers and producers want to stop delivering or producing heat, they are required to report this well in advance. Certain emergency policies are included, which will not be elaborated for now.
8. Enforcement powers. The ACM (Authority Consumer and Market) monitors whether actors are following the Heat Act. For this they have several powers, such as a fine.
9. Source guaranties and possible requirements regarding efficient utilisation of waste heat. 'Guaranties of Origin' are sustainable energy certificates given to DH grids when applicable so that actors can show they produce and/or use sustainable energy. Also, with approval from the Ministry of Infrastructure and Milieu, producers of waste heat can be demanded to utilise their waste heat. This could result in a fine for waste heat or banning waste heat.

Both Szendrei & Spijker (2015b) and Haffner et. al. (2016) have found many unintentional bottlenecks in the current Heat Act that reduces tariff protection, transparency, supply security, practicality and increases administrative burdens. Two things are notable here. First, many definitions of the definition clause need improvement and adaptations (Haffner et al., 2016), thus roles, tasks and responsibilities are still vague. Second, the most bottlenecks can be found for tariff protection, transparency and practicality, with tariff protection being the worst. For this thesis it is accepted that the knowledge of that these three aspects are the biggest issues, unintentionally created by the current Heat Act, will suffice.

Tariff regulation

Tariff regulation however seems to be an issue that needs some more attention. Tariff protection is secured by two starting points, namely (1) preventing that a consumer of heat pays more than a consumer of gas (No More Than Otherwise, or NMTO-principle) and (2) the prevention of unreasonable profits of heat suppliers through periodic monitoring of financial returns of heat suppliers (Haffner et al., 2016). Interesting to know is that the first financial return monitor showed an average financial return of 7.8 % in 2013 against 3.1 % in 2014. Most countries regulate district heating tariffs to be below or no higher than the next-available technology. In Norway for instance, this is electric heating, whereas in the Netherlands, this is gas heating (UNEP, 2015). Haffner et. al. (2016) mentioned eleven bottlenecks regarding tariff regulation, for which two main solutions could be possible. The first is improving the current NMTO-principle. This should include many changes such as simplifying the mathematics because no one but the calculators understands them, or more regularly monitor fast changing parameters. The second main solution would be to change to another NMTO system. This solution is regarded the most appropriate, because among others no matter what you change of the current system, this will not be future-proof since it is dependant of the gas system. The gas system is planned to be phased out in the Netherlands (Haffner et al., 2016). The authors recommend to apply a so-called index approximation method. This method uses the most recent NMTO tariffs as starting

point, to be yearly indexed with a measured cost change from a selection of heat suppliers. Several more changes to the tariff regulation are recommended. For now, it suffices to know that the subject is heavily criticised and is currently undergoing many studies how to improve it.
All in all, the Heat Act as of now does not succeed in an appropriate situation of tariff protection and transparency. There is also room for improvement regarding security of supply and practicality. Changes are being made within the coming two years, that only adds more uncertainty for actors.

Conclusion

It can be concluded that the policy framework is being changed, which is necessary due to the many unintentional bottlenecks it now creates. As said, the heat market is currently maturing. The following can be summarised. (1) Heat producers, users and real estate developers are inadequately incentivised to participate in DH because (a) energy ratings for consumers does not take sustainable heat in account and (b) there are not enough incentives for heat producers to utilise the heat. Secondly, (2) due to the absence of a market model a DH project requires intensive organisational modelling.

2.1.6 Summary

For this thesis, it is accepted that a District Energy System (DES) is comprised of two grids, namely a heating grid and an electricity grid. This thesis will focus on the heating grid part of the DES, using the term 'District Heating' (DH) and sometimes 'District Heating grid' (Figure 2-2). The definition used in this thesis of DH is as follows: "a local network of pipes connecting the buildings in a neighbourhood, district, whole city or region, so that they can be served from centralised plants as well as from a number of distributed heating and cooling producing units including individual contributions from the connected buildings. The concept District Heating or heating grid focusses on the integration and efficient use of potential future renewable energy sources as well as the operation of a grid structure allowing for distributed generation which may involve interaction with consumers".
District Heating can be described along four elements, namely (1) the building heating system, (2) the building connection to the distribution network, (3) the distribution and transportation network and (4) the heat sources (Figure 2-4). Important asset examples per element are (1) floor heating or radiators, (2) a heat meter to establish a real-time link between supply and demand, (3) carrier pipes to transport warm water from the heat source to the building connection and (4) a waste incinerator producing heat and electricity.
Currently, 59 % of the total Dutch energy demand is heat used for space heating, domestic hot-water, greenhouses and industrial processes. 88 % of that energy demand is mostly produced by individual gas-boilers at the same location of energy utilisation. Meanwhile, the

Dutch national government recently announced the ambition to phase out gas infrastructure as much as possible, to be replaced by District Heating or all-electric solutions. If 88 % of 59 % of the total Dutch energy demand has to be transformed from gas-fired energy to either District Heating or all-electric solutions, District Heating will clearly play an important role in the (urban) energy system.
Important aspects of a future role of DH are said to be (1) integrating DH with low-energy space heating, cooling and water systems in buildings, therefore (2) implement low-temperature DH (30-60 degrees Celsius instead of incumbent 100+ temperatures), (3) integrating renewable heat and sustainable waste heat instead of e.g. coal- or gas-fired waste heat, (4) create synergies with the electrical grid by e.g. using surplus electricity on windy and sunny days for heat production and (5) a changed institutional framework (Figure 2-5). The latter aspect will be the focus point of this thesis.

2.2 Drivers and barriers of District Heating

This paragraph will answer research question 2: what are the drivers and barriers towards District Heating project development?

2.2.1 Drivers of District Heating

A recent and comprehensive thesis into energy mapping for urban energy transition made a graphical model of all the state-of-the-art sustainable interventions within the urban energy system (Dronkers, 2015). The model can be seen in 'Appendix 1: Graphical model of the urban energy system'. Through this map it becomes clear that the Smart Grids (cold, heat and electrical) play a central role in connecting many interventions on all urban scales. In paragraph 2.1.4 it was explained that DH grids can create synergies with the electrical grid by e.g. using seasonal heating storage for surplus energy during windy and sunny days. This optimises and increases the economic viability of both grids; they need each other (Woods & Overgaard, 2016). Moreover, DH enables the utilisation of the renewable energy sources Combined Heat and Power (CHP) fuelled by biomass, deep water cooling, large-scale solar thermal, large heat pumps and geothermal heat. Also, DH can increase the energy system efficiency with the utilisation of CHP production, industrial surplus heat and waste incineration heat (Lund et al., 2014; Woods & Overgaard, 2016).

Another driver of DH comes from a influential (most interviewees mentioned this report) research of the road towards an energy neutral built environment in 2050 in the Netherlands (CEDelft, 2015). It provides essential knowledge of the most cost-effective and potential energy interventions nationwide. Most cost-effective would be to replace natural gas for bio gas, keeping the incumbent gas infrastructure. This however is physically not possible due to the large space requirements of bio gas production. Therefore, the future steps are (1) reduce demand as much as possible, (2) supply as much as possible with renewable heating and cooling sources (thus replace gas infrastructure for heating and cooling infrastructure) and (3) supply the rest with bio gas (CEDelft, 2015). Moreover, the built environment of the Netherlands can very roughly be categorized in three areas: (1) historic centres, (2) newly built and medium & high density areas and (3) sub-urban and rural areas (CEDelft, 2015). The second type are the only areas where it is expected that, due to the high enough density (thus heat and cooling demand), DH can be the most cost-effective solution in decreasing CO_2-emissions through interventions in the built environment. It is therefore essential that in these areas DH is implemented, so

that in the near future the scarce bio gas should only supply areas where DH are not the most cost-effective solution (CEDelft, 2015).

Concluding, there are four general drivers for developing DH. They (1) play a central role in the sustainable urban energy system by creating synergies with the electrical grid, (2) enable the utilisation of various renewable energy sources such as geothermal heat, (3) increase energy efficiency by enabling the utilisation of waste heat from industry and waste incinerators and (4) are in certain (higher density) urban areas the most cost-effective solution in replacing the incumbent gas infrastructure.
It is to be noted that these are all drivers from a general societal or environmental goal. Drivers from a business and end-user perspective are lacking in research. This will therefore also be interesting to investigate in this research; what are drivers of actors and users to participate in DH?

2.2.2 Connection to urban sector

Seeking research connecting the urban sector with DH grids a large set of combinations of the keywords as seen in 'Appendix 2: Key words' is used. Examples are 'Urban planning', 'Green building', 'District energy', 'urban development', 'Business model', 'District heating', 'urban energy'. Database used is Sciencedirect, along with the journals Environment and Planning A, B, C and D, Building Research & Information and Building Physics. Based on this research the following can be seen.

Focus is either broad low carbon development, electrical grids or new- and redevelopment

Many studies state the need to connect multiple sectors for urban responses to climate change mitigation (Adil & Ko, 2016; Aylett, 2013; Cajot, Peter, Bahu, Koch, & Maréchal, 2015; Summerfield & Lowe, 2012; Williams, 2013). Cajot et. al. (2015) state there is now a growing consensus that urban planning should undergo many adaptations, of which one is to integrate energy planning in early stages. Recent studies mainly focus on urban form, urban sprawl, solar exposure of buildings and promoting mixed-use. However, energy as central aspect of urban planning still lacks a proper framework and clearly defined methodologies (Adil & Ko, 2016; Cajot et al., 2015; Kaza & Curtis, 2014). Kaza and Curtis (2014) state that local land use regulations, plans and programs should account for energy production as a key element, because land use planners have a strong role to play in the emerging distributed energy production phase.

Those few studies that do connect the urban sector with the energy sector almost all concern the wider objective of encouraging CO_2 reduction in cities. Or, when they are about DES they

are mainly concerned with the electrical grid, not the heating grid (Adil & Ko, 2016; Aylett, 2013; Walliser et al., 2012; Williams, 2013). The only ones found so far that do connect the urban sector to DH are the studies of Williams (2013), Pol & Schmidt (2016), Gabillet (2015) and Späth and Rohracher (2015). All these studies focus on urban planning and policy, from the perspective of (local) governments. Urban planning can be defined as "intentional interventions in the urban development process, usually by local government. The term planning thus subsumes a variety of mechanisms that are in fact quite distinct: regulation, collective choice, organisational design, market correction, citizen participation, and public sector action" (Cajot et al., 2015). These four studies into DH from an urban planning perspective are all case studies, and study urban development projects that are either redevelopment projects or newly developed projects. A focus on existing stock is still lacking. All four studies seem to end with recommendations such as a need for closer collaboration of cross-sectoral actors, more community participation (not just more influence but real development in collaboration with cooperatives), municipal leadership in various forms, developing business models involving private-public partnerships and research this by conducting more case-studies. Below, some discoveries of the four studies are presented.

Municipal departments and energy privatisation

Within municipalities, the different institutional cultures of the environment and planning departments appear to be a barrier to an integrated approach of energy choices (Gabillet, 2015). There seem to be a lack of cooperation between municipal departments when working together on urban projects. A closer connection between urban planning and local energy policy is needed (Gabillet, 2015). This study looked at this connection, but then within the municipally alone: the departments of Urban Planning, Sustainable Development and Energy. Stated was that there is no expert energy-related input into urban planning from the Energy Department. Interaction between the departments do not deal with development projects and their urban dimension, and the Energy Department is contend to monitor the operator in its sectoral role. In the case, this initially resulted in an urban development plan with DH found to be economically inviable. In the end the departments collaborated, resulting in an economically viable DH grid (Gabillet, 2015). A side-note here is that the issue was solved by the developer that invested in the distribution network, to be included in the land price. Eventually resulting in higher prices for the consumers. As to how the developer was forced or triggered to consent is left unknown.

Furthermore, one of their case studies in Stockholm showed that a DH project was developed mainly due to close collaboration between the municipality owned utilities (energy, water and waste) and the urban planning department. The municipality acted as the multi-interest institution coordinating development. Afterwards, since the privatisation of the energy sector, this connection of sectors has become more difficult (Gabillet, 2015).

Conflict passive house (re)development and District Heating

There seems to be a tension between developing new, or maintaining the competitiveness of incumbent DH grids due to conflicting low-carbon urban interventions. Sweden, one of the leading district heating countries, is in a stagnation phase concerning district heating. Despite increased market share, favourable policies and technical system growth, this stagnation is occurring due to greater building energy efficiency, but also competition between energy supply solutions and climate change (Gabillet, 2015). Späth and Rohracher (2015) studied the conflict of passive house development and DH development through a case-study of the Vauban district in Germany. A conclusion was that these two strategies cannot be applied in the same district. Due to the extremely low heat demand, DH cannot be economically viable or heating tariffs are unreasonable high (Späth & Rohracher, 2015).

These two low-carbon urban interventions thus seem to exclude on another. For this research however, it is assumed that in certain areas, DH is more favourable than the other. A more in depth discussion for further policy and research recommendation will be done later on the thesis.

2.2.3 Barriers of District Heating

There are many barriers towards DH project development. This paragraph tries to structure the barriers along social, financial, technical and sectoral barriers. First, two particular context characteristics of DH will be elaborated that explain the existence of many of the barriers.

Context characteristic 1: a wicked problem

As stated before, DH is one of many sustainable interventions towards a sustainable urban energy system. Cajot et. al. (2015) uses the approach of a 'wicked problem' to formulate the key challenges of energy planning for cities. A 'wicked' problem is essentially characterized by the involvement of many actors with different interests, the difficulty to state the problem explicitly, and the lack of immediate or ultimate solutions. It is generally acknowledged that DH plays a key role in urban energy planning, thus knowing the general key challenges of energy planning in cities is highly worthwhile (Table 2-1).

Table 2-1: characteristics of a wicked problem with its application to energy planning (Cajot et al., 2015).

Condition			Application to energy planning
1	**Lack of a unique problem statement**	Different stakeholder perspectives result in an unclear nature of the problem.	Multiple key stakeholders at different levels view the problem differently (architects and planners must rethink buildings and spaces; public authorities need to adapt organization and procedures; lawyers need to adapt legal and policy adaptation, etc.)
2	**Conflicting objectives**	Ambiguity in purpose leads to a lack of clarity about successful outcomes.	Various valid objectives possibly conflicting on short to medium terms require prioritizing (carbon-free cities; cheap affordable energy for all; regional energy self-sufficiency; jobpromoting energy system; fully renewable energy sources; etc.)
3	**Conflicting values**	Ambiguity in values prevents the clear assessment of outcomes.	Urban actors will value sustainability criteria differently depending on their objective (societal benefits of clean energy opposed to the need for low investment costs, the "landlord-tenant" dilemma; top-down planning or bottom-up collaborative planning; etc.)
4	**Dynamic context**	Static solutions do not work well in a dynamic context.	Energy planning in cities dependent on highly time-bound and volatile parameters (energy price fluctuation; evolving new technologies; population growth; high urbanization rates; changing political actors and agendas; etc.)
5	**Scientific complexity / uncertainty**	Uncertain or incomplete knowledge impedes adequate decision-making.	Different scales and actors induce scarce, dispersed and low quality physical data, often hindered by privacy or measurability issues; vast set of technological options, constantly evolving; scientific uncertainty on consequences and intensity of climate change; etc.
6	**Political complexity / uncertainty**	Ambiguity in political power results in unclear prevailing values.	No single body can take all decisions (horizontal and vertical shared responsibilities); unclear policy responses to appropriately address climate change; disagreement on estimating social costs and benefits of global warming policy; etc.
7	**Administrative complexity / uncertainty**	Ambiguity about budgets and procedural continuity results in inadequate implementation.	Public investment is often low or unavailable, and private investments are difficult to guarantee; responsibilities are often defined historically, and interaction is difficult or delayed; no standard way to describe key energy information (floor area calculation, primary and final energy metrics, …), causing exchange and monitoring difficulties; etc.
8	**Multiple tactics to address problems**	Unclear objectives values result in lack of clarity about how best to proceed.	No preferred optimal solution type (technological, behavioral, political, economic, …); solutions and measures are sometimes conflicting (e.g. insulating buildings may render district heating infrastructure obsolete); etc.
9	**Multiple stakeholders with the power to assert their values**	Multiple value sets and power structures lead to conflicting definitions of success.	Many stakeholders have a say in urban planning and/or energy issues. Governments need to reach sustainability targets and safeguard public interest; energy providers need to make benefit; individuals need to reduce expenses; etc.

Context characteristic 2: changing institutional framework, business models and markets

For the wide-scale roll-out of more sustainable DES, business models play a key role (Sepponen & Heimonen, 2015) and collaboration is a key in future business models to handle increasing complexity concerning DES (Engelken et al., 2016). DES rely on a different logic compared to large-scale, centralised power plants and fuel production units. This requires new and different types of business models, often putting the entrepreneur at a centre stage. Few business models have become established in this field, but new ones are continuously being developed and tested (Hellström et al., 2015). An important aspect here is the transformation from the collaboration of a few single-purpose companies (energy and utility companies that produce or distribute fossil based energy) towards many multi-purpose companies that do not have energy related technologies as their core business (Lund et al., 2014). Such organisations (e.g. a company owning an office or a housing corporation) often lack capital for investing in renewable energy system technologies, including energy conservation activities, and have no common organi-

sation of activities related to these technologies (Lund et al., 2014). The change to renewable energy systems entails substantial changes in existing organisations and institutions and their knowledge base of tackling the dilemma between short- and long-term costs, with a need to integrate better long-term costs (Lund et. al., 2014).

In practice, common processes such as financing, design, technology, procurement and collaboration is characterised by being fragmented, short-term thinking, low notion of each other's interests and suspicion (RVO, 2012). There is a need for (1) attention to long-term value (by considering costs and revenues in the whole life-cycle), (2) integral collaboration (by connecting diverse expertise's, interests and backgrounds and really dare to work differently and learn from this) and (3) smart governance (by working on a common goal and creating the space for new practices and unsuspected role divisions) (RVO, 2012). This study by RVO (2012) defined 21 necessary steps towards energy neutral urban development; ten are within finance and collaboration areas, whereas the rest are mostly about energy mapping and choosing the suitable sustainable intervention for the particular urban development. Also, one of the questions a large energy and utility company in the Netherlands still has is about investments and ownership of DH; who invests in and who owns what (Den Ouden, Hoeksema, & Graafland, 2015)? Community ownership models seems to be a promising option here (Adil & Ko, 2016; Aylett, 2013; Williams, 2013).
Despite of the need to research and develop this area, scientific research is dominated by technical research (Sepponen & Heimonen, 2015). However, business model research in renewable energy context is becoming increasingly popular (Engelken et al., 2016).

Moreover, looking back at paragraph 2.1.5 concerning the policy framework, it was concluded that the lack of a market model with the current development of the Heat Act adds uncertainty.

Thus, due to the decentralized nature, increasing complexity and maturing heat market there is a need for new cross-sectoral collaboration models that imply new and/or other actors and roles, forms of ownership, finance and risk division. This is inherent to new business models of the involved actors and is only just beginning to be researched and developed. This is not a barrier in itself, but as with the wicked problem issue, this characteristic of the context of DH is creating certain barriers. These barriers will now be elaborated.

Social: low public acceptance and trust

Raising awareness and technical understanding of district energy applications and their multiple benefits is critical in order for city authorities to engage with the market. Managing feasibility analyses, developing appropriate policies, engaging with stakeholders, developing business models and ensuring public acceptance, all of which are critical to build the trust of potential users. Examples include Milan's designated "help desks" and Frankfurt's Energy Agency (UNEP,

2015). Other studies state the need for more research on the topic of social acceptance and social learning related with the heating costs (Glad, 2012; Morgenstern, Lowe, & Chiu, 2015). Also, the high upfront investment and the need for a certainty of heat demand leads to monopoly positions, no freedom of choice for consumers and in some cases higher costs than conventional for consumers (Gabillet, 2015). Furthermore, the 'sustainability-level' of DH are also controversial. Questions arise as to what extent utilizing e.g. waste heat from a waste incinerator or coal-fired Combined Heat and Power Plant can be considered sustainable energy. A study done for Nuon into their Customer Satisfaction Index concluded exactly the same ("De waarde van Nuon Warmte," 2016).

Summarizing, three main issues undermine public acceptance of and trust in DH, namely (1) monopoly positions with no freedom of choice for consumers, (2) controversy about higher costs for consumers than conventional means of heating and cooling and (3) controversy regarding the sustainability of many heat sources. It is to be noted that this concerns the view of the users, although it could be said that this negative image also might have negative implications for how (political) decision makers perceive DH.

Financial: closing the business case

There is a need for attention to long-term value (by considering costs and revenues in the whole life-cycle (RVO, 2012). Also, for DH, capital is typically invested prior to the connection of customer buildings. Thus, the greatest risk in system deployment is load uncertainty (UNEP, 2015). Here are three barriers to consider, namely (1) the need of a high upfront investment with long term commitment due to a long (10-30 years) payback time, (2) demand or load uncertainty, leading to (3) difficulty closing the (integral) business case.

Technical: novelty and rapid development

Currently lots of effort is put on research and technical development related to improving energy efficiency, increasing the share of renewable energy and improving of districts' energy systems (Sepponen & Heimonen, 2015). There still exist many technological barriers, such as that the infrastructure is still highly expensive, inflexible and having high heat losses. A solution for instance is low-temperature heating. Research is addressing these issues extensively (Lund et al., 2014). Two barriers arise out of this and the issues resulting from the context of a wicked problem, namely (1) novelty issues resulting in unwillingness from personnel and (2) rapid technical development resulting in a lack of clarity whether DH is the optimal solution.

Sectoral: lack of cooperation and understanding

Cajot et al. (2015) concluded that there is a need for a combination of interconnected solutions, which reinforce each other to tackle the issues in a comprehensive and dynamic
Looking back at paragraph 2.2.2 concerning the connection to urban sector, it becomes clear

that current practices are not adequate for the development of this required combination of interconnected solutions. The urban and energy sector are as of now to a large extent two separate discourses, both in practice and research. The municipal departments and energy privatisation problem from Gabillet (2015) being a clear example.

In addition, an article in the international magazine on district heating and cooling mentioned that the main hurdle to new district heating expansion today seems to be the lack of mutual understanding between the financial sector, political decision makers and promotors of district heating (Lygnerud, 2015). This research area is addressed in 2016/2017 calls of EU horizon 2020 projects (secure, Clean and Efficient Energy). A more in-depth explanation of these hurdles is lacking. It does however add an argument to the need for cross-sectoral understanding and collaboration, being then mainly the energy, urban and financial sector.

To conclude, two barriers can be distinguished concerning this aspect, namely (1) a lack of co-operation between municipal departments when working together on urban projects and (2) a lack of mutual understanding between the financial sector, political decision makers and promotors of district heating.

2.2.4 Summary drivers and barriers

Four general drivers are recognised for DH. They (1) are expected to play a central role in the future urban energy system by creating synergies with the electrical grid, (2) enable the utilisation of various renewable energy sources such as geothermal heat, (3) increase energy efficiency by enabling the utilisation of waste heat from industry and waste incinerators and (4) are in certain urban areas the most cost-effective solution in replacing the incumbent gas infrastructure and/or lowering CO_2 emissions. However, drivers from a business and end-user perspective are lacking in research. This will therefore also be interesting to investigate in this research; what are drivers for actors and users to participate in DH? See Figure 2-8.

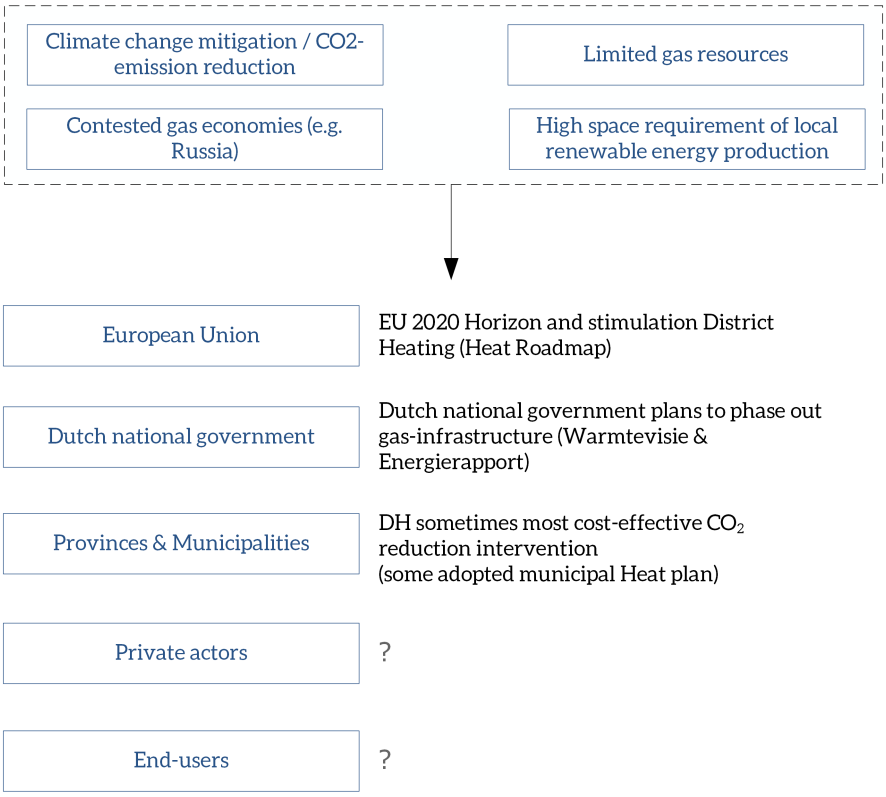


Figure 2-8: overview of the driving forces behind District Heating based on literature.

Regarding the barriers, institutional and societal barriers towards DH development are acknowledged as being of importance, but these areas are surprisingly underrepresented in scientific research. At the same time, there are also still many technological barriers, but these are currently undergoing extensive research and development.

Two characteristics of the context in which DH finds itself are especially important for the existence of many barriers towards DH development. The first is that due to the decentralized nature, bad image and the immature heat market, there is a need for new cross-sectoral collaboration models that imply new and/or other actors, roles, forms of ownership and risk division. This is inherent to new business models and is only just beginning to be researched and developed. The second is that DH is part of a so-called 'wicked problem', which essentially is characterized by the involvement of many actors with different interests, the difficulty to state the problem explicitly, and the lack of immediate or ultimate solutions. Ten barriers are discovered, categorized along social, financial, technological and sectoral barriers. See Figure 2-9.

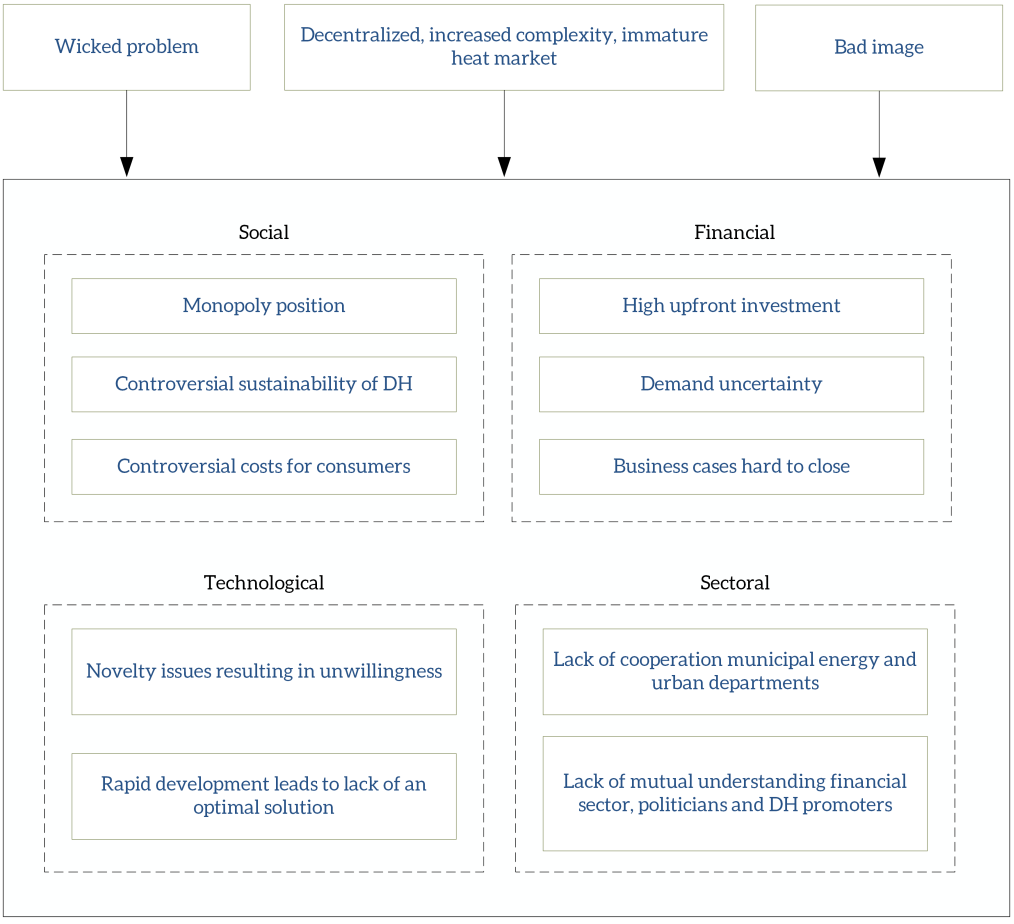


Figure 2-9: overview of the barriers towards DH development.

2.3 Business models and collaboration

This paragraph will answer research question 3: how can the business model and collaboration mechanism concepts be used to study district heating project development?

2.3.1 The business model concept

Business model research and development has significantly increased since the late 1990's. Due to the global digitalization trend the focus recently has been on business model innovation, sustainable business models and on networked business models (Wirtz, Pistoia, Ullrich, & Göttel, 2015). Many studies concern the structure and use of the concept.

Elements and structure of the business model

One study puts it quite simply as who is offering what to whom and expects what in return (Gordijn, Akkermans, & van Vliet, 2000). The widely cited research of Osterwalder and Pigneur (2010) define it as the rationale of how an organisation creates, delivers and captures value. They have divided the business model itself into nine elements, being
(1) customer segments such as target group and which market,
(2) value proposition such as the value to customers through products and services,
(3) channels such as websites and sales teams,
(4) customer relations such as personal assistance,
(5) revenue streams such as asset sales or usage fee,
(6) key resources such as type of personal and equity,
(7) key activities such as production of products or designs,
(8) key partnerships such as joint-ventures and
(9) cost structure such as production costs and salaries.

These are appointed to four subcategories, of which 1,3 & 4 are part of value delivery, 2 of value proposition, 5 & 9 of financial structure and 6 - 8 of value creation (Figure 2-10).

In addition, the context of a company's business models is categorized in
(1) key trends such as societal and cultural,
(2) industry forces such as new actors and products,
(3) macro-economic forces such as the global market and

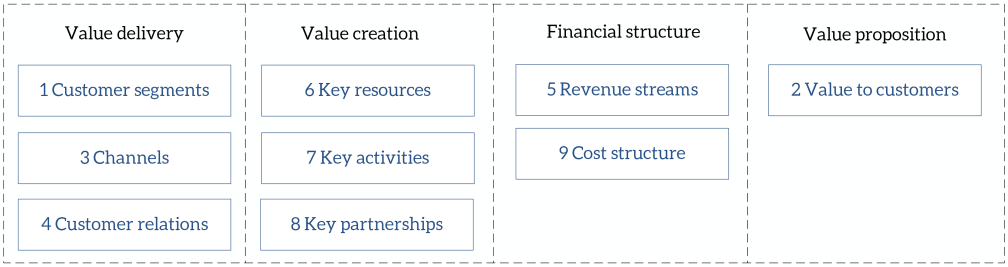


Figure 2-10: business model structure from Osterwalder and Pigneur (2010).

(4) market forces such as different needs and demand.
Osterwalder and Pigneur (2010) advocate mapping this environment so as to be better equipped choosing the direction of a future business model. Knowing this study is widely acknowledged within the business model discourse, it is striking to see that the main focus is the structure of the business model from the perspective of one company. The network or system it is part of is seen as an environment to be merely mapped so as to improve its own business model. Other more recent studies share this critique, stating among others that the use of business models in the activities of market actors has not yet been thoroughly examined (Palo, 2014). One other extensive study looked at business models' origin, development and future research perspectives. The authors stated that the key players and their interactions, like the coexistence of different business models on a corporate level, are seldom taken into account. Even though, they concluded that many experts put a lot of importance on it, leading to their further research recommendation (Wirtz et al., 2015). One of the few studies that do include the network perspective is the developed V4 business model, having divided the business model into the four dimensions, namely
(1) value proposition,
(2) value architecture,
(3) value network and
(4) value finance.

The value network is described as a way in which an organization enables transactions through coordination and collaboration among parties and multiple companies. The characteristics of a network come into play in regard to aspects such as openness, the extent to which suggestions and information is shared, the role of different actors and the governance within the network (Al-Debei & Avison, 2010; Gordijn et al., 2000). Value proposition is in essence the same as the one used by Osterwalder and Pigneur (2010). The same applies for the other dimensions, however value architecture is referred to as value delivery and value finance as financial structure.

Utilisation of the business model

Palo (2014) examined the ways in which business models are used by market actors in their efforts to create and stabilize business in interaction with others in emerging technology-based service contexts. He advocates research of the dynamic, processual and interactive nature of business models instead of its mere structure. Having done so, it was concluded that a business model can be seen as a devise in a context of uncertainty, such as technology-based service markets and in networks of market actors, to coordinate and mobilize action. "They can be considered as tools for forming the network for a new innovation or venture. The level of business model use now shifts from individual actors to a network." (Palo, 2014). They describe the 'networked business model' as "a device that creates a shared understanding among the market actors with a structure or a narrative, e.g. concerning their roles and activities in the network, the service offering, and their relations to each other and to the networked market. It can be used to identify and open up business opportunities for new actors." (Palo, 2014). So the business model to be used to analyse and describe markets, coordinate and create actors and relationships, eventually shaping new markets.
Most recent studies about business models share this view. Kijl (2015) uses the definition "a business model describes the way a company or network of companies aims to create customer and network value". They state that in discussions of business model concepts, the relation between external influence and business models is mostly missing. It is interesting they introduce the notion of the 'centre of gravity' in a value network. They perceive leading, powerful actors forming the centre of gravity, who are then important to focus on for redesigning networked business models.

In short, it became clear that business models are to be used as tools to (1) analyse and (2) describe markets. This knowledge can then be used to coordinate (and maybe also create new) actors and relationships, eventually shaping new markets. Regarding the structure and elements of the business model, many studies have different views. However, certain elements are used in most studies, be it with different terminology. When developing a conceptual framework, these elements will be taken into account.

2.3.2 Business model research on renewable energy

Along with the sustainability trend, there is lots of research on the so-called sustainable business models. One study defined business model innovation for sustainability as "innovations that create significant positive and/or significantly reduced negative impacts for the environment and/or society, through changes in the way the organisation and its value-network create, deliver and capture value (i.e. create economic value) or change their value proposition" (Bocken, Short, Rana, & Evans, 2014).

More specifically for (renewable) energy, scientific research on business models is emerging (Engelken et al., 2016). Globally new business models are facilitated due to the liberalisation of the energy sector, the unbundling of energy systems' functions (e.g. generation, transmission, distribution), and the change from large state-owned utilities to an increasing involvement of private actors, which is taking place in all countries worldwide (Engelken et al., 2016). See Figure 2-11.

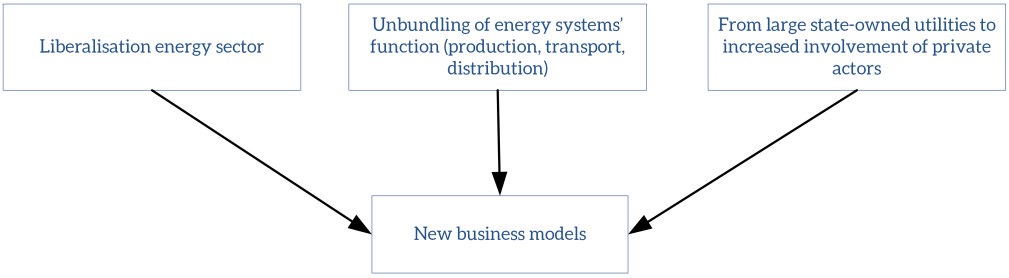


Figure 2-11: global reasons for new business models in (renewable) energy (Engelken et al., 2016).

Opportunities are found to be adaptation of utilities' business models, cooperative business models, combination of mobility and electricity, solutions for load management and storage, consumer involvement, enabling and supporting distributed generation and integration of renewable energies into industrial processes. Figure 2-12 shows the amount of papers the authors have found in their extensive study. There is a strong interest in electricity and the combination of electricity with heat or mobility is also eye-catching. Business models for heat appear less often, however there is a literature stream that analyses heat business models and increasingly considers renewable energy technologies in the context of DH (Engelken et al., 2016).

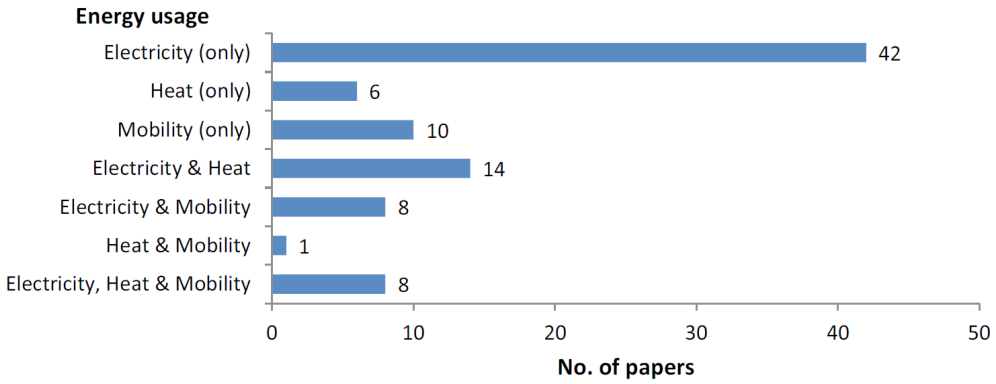


Figure 2-12: number of papers on business models analysing energy usage (Engelken et. al., 2016).

Among others, the authors conclude that in existing research, heat is out of focus, that it requires new approaches and that cooperation is a key in future business models to handle increasing complexity. Furthermore, in terms of the structure and elements of the business model concept, the authors acknowledge and use the model of Osterwalder and Pigneur (2010).

2.3.3 Business model research on District Energy Systems

Business models play a key role in the wide scale implementation of new DES (Sepponen & Heimonen, 2015). It is interesting the authors use the term 'business concept' rather than business models. Business concepts are general level business ideas and elements, whereas business models are their next, more mature level for real life company specific operation models. Thirteen business concepts are found, for example 'co-operative ownership of district heating networks' or 'heat recovery of excess heat utilised in district heating and cooling'. In their view, many of the typical European Commission funded projects state they are studying business models, although they are actually studying the business concepts. UNEP (2015) is one of these studies, cited many times in this research. The authors show an example of a network of actors in a so-called 'energy hub district'. Five different business concepts are combined into one generic model which is called the 'full service provider' concept. It e.g. introduces the role of 'energy broker'. In essence, they scrutinized DES on a business concept level rather than a business model level. It provides an example of the way in which a network of actors could cooperate with each other, based on several business concepts. However, it remains on the level of business concepts and theories; it lacks for instance an implemented case-study.

One other paper explored how firms together in the district energy system develop their business models to facilitate change (Hellström et al., 2015). Their conception of a DES differs somewhat from the one used in this thesis, however it can be said the principles are the same: decentral energy systems rather than centralised systems, requiring new business models and collaboration. Thus highly relevant for District Heating.
They state that very few researchers have focused on explaining what actually connects two (or more) business models with one another. They used a business model as 'lens' to study collaboration between companies, which is an interesting approach. The aim was to explore the mechanisms that enable closer collaboration and connect business models and enable value creation and capture within the context of DES. Interesting about their study is the use of case-studies, after having formed a framework to study the cases with. However, the cases are not implemented, they remain ideas formed during interviews and workshops. Still, this makes it more practical than the fully theoretical business concepts from Sepponen & Heimonen (2015).

The authors used a so-called 'activity system perspective' to the business models. This suggests that business models are seen as systems of interdependent activities spanning a firm's boundaries. The activity systems perspective addresses value creation on an system level while keeping the focus on a focal company which actively tries to reconnect the links between itself and other companies (Hellström et al., 2015). It resulted in a framework divided into three elements, namely (1) content of transactions, (2) structure of transactions, and (3) governance of transaction, and four sources of value creation: (1) novelty (2) complementarity (3) lock-in and (4) efficiency.

They compared three cases and came up with some interesting statements and ideas. One of them being "one of the major conclusions of this research is that companies striving to make radical system innovations need to shift the innovation effort from the products or processes they control to the larger systems they are part of. The next step is to actively construct the appropriate business model and engage the relevant stakeholders in such a development." (Hellström et al., 2015). Also they state that in the distributed energy systems industry, a profound feature of business models is the way they make companies interdependent upon each other and how they share common business model elements so as to drive value, not only for themselves, but also for their partners. Thus, the analysis of one business model in isolation is not able to explain the way towards increased value creation. However, it is a crucial concept for grasping the value capture of each individual company, which in the end is the main incentive for engaging in collaboration.

Finally, they suggest to add 'collaboration mechanisms' in the business model design. Collaboration mechanisms are vehicles of business model innovation that enable new business models and business by connecting elements that previously were not primary parts of the business models. In essence, a collaboration mechanism reflects the part of overall value creation for each company, i.e. its role or function in the system, and value capturing for each company (Hellström et al., 2015). This seems to be a concrete example of the conclusions from Engelken et. al. (2016): cooperative business models as opportunity and that cooperation is a key in future business models to handle increasing complexity. See Figure 2-13 for the developed framework. However, this concept is only used to design new collaboration mechanisms in theoretical cases; not to study a real-life case with. This would therefore be interesting to execute, as the authors also recommend to do.

Concluding, business model research on DES is thin but emerging. Collaboration is said to be a key in future business models to handle increasing complexity and the concept of 'collaboration mechanism' is suggested to be added when doing business model research on DES. This will then be taken into account when forming the conceptual framework.

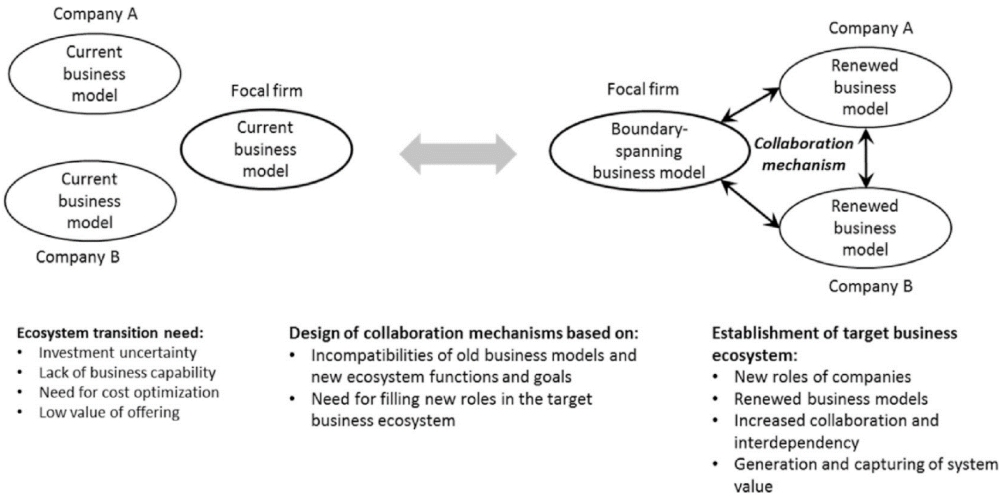


Figure 2-13: framework for business model innovation in ecosystem transition context (Hellström et al., 2015).

2.3.4 Business model research on District Heating

This paragraph is divided into scientific and practical research.

Scientific research

One paper aimed to show how the business model concept can be utilized in order to understand the competitive challenges facing today's DH firms in Sweden (Sandoff & Williamsson, 2016). Because Sweden is a leading country in district heating, they also speculated how their lessons can be used in countries with less DH implementation, under which The Netherlands can be considered. They used a network and customer perspective business model framework, containing four elements.

(1) Value offering, which describes customer value, customer relations and market-segmenting.

(2) Resources and activities, which describes how production of the value offering is done through the management of production factors and activities.

(3) Value capture, which describes the fiscal flows and economical aspects of relations to main stakeholders, such as employees, suppliers, owners, and customers. It also describes other types of intangible values that different stakeholders capture through engaging in the value offer.

(4) Long-term competitiveness, which describes the economic durability and ecological sustainability of the business model (Sandoff & Williamsson, 2016).

The challenge for Sweden is to transform existing, traditional business models in the heat market from the 3rd generation DH to the 4th generation DH. As stated before, the 4th generation concept is built on the idea of creating low-temperature District Heating grids interacting with low-energy buildings. From a business model point of view, transition from 3rd to 4th generation district heating not only lowers revenues from new installations but also lowers their costs (e.g., decreased investment costs, grid loss and increased efficiencies of low temperature production units) (Sandoff & Williamsson, 2016). The authors do not state to which actors this applies, however this is most likely dependent of how a DH grid is organised; it can vary per grid. This is a very important shift with considerable changes needed for future networked business models, above all the resource and activities part of business models.
(Sandoff & Williamsson, 2016).

To conclude, research into business models of DH grids is also thin. In terms of the elements and structure of the business model, an interesting new element used in one of the studies that specifically focused on DH is 'Long-term competitiveness', which describes the economic durability and ecological sustainability. This, along with the other elements as described in paragraph 2.3.1, will be taken into account when forming the conceptual framework.

Practical research

Business model research from practice on DH seems to show a focus on ownership and finance aspects. Also, Sepponen & Heimonen (2015) critiqued that these many of the studies from practice (such as EU funded studies) actually study business concepts rather than business models. In any case, the highly extensive and international study from UNEP (2015) divide the business model of DH into four types of 'business models'. They have grouped them along a continuum from public to private which according to them depend on two factors, namely (1) the return on investment for project investors and (2) the degree of control and risk appetite of the public sector. These four types of business models are then described along the aspects 'risk and governance', 'sources of finance' and 'control'. With risk and governance, it is described what the actors are responsible for and what kind of risk they bear. With control they describe how the organisation of the project is done, having influence on decision-making power and e.g. exit-strategies.

Another study from practice in Canada also uses this division of four 'business models', namely (1) private project development companies (PPDs), (2) public project development companies, (3) hybrid public/private partnerships (P3s) and (4) stakeholder-owned special purpose vehicles (SPVs). Sources of finance, the roles required to deliver and operate a DH project and the proportion of private and public sector involvement are said to be of importance for consideration (King, 2013). The roles required as stated in the study are as follows. Project champion, identification and definition of a project, achieving stakeholder buy-in, initiating technical feasibility

studies and financial investment appraisals, initial fundraising, and driving and promoting the project. The project champion could be the local mayor or the sustainability officer seeking carbon reductions, or the economic development officer seeking to create jobs. Regulation: establishing and monitoring standards of performance and/or consumer protection across a wide area, such as a town, city, or region, with which all district energy projects in those areas must comply. Governance: this is specific to the particular entity and is concerned with providing strategic guidance, stakeholder accountability, and high-level relationships. Contractor: a more limited engagement concerned with the physical delivery, including design and construction. Asset owner: the party that owns the actual physical assets. This could be a bank or financial investor. Operator: responsible for the project's technical operation. Retailer: responsible for the retailing of energy across the project, for example, buying it from the central plant operator, arranging its transportation to the end-consumer, and its sale to that consumer.
Supply chain manager: responsible for the procurement of fuels, equipment, and services necessary for the development and operation of the project (King, 2013). It is to be noted that nothing is said about actors having multiple roles.

Clearly, from practice perspective business models of DH projects concern the so-called four 'project types' (from fully public to fully private), with the emphasis on sources of finance, division of ownership, amount of risk and control per actor and the roles of the actors. One can have doubts as to what extent this is actually a business model. It rather seems to be only a part of what actually constitute a business model. However, also these elements will be taken into account when developing a business model framework for this research.

2.3.5 Business model framework

This paragraph is divided into a business model analytical framework and a network analytical framework

It was concluded that the business model concept can be used as a tool to (1) analyse and (2) describe prevailing business models (with a network focus). A business model framework will be developed to analyse the actors with that are involved in DH projects.

Business model analytical framework

Engelken et al. (2016) acknowledged and used the business model structure of the widely cited study from Osterwalder and Pigneur (2010). One of the few business model studies on DH performed by Sandoff and Williamsson (2016) in essence used the same elements as Osterwalder and Pigneur (2010), only adding the element 'long-term competitiveness'. The main critique is that the business model of Osterwalder and Pigneur (2010) lacks a network and/or collabora-

tive perspective to the business model. Considering all this, the four main elements from Osterwalder and Pigneur (2010) will be used to analyse the actors, but with a focus on the values to the network rather than for the actor. However, value capture is an element that only applies to the actor. The following four elements will be used.

(1) Value capture (Figure 2-14), to get a description of how financial value is captured for an individual company from their and the networks value creation. 'Revenue streams' represents the cash a company generates. Examples are (1) transaction revenues resulting from one-time payments and (2) recurring revenues resulting from ongoing payments. This can be from asset sale, a usage fee, subscription fee, lending/renting/leasing, licensing, brokerage fees or advertising. 'Cost structure' describes all costs incurred to operate a business model. Examples are (1) fixed costs such as salaries and manufacturing facilities and (2) variable costs that vary proportionally with the volume of goods or services produced. Besides these two financial values a company can also capture less tangible values. An examples is an improved corporate image.

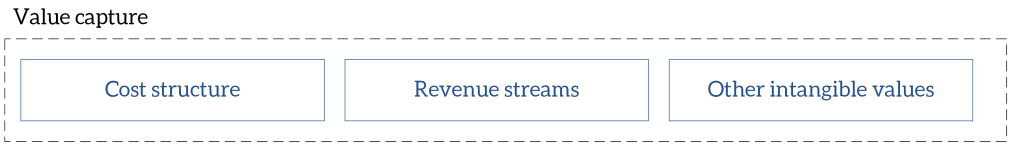


Figure 2-14: business model element 'value capture' with its three aspects.

(2) Value delivery (Figure 2-15), which according to Osterwalder and Pigneur (2010) is formed of the elements 'customer relationships', 'channels', and 'customer segments', of which it can be questioned as to what extend it is relevant to analyse these elements in full. Engelken et al. (2016) explain it as follows: which customers are targeted, how the company delivers the product or service and how the customer relationship is maintained. The authors have found that this concept, together with value creation and collaboration, in many business model studies is underrated. For this research, it is accepted to focus on the aspects 'customer relationships' and 'customer segments', discarding the aspect 'channels' from Osterwalder and Pigneur (2010) for demarcation purposes.

Figure 2-15: business model element 'value delivery' with its two aspects.

(3) Value creation (Figure 2-16), to get a description of the benefits of products and services offered by actors. The element 'resources' describes the most important assets required to make a business model work. They can be physical (e.g. a distribution network), human (e.g. knowledge of personal), financial (e.g. cash or lines of credit) and intellectual (e.g. brands, patents, partnerships) assets. These resources lead to possible 'activities', which describes the most important things a company must do to make its business model work. Examples are (1) production such as designing, making or delivering a product, (2) problem solving such as consultancy work and (3) providing a platform for actors such as doing service provisioning and platform management. This can concretely be described as 'products and services'.

Figure 2-16: business model element 'value creation' with its two aspects.

(4) Value proposition (Figure 2-17), which described why customers (or actors) choose a company, or in this case a product, over another. It embodies the benefits of products and services offered to customers and actors.

Figure 2-17: business model element 'value proposition' with its two aspects.

These elements will be used for forming the conceptual framework, which will be elaborated later.

Network analytical framework

Osterwalder and Pigneur (2010) have placed the aspect 'key agreements' within the element 'value creation' of an actor. However, as stated before, the main critique is that the business model of Osterwalder and Pigneur (2010) lacks a network and/or collaborative perspective to the business model. In addition, this research focusses on the networked business models. Hence, it is chosen to seperately study the network, by means of the elements 'key agreements' and the 'organisational structure'. The former aspect stems from Osterwalder and Pigneur (2010), the latter stems from a combination of the business model frameworks used by Al-Debei and Avison (2010) and Hellström et al. (2015). Figure 2-18 shows the network analytical framework.

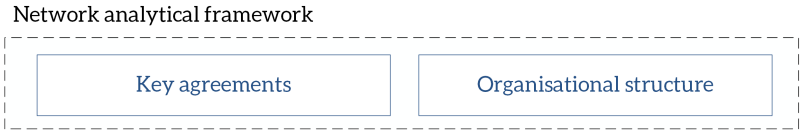


Figure 2-18: network analytical framework

2.3.6 Summary

A business model is a widely accepted concept among researchers to (1) analyse and (2) describe markets. This knowledge can then be used to coordinate (and maybe also create new) actors and relationships, eventually shaping new markets. However, there are many views of how to actually describe and define the business model concept. This is in recent years heavily discussed, developed and applied. For this research, a combination of business model studies is used to form a business model and network analytical framework, although most of the elements forming this framework stems from Osterwalder and Pigneur (2010), Engelken et al. (2016) and Al-Debei and Avison (2010). Reasons for this are as follows. The former study is widely acknowledged, also by Engelken et. al in regard of applicability in the renewable energy business. The main critique of the study from Osterwalder and Pigneur is the lack of focus on the network and/or collaboration, of which the importance for especially in the context of renewable energy is acknowledged by many studies, among others Engelken et al. (2016). The study from Al-Debei and Avison (2010) is used to provide this network approach. The acknowledgements and critiques of Engelken et. al. (2016) are taken seriously as this study is a highly extensive literature review of business models in renewable energy, and it is the most recent.

Moving to business models research specifically on DH grids, it can be seen the research quantity is thin and remains on a theoretical and system level. In terms of the elements and structure of the business model in this regard, an interesting new element used in one of the studies is 'Long-term competitiveness', which describes the economic durability and ecological sustainability. It describes the resources, processes and competencies, which ensure necessary adaptability to be able to create competitiveness in the future. This element will however for demarcation purposes not be incorporated in this research business model framework. Further study recommendations will elaborate more about this element. The business model elements as described in paragraph 2.3.5 will be used for the conceptual framework.

In addition, collaboration is said to be a key in future business models to handle increasing complexity. Therefore, the concept of 'collaboration mechanism' is suggested to be added when doing business model research on DES, which this research will do. A collaboration mechanism in essence reflects the part of overall value creation for each company, i.e. its role or function in the system, and value capturing for each company. This research will form a strong focus on this concept, which will be incorporated into the conceptual framework.
Furthermore, moving to business models research specifically on DH grids from practice, an emphasis can be seen on sources of finance, division of ownership, amount of risk and control per actor and the roles of the actors. One can have doubts as to what extent this actually constitutes a business model, hence these elements are not incorporated into the conceptual model.

2.4 Concluding conceptual framework

The conceptual framework can be seen as a synthesis of the answers from research question two and three. It will be used as a focus tool to study research question four with. See Figure 2-19.

When studying the intended cases, (1) the business model involvement per key actor will be analysed. For this the four main business model elements are used, with their aspects as described in paragraph 2.3.5. The first part of the interview protocol used is based on these elements and aspects. Thus, the content of the business model elements and aspects will be identified during the interviews. Also, project documentation is used to identify this content. It has to be said however that the identification of the content of these business model elements and aspects will always have a certain subjectivity. Some interviewees can literally say that for instance their value capture is such and such, whereas others do not say it that literally. In the latter case, the value capture will have to be pinpointed as objective as possible, based on the interviews and project documentation. Still, because paragraph 2.3.5 clearly outlines the intended content of the business model elements and aspects and many scientific studies are used, it can be stated that the identified content of the actors' business models will be reliable.

Next, the organisational set-up of the network (2) is analysed. This is done by analysing the two elements 'key agreements' and 'organisational structure' as explained in paragraph 2.3.5. As with the business model analysis, the content of these elements will be identified through the interviews and project documentation. In the interview protocol (Appendix 3) it will for instance be clear what type of question will address this aspect. Still, as with the business model elements, there will always be a subjective part of translating or pinpointing the data gathered into identified content for these elements. In the case analyses this process will be described as clearly as possible. However, so as to keep the amount of pages of this thesis on an acceptable level, a balance has to be found between elaborating too much and too less on this process.

Lastly, these two concept will provide the necessary input to identify the collaboration mechanisms in place. The conceptual framework shows that 'value creation' and 'value proposition' point towards the concept 'collaboration mechanisms', whereas the element 'value capture' is derived from the system value creation that is enabled by collaboration mechanisms and 'value delivery' from the actors' business model. This shows that the collaboration mechanisms per case can be identified when one combines the 'network' (by means of the 'key agreements' and

'organisational set-up' with the 'value creation' and 'value proposition' from the actors involved. This will be the focus of the case-studies. It has to be clear that the identification of the collaboration mechanisms and the system value creations they enable is solely one's own interpretation of the data. However, this process is made as objective as possible by structuring it in this matter, thus by means of first gathering and identifying the separate elements and aspects (which are derived from extensive literature research, and identified following a case study protocol), and then combining only the network, value creation and value proposition elements.

This focus of network, value creation, proposition and capture is based on the definition of collaboration mechanisms that is used from Hellström et al. (2015): a collaboration mechanism is used to signify something that both triggers and enhances collaborative value creation and capture. In essence, it reflects the part of overall value creation for each company, i.e. its role or function in the system, and value capturing for each company.

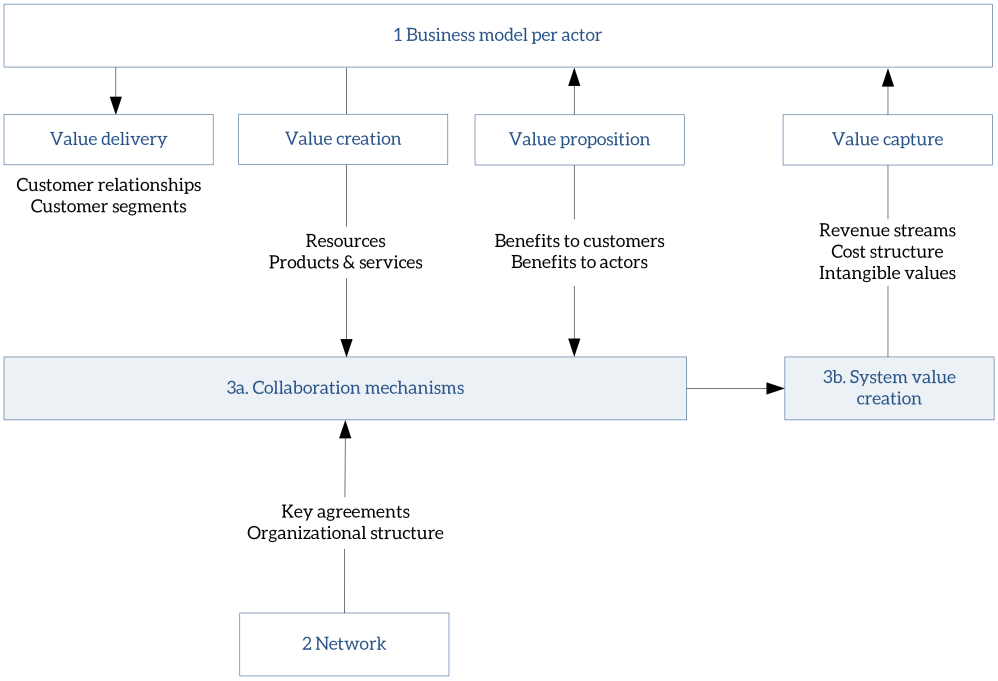


Figure 2-19: the conceptual framework.

CHAPTER
03

Research design

This chapter will describe the design of this research along the subjects as depicted in Figure 3-1.

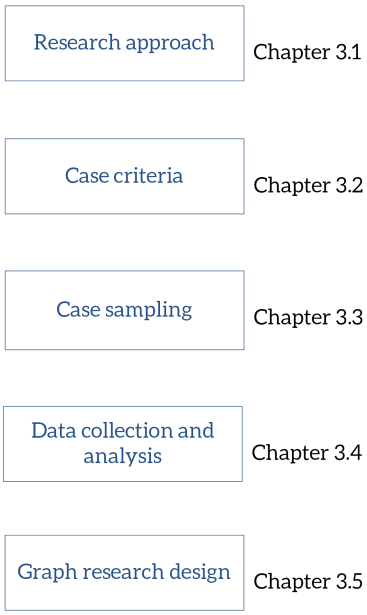


Figure 3-1: readers guide of chapter 3.

3.1 Research approach

Research in business models has attracted a lot of interest during the past decade. Their role in energy systems and industry transitions are an unexplored phenomenon, which justifies a case study approach (von Krogh, Rossi-Lamastra, & Haefliger, 2012). The paragraph 'connection to urban sector' (paragraph 2.2.2) recognized among others "developing business models involving private-public partnerships and research this by conducting more case studies" as further study recommendations from literature (Gabillet, 2015; Pol & Schmidt, 2016; Späth & Rohracher, 2015; Williams, 2013).

This research started with the idea to develop a generic collaboration mechanism and test this 'product' within a new context (new case to be developed) to evaluate ex-ante if this collaboration mechanism is indeed usable. Hence, a multiple case study approach with heterogeneous sampling was suggested. One could sample DH cases that are developed with private, public-private and fully public models, with many different heat sources and parties involved. Comparing these cases would definitely lead to usable generic collaboration mechanisms, development models and well-founded policy recommendations. However, after the first case study it finally became clear that this plan was not feasible. Considering the limited resources of a MSc thesis research, a humbler and more realistic research aim was needed. Hence, the research aim changed to providing an analysis of the barriers towards DH project development and 'merely' investigate the role of business models and collaboration mechanisms in this context.

3.2 Case criteria

It is important to sample cases that are appropriate in explaining the phenomenon of interest. Three main criteria apply which will be elaborated.

(1) First, as this research concerns DH grids, a case has to meet certain DH grid characteristics. As elaborated in the definition of DH in paragraph 2.1, a DH is open to new heat sources in the future, has at least one renewable heat source and create optimisation synergies with the electrical grid through e.g. energy storage and/or other technologies. Thus, the cases have to meet some of these characteristics. Furthermore, precise minimal figures as to how many customers is hard to provide. Considering the small amount of available cases, a minimum of several thousand customer connections will have to suffice.

(2) Secondly, this research investigates the role of collaboration mechanism and business mod-

els. In the problem statement (paragraph 1.2), connection to urban sector (paragraph 2.2.2) and business models research (paragraph 2.3) it is concluded that many studies advocate studying public and private collaborations as this model seems to have the most future potential. This requires (1) multiple actors from both the public and private domain that are (2) collaborating in a public-private model. Thereby, for the sake of demarcation, excluding fully public or private development models.

(3) Third and lastly, this research also investigates the role of collaboration mechanisms and business models in overcoming the development barriers of DH projects. Hence, a case should be sampled with certain characteristics so that there is a high probability the formulated barriers were present and eventually overcome. In this case, this means the inclusion of the urban sector so that the sectoral barriers come into play. Thereby preferring DH project combined with urban (re)developments or retrofit development plans.

As seen in the literature from paragraph 'connection to urban sector' (paragraph 2.2.2), there exists a large gap between the energy and urban sector. Studies show that urban (re)developments create the opportunity to overcome many of the challenges that DH development face. However, also a tension between passive house and DH grid development is recognized. Also, the biggest challenge for energy efficiency and renewable energy in the built environment is said to be the existing stock. As stated before in the aforementioned paragraph, studies of DH development focussing on the existing stock is missing. Considering these (cross-sectoral) gaps, it would be interesting to study an implemented DH, connected to both the existing stock and newly developed buildings, thus developed in conjunction with new and/or redeveloped urban areas. This excludes DH cases that have no relation to the building/urban sector, e.g. when two or three (industrial) companies decide to utilise each other heat supply and demand.

Thus, the most appropriate cases to study the role of collaboration mechanisms and business models towards DH project development would be a DH project on its own accord, open to new heat sources and users, with at least one sustainable heat source, has consumers of both dwellings, offices and commercial functions and create synergies with the electrical grid. Also, many parties should be involved, from both the public and private domain, engaging a certain public-private model. Lastly, it needs to be combined with new urban development and preferably also connected to the existing building stock.

3.3 Case sampling

At the beginning of this research, it was decided to start with a pilot case so as to be better able to formulate a conceptual framework and research design. The pilot case chosen was an implemented large scale Seasonal Thermal Storage System (STSS) together with the urban development Paleiskwartier in 's Hertogenbosch. It was chosen because the STSS, although not a DG grid, shares almost all characteristics with a DH grid and is developed in conjunction with an urban redevelopment. It was also chosen because of convenience reasons, namely that the graduation company could provide data on a short notice.

As it turns out, for the research goal, many findings of this initial pilot case is very much usable together with the other choses cases. Therefore, the case Paleiskwartier will be seen as a normal case. However, the main limitation of this case towards the case criteria is that (1) it is not a fully private owned system instead of a public-private owned system and (2) it is not open to new sources and expendable to a regional grid. This makes the case less complex than other DH grids cases because e.g. less actors are involved and the financial and collaboration model is less complex because the whole system is owned by a single party. This is also the rationale for conducting less interviews for this case than the other cases, of which an overview can be seen in Table 3-1. Another rationale is the fact that this case is a less representative case for DH grids than the other cases, hence it is worthwhile to add a bit more focus on the other cases.

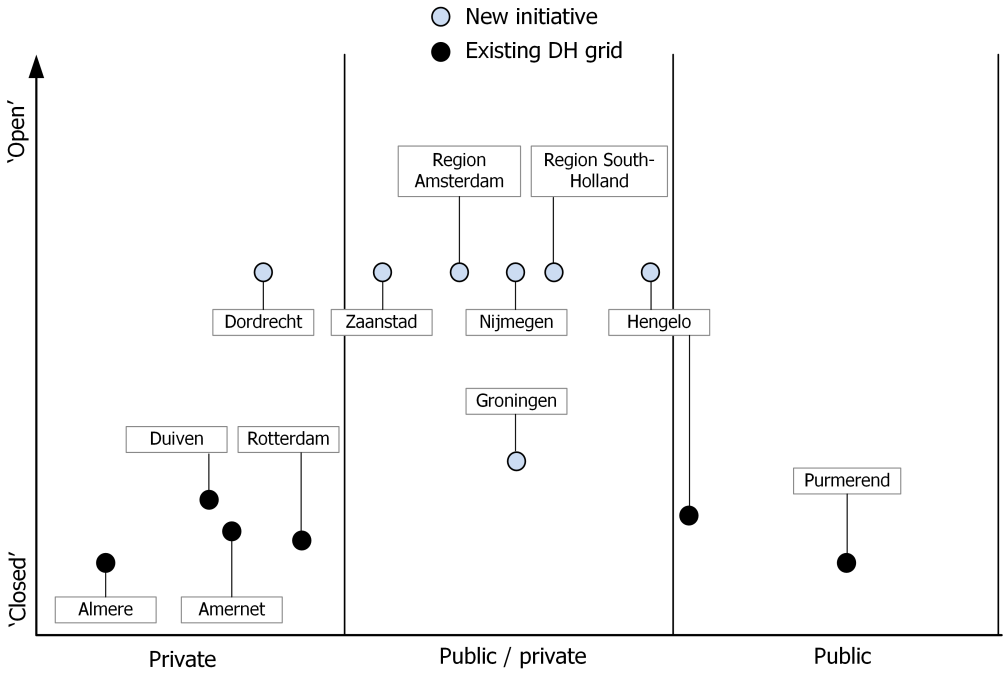


Figure 3-2: DH grids in the Netherlands (based on Haffner et al., 2016).

Looking for the other cases, Figure 3 2 shows most of the DH grids in the Netherlands of sufficient size (several thousand connections), categorized from open to closed and public to private. Looking at the case criteria, this leaves Zaanstad, Rotterdam, Amsterdam, Nijmegen, Hengelo and Groningen because they are public-private and open to new sources and customers. Those involved in Zaanstad were not willing to cooperate because the project currently is in the phase of negotiations. The case in Nijmegen is of particular interest because this case meets all the criteria, is fully operational but still very new (developed in 2012) and is the start of a new regional grid. Based on this the case Nijmegen is chosen. Next, the case of Amsterdam is chosen because it meets the case criteria and those involved were found willing to cooperate. Hence, this case is sampled for a combination of meeting the criteria and convenience. The cases Rotterdam, Hengelo and Groningen all meet the case criteria, but considering the research goal these were deemed unnecessary to study in addition to the three cases chosen.

3.4 Data collection and analysis

The conceptual framework will be used to structure the analysis of the cases. Data will be collected through studying case documentation and semi-structured interviews. 'Appendix 3: Interview protocol' shows the interview protocol based on this framework. Table 3-1 shows an overview of the interviews taken per actor and case.

Table 3-1: overview of conducted interview per actor.

	Case interviews		
Role interviewees	**Paleiskwartier 's Hertogenbosch**	**Warmtenet Nijmegen**	**Westpoortwarmte Amsterdam**
Politician		Alderman Milieu at municipality Nijmegen	
Municipality		Project leader District Heating at municipality Nijmegen	Project leader District Heating at municipality Amsterdam
Real estate developer	Project manager at Developing contractor: Volker Wessels		Project developer at housing association: Eigen Haard
Energy company	Commercial manager & asset manager at Ennatuurlijk / Essent	Business Development Manager Disrict Heating and Cooling at Nuon	Project director at Nuon
Utility company		Development manager at Alliander	
Energy waste company			Project leader District Heating at Amsterdams Energie Bedrijf (AEB)
Neighbourhood cooperation	Chairman at 'Wijkbelangen Paleiskwartier'		

3.5 Graph research design

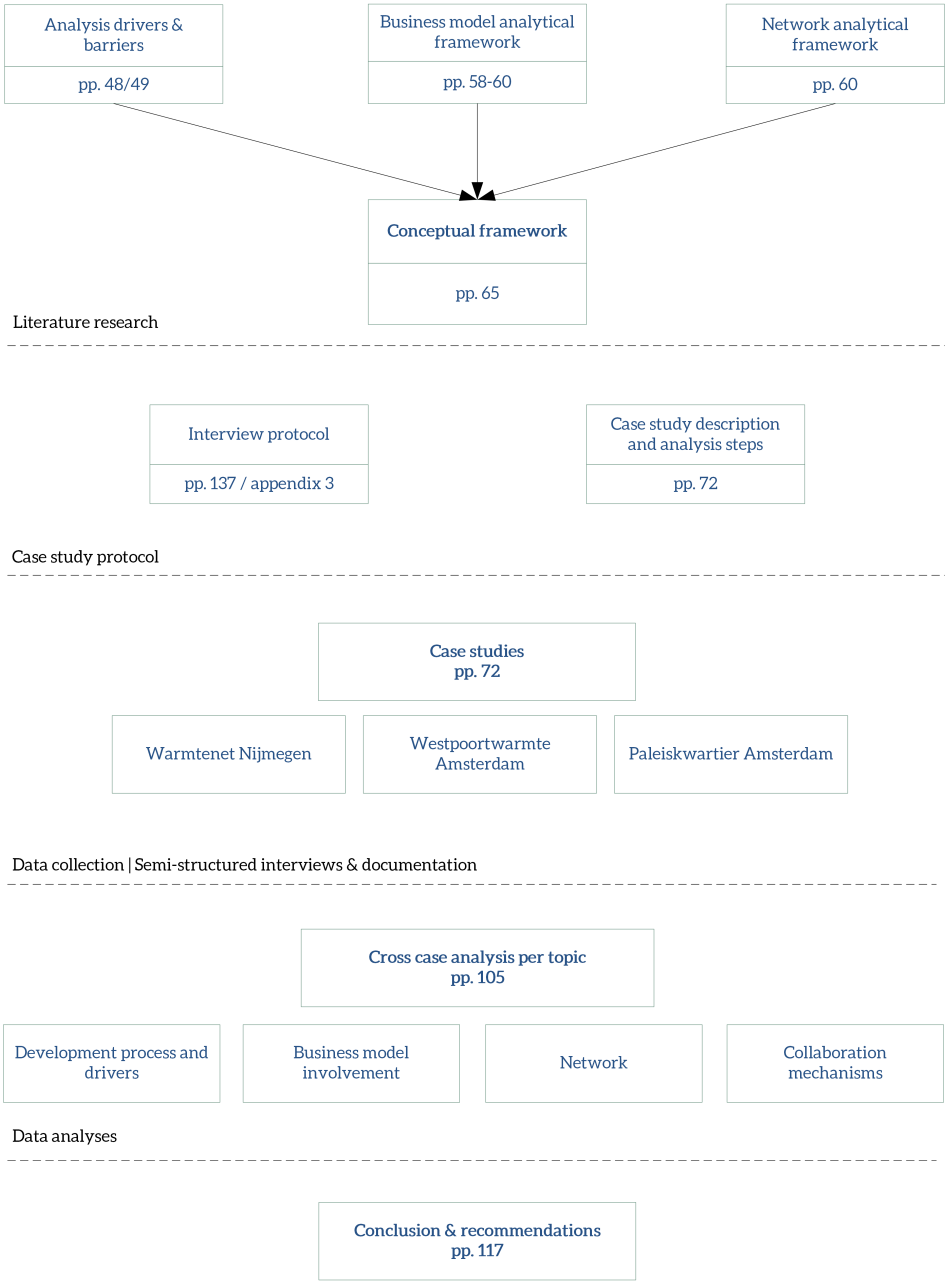


Figure 3-3: the research design and report set-up combined. For a more elaborate report set-up, consult Figure 1-2.

CHAPTER
04

Case studies

This chapter will describe the empirical research of the cases as shown in Figure 4-1. The description and analysis of the cases each will follow the steps as depicted in Figure 4-2.

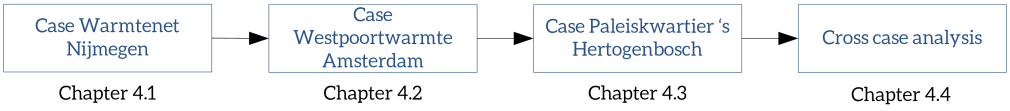


Figure 4-1: readers' guide chapter 4

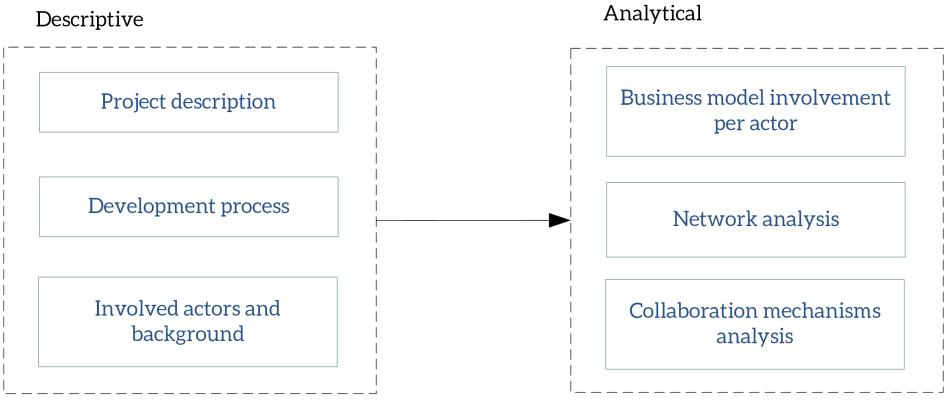


Figure 4-2: steps of the case study description and analysis

4.1 Case Warmtenet Nijmegen

Since 2012 the Dutch city Nijmegen has a District Heating Grid, called 'Warmtenet Nijmegen'.

4.1.1 Project description

See the figure below for an overview of the heating grid as it exists in April 2016.

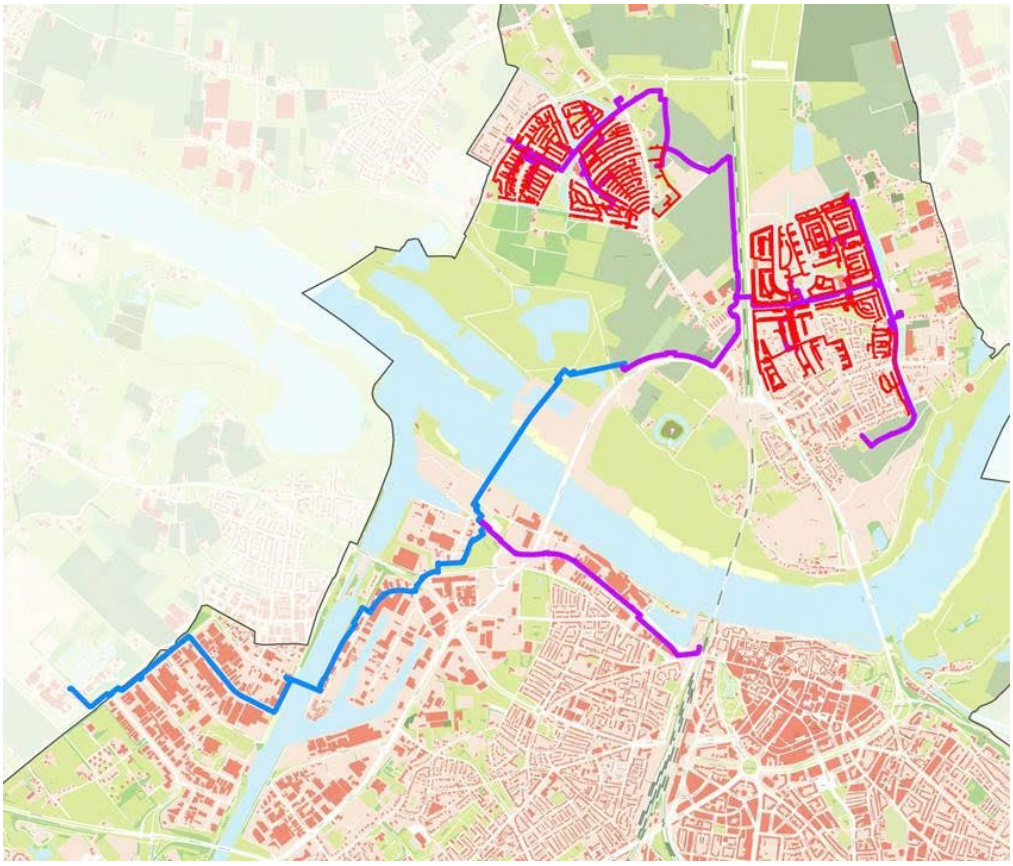


Figure 4-3: overview current district heating grid. The blue line is the transportation pipe, owned by the PPP 'Indigo BV'. The purple line is the primary distribution grid; the red lines form the secondary distribution grid. Both purple and red is owned by Nuon (Ploumen, 2016)

North of the river Waal is the location of the urban development called 'the Waalsprong' (jump over the Waal). Currently, around 3500 dwelling equivalents (25 GJ per year) are connected to the grid. This is to be extended to about 10.000 dwelling equivalents. Mostly dwellings will be developed, together with a few offices, schools and other facilities. South of the river is another urban development, called 'the Waalfront'. The 2000 to be developed dwelling equivalents will also be connected to the district heating grid (Ploumen, 2016). In total, the project has 12.000 dwelling equivalents fixed, according to the urban development plans. The ambition is to expand this grid to a regional district heating grid of about 90.000 dwelling equivalents in 2035 ("Ambitieverklaring en samenwerkingsovereenkomst voor een duurzame warmtevoorziening in de regio Arnhem-Nijmegen," 2014). For this development, the municipalities Nijmegen and Arnhem, the province Gelderland, Nuon and Alliander signed a Letter of Intent in October 2014 for developing a regional district heating grid Arnhem-Nijmegen. The ambition is to connect the existing heating grid of Arnhem with the grid in Nijmegen. The first step will be to expend the existing grid in Nijmegen to the inner-city and so create a ring. This is currently being developed by the parties involved in this Letter of Intent ("Ambitieverklaring en samenwerkingsovereenkomst voor een duurzame warmtevoorziening in de regio Arnhem-Nijmegen," 2014).

4.1.2 Development process

In the 1990's there were already plans to develop a regional district heating grid between Arnhem and Nijmegen. It remains unclear what actors precisely started this ambition, although ARN was sure to be one of the actors (Interview 4, 2016; Interview 5, 2016). Around 2002, the municipality Nijmegen bought the land from the former municipality Elst and the Waalsprong urban development was initiated. The municipality started a PPP (from now on called the GEM) with certain real estate developers and housing associations for the land and real estate development, of which the municipality has 50 % shares (Interview 5, 2016). The first developed buildings were connected to a local heating grid with temporal gas boilers as heat sources. The idea was to switch to the future district heating grid, which was being developed with Nuon and the GEM.

However, in 2006 these plans failed due to among others aversion to a monopoly position and a lack of personal connection between people from Nuon, the GEM and the alderman of urban development. The alderman of Milieu of Nijmegen commented: "the amazing thing was that, during the urban development, there has never been a contract between Nuon and the GEM about the ideas of a district heating grid" (Interview 5, 2016). The alderman of Milieu agreed with the proposal of the alderman of urban development to build an alternative energy system but with the same CO_2 reduction as with the district heating grid. Alderman Milieu: "In all my naivety [the Alderman was elected in 2006, thus just started], I accepted". Next, building permit

requests came in from the GEM that meets the national energy performance, which was well below the energy performance of when a district heating grid was implemented. By now, the alderman of Milieu Nijmegen felt deceived and made the development of the district heating grid his main objective (Interview 5, 2016).

The alderman Milieu got a motion filed by his political party to reinvestigate the possibility of developing a district heating grid. At the same time the Province put pressure on the district heating grid after they heard about the failed agreement between Nuon and GEM in 2006. "So now we had a top-down pressure and the alderman of urban development started to be a bit more cooperative", says the Alderman Milieu (Interview 5, 2016). Around 2008 a new team was set up at the municipality, with a more appropriate project leader (Interview 5, 2016). Next, in 2010 the municipal elections were held and the former Alderman Milieu as Party leader won. He claimed the position of alderman of both Milieu and the urban development Waalsprong. He also claimed 5 million euros for the heating grid during coalition negotiations. This was said to be highly important for the development of the grid (Interview 5, 2016).

Next, a study initiated by the municipality stated that a hybrid district heating grid (low-temperature with heat pumps at the buildings, in fact one of the main characteristics of a 4th generation district heating grid as defined in paragraph 2.1.2) would be the most cost-effective. However, no private or public party was willing to engage in such an innovative system. Quickly after, a normal temperature district heating grid was chosen ("De waarde van Nuon Warmte," 2016; Interview 6, 2016; Interview 7, 2016).

Around 2011, Nuon, ARN, the municipality, the GEM and the Province could not close their business cases. Nuon did not want to invest in the transportation pipe. As the project leader of the heating grid from the municipality says: "so you know that the transportation pipe is not profitable, but still, we wanted that district heating grid" (Interview 7, 2016). Therefore, the municipality and Province asked Alliander whether they could participate in this project in some way. Negotiations were held to create a collaboration model, of which the business developer from Alliander says: "This arrangement is based upon the question 'who is best in managing what type of risk', resulting in the most cost-effective option of covering the risks and financing" (Interview 4, 2016). The negotiations between the same parties and Alliander resulted in an informal agreement between the Province, Nuon, Alliander, AVR and the municipality. The municipality started a PPP with Alliander to invest in and exploit the transportation pipe. Alderman Milieu: "the success of this project is that we said to each other: we want an integral business case, with as much as possible transparency, so we can see who is earning how much. Also, everyone has to capture value and preferably also the consumer" (Interview 5, 2016).

However, the developers from the GEM still did not want to cooperate because of among others the monopoly position, the fact that they will not be able to utilise potential future energy technologies in the urban development and difficult different ways of working (Interview 5, 2016). In response, the alderman of Milieu and the urban development Waalsprong, by now also chairman of the GEM, vetoed the decision to implement a district heating grid, i.e. provide Nuon a concession for 30 years in the Waalsprong and Waalfront. This was ill received by the developers, but later on a 'charm offensive' was embarked by the Alderman so as to be able to continue working together (Interview 5, 2016). Finally, the Alderman Milieu & Waalsprong convinced the City Council to invest the claimed 5 million euro (by now reduced to 3.8 million euro) in the district heating grid, to be given to the PPP with Alliander. Most of all the City Council was convinced because of a study providing an overview of CO_2 reduction measures on city scale, of which the district heating grid was by far the most cost-effective measure, from the municipalities point of view (Van der Meer & Matthieu, 2012)(Interview 5, 2016). In 2012 all contracts were signed, the plan was brought to the public and executed (Gemeente Nijmegen, 2012).

4.1.3 Background involved actors

This paragraph will provide an overview of the most important involved actors with regard to the development of the district heating grid.

Municipality (Nijmegen)

From 2006 until 2010 the political parties GroenLinks, PvdA and SP formed a coalition. From 2010 until 2014 changed to a coalition of GroenLinks, PvdA and D66. Clearly. left-wing politics dominates in Nijmegen. Furthermore, the municipality is involved through Indigo BV, a PPP with Alliander that owns the (blue) transmission pipe. Also, they are one of the parties that signed the Letter of Intent for developing a regional district heating grid. Among others, this means they have multiple civil servant working in a team on this project (Interview 7, 2016; "Ambitieverklaring en samenwerkingsovereenkomst voor een duurzame warmtevoorziening in de regio Arnhem-Nijmegen," 2014). When the 12.000 dwelling equivalents of the current plans are connected to the district heating grid, this will provide for 40 % of the intended CO_2 reduction goals of the municipality towards 2030 (Van der Meer & Matthieu, 2012).

Utility company (Alliander)

Alliander N.V. is a utility company coming from Nuon in 2008 during the energy liberalisation process. Alliander N.V. is formed by Liander N.V. (a utility company for electricity and gas), Liandon (an engineering company) and Endinet (a utility company). Nuon was an integrated public utility company (production, transmission and distribution activities), however since

2006 a new Act was enacted, obliging the integrated public utility companies to split these three activities. So Nuon split into Nuon Energy N.V. for production and distribution as a new energy company, and into Liander for transmission as a new utility company. Alliander is involved through Indigo BV, a PPP with the municipality that owns the (blue lines) transmission pipe.

Energy company (Nuon)

Nuon N.V. is an energy company that produces and distributes electricity, gas and heat. It came into existence by a fusion of PGEM and PEB Friesland with the VNB in 1994. In 2009 Nuon was taken over by Vattenfall, a Swedish energy company fully owned by the Swedish state. Nuon invests in and exploits the distribution network (purple and red lines).

Heat producer (ARN)

ARN B.V. is public-private company formed by several public parties and a German private company). ARN is a waste producer that profiles itself as a waste-energy company. They collect and incinerate waste that is not suitable for recycling from their region. In this process they produce electricity, heat and ash. The electricity is supplied to the public grid and heat is supplied to the district heating grid in Nijmegen and the sewage cleaning installation. The ashes are being used as foundation material for road construction. They also process organic waste into biogas.

Province (Gelderland)

A province is the administrative entity between a municipality and the national government. One of their policies important for the development of this project is their policy to produce an amount of 31 PJ of sustainable energy. When the regional district heating plans are executed, this will provide for 13 % of their policy goals (Van der Meer & Matthieu, 2012).

Real estate developers / housing associations

Bouwfond (since 2016 BPD, an urban area developer), AM (a project developer), Heijmans (a developing contractor) and two housing associations, Talis and Portaal. They are involved through the formed PPP (GEM) with the municipality Nijmegen, which is carrying out the land and real estate development of the Waalsprong and Waalfront developments. Due to limited resources and data for this research, it cannot be stated how exactly the division of power, risk and decision making is arranged in the PPP. However, the development process (paragraph 4.1.2) made it clear that the municipality has 50 % shares and the possibility to veto a strategic decision such as choosing for district heating. However, since 2013 the PPP is fully owned by the municipality ("GEM Waalsprong Beheer BV," n.d.).

PPP 1: Gemeenschappelijk Exploitatie Maatschappij Nijmegen B.V. (GEM)

A PPP formed by the municipality and several real estate developers and housing associations.

See the paragraph above for further information. During the summer in 2013, all shares were sold to the municipality Nijmegen, meaning that the municipality has full control over the land and real estate development of the Waalsprong and Waalfront ("GEM Waalsprong Beheer BV," n.d.).

PPP 2: Indigo B.V.

A PPP formed by the municipality Nijmegen (5 % share) and Alliander N.V. (95 % share). Indigo invested in, owns and exploits the transmission pipe. The municipality invested 300.000 euros in the PPP, Alliander 5,7 million euro. The strategic decision-making power is 50/50, while the municipality is only liable for the 5 %. In addition, the municipality provided a subsidy of 3,5 million euro to the PPP, the Province provided a subsidiary loan of 4 million euro and the Green Deal provided an extra subsidy of 1.25 million euro ("Oprichten Indigo B.V.," 2012).

4.1.4 Business model involvement per actor

This paragraph will analyse what part of the actors' business model plays a role in the district heating project, following the conceptual framework (Figure 2-19).

Business model energy company (Nuon)

For value creation, in terms of resources Nuon invested in and owns the primary and secondary distribution network (purple and red), a delivery set with a heat meter at the buildings and back-up gas boilers. They will invest about 70 million euro in total for this network. These investments will be made in parallel with the expansion of the urban development. So when the urban developments Waalsprong and –front has been fully completed, Nuon will have invested about 70 million euro. In terms of activities, Nuon arranges the heat metering, the billing and the management and maintenance of the delivery system. They also acquire new customers to be connected to the existing grid, while also acquiring new customers to be connected to the expended grid (Interview 6, 2016).

For value capture, in terms of revenue streams, see Figure 4-4. Nuon has two revenue streams in this project, which is (1) a fixed connection fee of 4250 euros per dwelling from the GEM and (2) a fixed variable customer price. Considering the pricing method, the latter price is based on two aspects, namely (1) a fixed charge and a (2) variable charge connected to the GJ consumption. This fixed variable consumer price is regulated by the Heat Act. In terms of cost structure, Nuon has four costs. The first is a fixed carrier fee of 132 euro per year per connected dwelling to Indigo BV. The second cost is the purchase of heat from ARN for 4,50 euro per purchased GJ. The third is the investment in the infrastructure and the fourth are the costs involved with the commercial and technical exploitation of the distribution and delivery system (Interview 6, 2016).

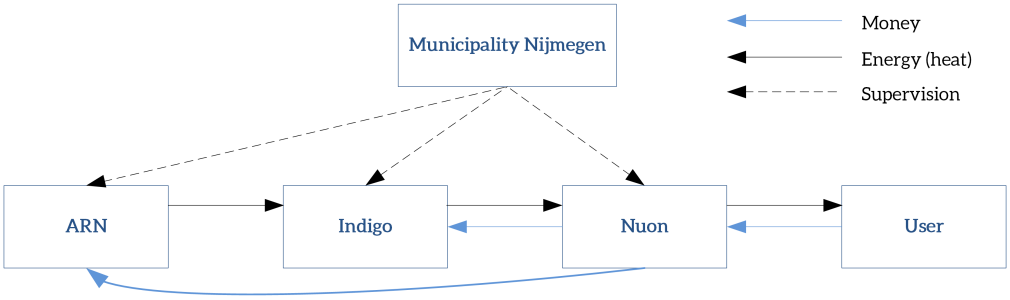


Figure 4-4: the relation of Indigo BV with other parties. The municipality supervises Nuon through the concession, has a share in Indigo and provides waste for ARN (Van der Meer & Matthieu, 2012).

For value delivery, in terms of customer relationships and channels Nuon had performed studies into the customer satisfaction ("De waarde van Nuon Warmte," 2016). In addition, they have several teams for marketing and communication, to deal with among others questions and complaints of customers (Interview 6, 2016). Moreover, they are the sole communicator with the customer, as they deliver the heat and manage the administrative system.

For value proposition, in terms of benefits to customers, the most important conclusions from studies are that in general, customers appreciate the good service, the low maintenance and space requirements. However, in general customers belief they pay too much for the heat. They want to have the option to switch ("De waarde van Nuon Warmte," 2016). However, so says the business development manager of Nuon, "when it's cheaper [than the gas alternative], freedom of choice is no longer an issue" (Interview 6, 2016). Moreover, Nuon has examples of customers asking them to explain the prices used. They then try to explain the price as is fixed by the ACM, however that is very hard to explain. As the same employee of Nuon says: "we are very on top of things in that [relationship with the customer] regard. We try to be very transparent, but the reference system [the price reference calculation to the gas alternative] is hard to explain". In terms of benefits to actors, it could be said that they provide important resources and activities that enabled the project to be developed, such as the 70-million-euro investment and the administrative management system.

Clearly, all elements of the business model of Nuon come into play for the district heating project.

Business model utility company (Alliander)

For value creation, in terms of resources, Alliander invested 5,7 million euro in Indigo BV, having 95 % of the shares of the PPP. Hence Alliander owns the transport pipe for 95 %. In terms of activities, Alliander does all the work for Indigo BV, meaning they do the work a utility com-

pany does. This is in this case investing, designing, and commercially and technically exploiting the transportation system of the heat from ARN to the main delivery point that connects the distribution network of Nuon ("Oprichten Indigo B.V.," 2012; Interview 4, 2016)

For value capture, in terms of revenue streams, Alliander should in the end get 95 % of the dividend from Indigo BV. This is however expected to take many years and not highly profitable (Interview 4, 2016). Looking at Indigo BV, revenue streams are a subsidy from the municipality of 3,5 million euro, a Green Deal subsidy of 1,25 million euro and a subordinated loan of 4 million euro from the province Gelderland. These incomes were all at the start of the project, while during the exploitation the carrier fee of 132 euro per connected dwelling is the only revenue stream. In terms of the cost structure, Alliander invested 5.7 million euro in Indigo BV. Indigo BV has to commercially and technically exploit the transportation system, requiring an investment at the beginning, and exploitation costs thereafter. In terms of pricing method, the amount of the carrier fee and the required investments resulted from the negotiations with the other parties (Van der Meer & Matthieu, 2012; Interview 4, 2016). In terms of other intangible values, district heating is said to be one of their focus expertise so this project provides new business in line with their company vision (Interview 4, 2016).

For value delivery, in terms of customer relationships, Alliander has no direct relationships with customers as end-users. In this project, this task is fully in the hands of Nuon. They do have contact with potential future customers, such as office owners and lenders, so as to acquire new customers for the district heating grid. However, once they are connected, the relation and communication ends (Interview 4, 2016).

For value proposition, in terms of benefits to customers, there is none as they have no direct relation with customers. In terms of benefits to actors, they seem to play a crucial role. By including them in the project, they brought in 5.7 million euro for the PPP and made it possible for the Province to provide a subsidiary loan of 4 million euro for the PPP. In addition, their own rate of return is lower than a commercial party (Interview 4, 2016). In essence, their participation was crucial to the development of this project, being a benefit for all actors.

Clearly, all elements of the business model of Alliander come into play for the district heating project.

Business model municipality (Nijmegen)

For value creation, in terms of resources, the municipality brought in 3.8 million euro for Indigo. Also, they brought in all the land required for the construction of the district heating. In addition, they have the resources to steer real estate developers to only develop in the Waalsprong and Waalfront areas, resulting in more customers for the district heating grid. Another

resource provided could be the concession to Nuon for exploiting the district heating. In terms of activities, it could be said that they to a large extend initiated the project and also played an important role in the development by having a motivated project team getting the parties together and hiring consultancy and engineering bureaus for making studies (Interview 5, 2016) (Interview 7, 2016)

For value capture, in terms of revenue streams, the five % dividend of Indigo in the far future can be considered neglectable. Also, during the start of the DH grid in 2012, they were 50 % shareholder of the GEM, thus they could get 50 % dividend which is since 2013 100 %. However, the GEM has as of now considerable debts ("GEM Waalsprong Beheer BV," n.d.), thus no revenue can be expected for a long time. The cost structure is formed by the 300.000-euro investment in Indigo and a 3,5-million-euro subsidy to Indigo. Of the Pricing method it can be said that the 3.5-million-euro subsidy was a result of the claimed 5 five million by the alderman Milieu, and the 300.000-euro investment in Indigo is the result of Alliander wanting the municipality to participate in Indigo for a small share. Other intangible values come across strongly in the interviews (Interview 7, 2016; Interview 6, 2016) and the documentation (Van der Meer & Matthieu, 2012). Often the CO_2-emmision reduction is mentioned, which is calculated to be the most cost-effective reduction measure compared to e.g. wind or solar farms. The alderman stated "this is a multiplier from 3,8 million euro to about 90 million euro [20 million Indigo, 70 million Nuon]" (Interview 5, 2016). Even more, this project is the start of a regional grid, which in theory in the end will provide in 40 % of the municipal CO_2 reduction goals until 2035. Lastly, another value is the fact that this heating grid excludes gas infrastructure, which is in favour of the national policy and giving Nijmegen an innovative status in the urban energy discourse (Van der Meer & Matthieu, 2012).

For value delivery, in terms of customer relations, the same applies as with Alliander: they only seek contact with new potential customers. When they are connected, the contact is transferred to Nuon.
For value proposition, in terms of benefits to customers, there is none as they have no direct relationship with the customer. For benefit to actors, it could be said that they initiated the project, assumed a leading role by bringing the parties together and provided in various ways a customer base.

It seems the municipality plays a large role in mostly value creation, bringing in many necessary resources and activities. Value capture is not financially driven, however CO_2 reduction and contribution to the energy transition comes across very strongly. Value delivery comes across weakly, as with value proposition to customers, whereas value proposition to actors come across strongly as they provide a concession and subsidy to the DH owners which reduces their upfront investment and assures a demand certainty.

Business model real estate developer (GEM)

For value creation, in terms of resources, the real estate developers bring in the connection fee, which was in 2011 fixed on 4250 euro per dwelling. On the total project, this brings their investment around 50 million euro. In terms of activities, not much activities for the DH grid can be distinguished other than designing and constructing the necessary facilities at the building level (Van der Meer & Matthieu, 2012). Still, this is highly important as this provides the customer base for the DH project.

For value capture, in terms of revenue streams, this project for them brings no revenue streams. However, it was calculated that per dwelling 1545 euro is saved when comparing the connection fee with the necessary investments for an energy heating system with the same energy performance (Van der Meer & Matthieu, 2012). In terms of other intangible values, no other values can be distinguished. They had to meet the energy performance anyway, thus connecting to the DH has no particular added value in that regard. For the cost structure, they have to pay 4250 euro per dwelling to Nuon. The pricing method is based on the negotiations, as the connection fee differs per DH project (Van der Meer & Matthieu, 2012).
For value delivery, in terms of customer relations, they have to sell their buildings, thus the bad public image of a monopoly position concerned them greatly (Interview 5, 2016). As explained by the business developed from Nuon, they could use the regulated prices from the Heat Act for their customer relations (Interview 6, 2016). For value proposition, in terms of benefits to customers, it could be stated that they provide a low maintenance and space requiring heating system which is also comfortable. For benefits to actors, the one benefit seen is their contribution to the total investment, namely the connection fee paid to Nuon.

All in all, it seems that for the real estate developers value capture is mostly financially driven. They do provide certain important resources and activities for the project to be able to be developed, and value delivery is important for them as they have to sell the buildings. Value proposition comes across rather weak compared to the actors analysed so far.

Business model heat producer (ARN)

In terms of resources, ARN invests in and exploits the technology to utilise waste heat. A highly important resource is said to be a guarantee to Nuon that they can produce enough heat for the coming decades (Interview 6, 2016). In terms of activities, they sell the produced heat to Nuon.

For revenue streams, it can be seen that they earn 4,5 euro per GJ waste heat (Van der Meer & Matthieu, 2012). It remains unclear as to how much this reduces revenue streams from potentially unsold electricity. This brings us to other intangible values, as ARN is now able to produce heat when electricity prices are low and vice versa (Interview 5, 2016). A clear example of creating synergies with the electrical grid as discussed in the definition of DH (paragraph 2.1.2).

Moreover, this project is perfectly in line with their company vision to transform to an (sustainable) energy waste company, rather than a waste incinerator (Interview 6, 2016). In terms of cost structure, they have to invest in the waste heat utilisation technology and commercially and technically exploit the system.

For value delivery, no particular role can be distinguished as they have no direct contact with the customer or potentially new customers. With regard to value proposition, benefits to customers can be seen as the provision of sustainable energy, whereas benefits to actors can be the provision of long-term sustainable heat at a low price to Nuon. This assures heat provision.

Concluding, their value capture is mainly financial, but also the fact that this project adds to their company vision and image as an innovative energy waste company. Their main contributing role is through value creation, providing and selling the waste heat for a long term. Value delivery plays a small role, as with value proposition to the customers. However, their value proposition to other actors is of high importance.

Concluding

The energy company, real estate developers and energy waste company are mainly financially driven. The municipality is mainly driven by CO_2 reduction measures. The utility company is mainly driven by contributing to the energy transition as a front running utility company. The heat producer has this drive as well, together with their financial drivers. Value delivery is mostly provided by the energy company; however, the real estate developers find this important as well. Noticeable is that the role of value creation, of which both resources and activities, comes across strongly from every actor involved. Value proposition differentiates per actor.

4.1.5 Network

The network is analysed along the aspects key agreements and organisational structure.

Key agreements

The following agreements of importance to the development of the DH grid can be distinguished.

Carrier fee from Nuon to Indigo.

This is based on the amount of dwellings connected to the grid so the increase of demand is also in the interest of Indigo BV. This results in that the municipality will steer any real estate developers towards the Waalsprong and Waalfront instead of other parts in the city (Interview

6, 2016).

The formation of the PPP Indigo BV by the municipality and Alliander.

Alliander could have done this without forming a PPP but they demanded the municipality to participate. Main reasons for Alliander to include the municipality is (1) it shows commitment of the municipality, (2) the municipality has 50 % decision power with 5 % shares for political support purposes and (3) now the municipality is incentivised to steer real estate developers towards the Waalsprong and -front as they share the risk of demand uncertainty. Moreover, with the transport pipe in fully public ownership, it was politically acceptable for the Province Gelderland to provide a subordinated loan to Indigo, whereas this would not be acceptable for a commercial party such as Nuon (Interview 6, 2016; Interview 4, 2016).

Heat purchase from ARN.

Heat supply for Nuon is assured by an agreements of a certain amount of energy (35 MW) per year. In this way, ARN has an additional income and Nuon buys relatively cheap heat (4,5 euro per GJ). Per year the amount of heat purchase is recalculated; there is no fixed agreement that ARN will provide heat for e.g. 30 years (Interview 6, 2016; Van der Meer & Matthieu, 2012).

Concession of 30 years to Nuon in the Waalsprong and Waalfront.

The concession says that every building built in these areas are to be connected to the heat distribution network from Nuon. This provides in theory (linked to the urban development program planning) a customer base of about 12.000 dwellings for Nuon and 12.000 carrier fees for Indigo (Interview 6, 2016; Interview 4, 2016)

Concession trade.

When Nuon gets a concession of e.g. 500 dwellings in another part of the city, this amount is subtracted from the concession in the Waalsprong and –front. This is not fully subtracted but creates for - in this case - 500 dwellings the freedom to establish another energy system, under the condition that is meets the same CO_2 reduction as the DH grid. In this way, a certain amount of freedom will be created as answer to the monopoly problem issued by the real estate developers (Interview 5, 2016) (Interview 6, 2016).

Letter of Intent for a regional DH grid between Nuon, Alliander, the province Gelderland and the municipalities Nijmegen and Arnhem.

This provides an intention, a vision and a working force to work towards at least 90.000 connected dwelling equivalents (Interview 7, 2016).

Organizational structure

Combining all the gathered data about the actors and key agreements into a graphical set-up of the organisation, Figure 4-5 emerges. Main actors clearly are the municipality, real estate developers, users, energy waste company and the DH owners which are the utility company and energy company. Noteworthy is that only the energy company delivers heat to the user, for which the energy company pays the carrier fee. Also, the municipality has a strong position through their two companies in which they have a share.

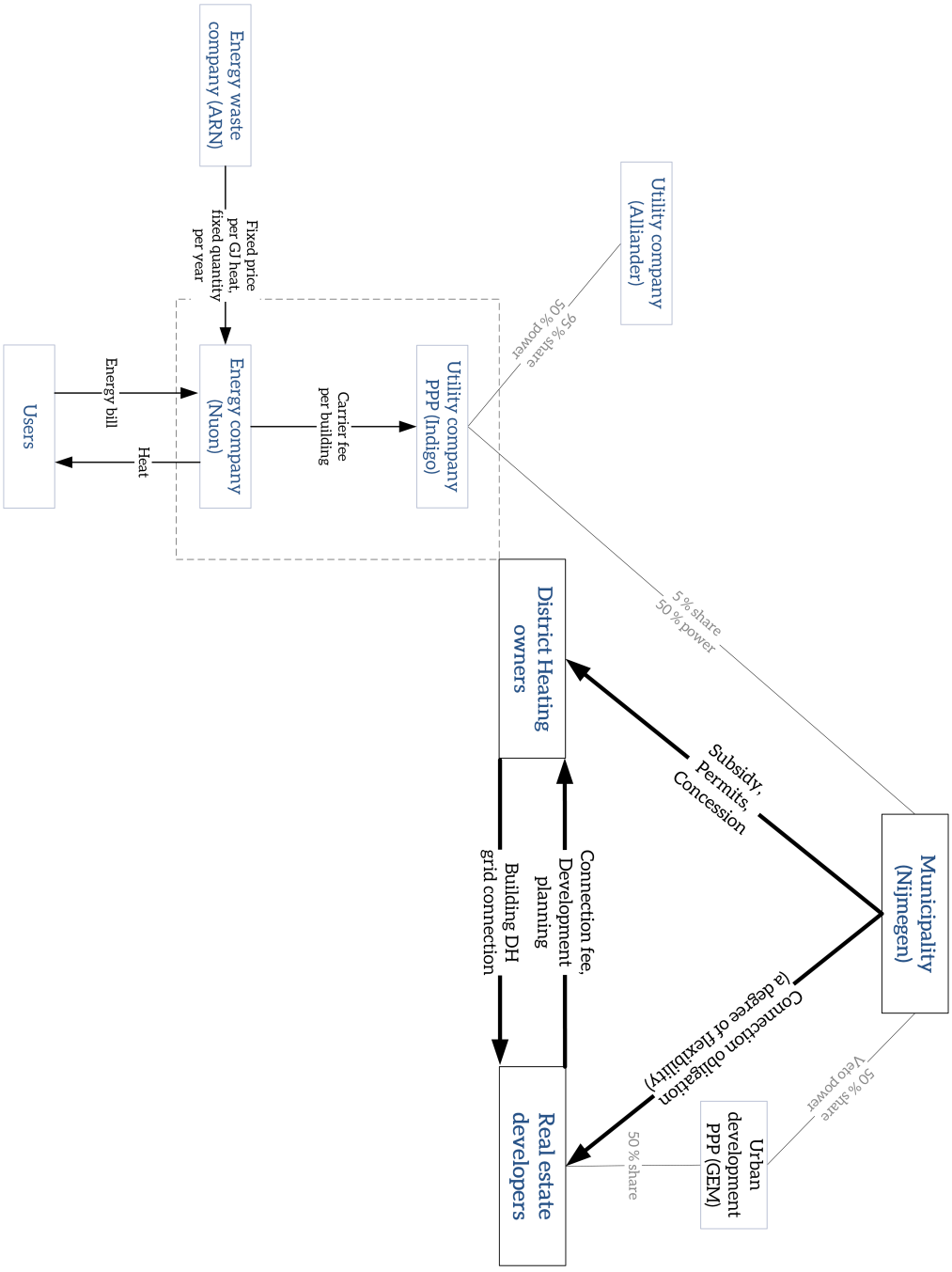


Figure 4-5: the organisational structure of the network Warmtenet Nijmegen.

4.1.6 Collaboration mechanisms

As explained in the conceptual framework (Figure 2-19), when the organizational structure from Figure 4-5 is combined with the value creation and proposition per actor as is analysed in paragraph 4.1.4, it should be possible to identify collaboration mechanisms that enable certain system value creation to be captured by various actors. For now, only the step of combining the value creation and proposition of the actors with the network analysis will be performed (Figure 4-6). Only in the cross case analysis, generic collaboration mechanisms will be identified.

It is believed it will demand too much text to explain all the arrows and connections of Figure 4-6 (and the other cases). As an example, looking at the municipality, in the network analysis (Figure 4-5) it can be seen the municipality provides permits, a concession and a subsidy to the DH owners. In the figure below, when this is translated and combined with the actors' value creation and proposition, it can be seen the municipality 'reduces upfront investment' through the subsidy and 'creates demand certainty' to the DH owners through their provided concession and the connection obligation to the real estate developers with a small amount of flexibility. At the same time, the DH owners are able to propose the value of CO_2-emission reduction to the municipality.

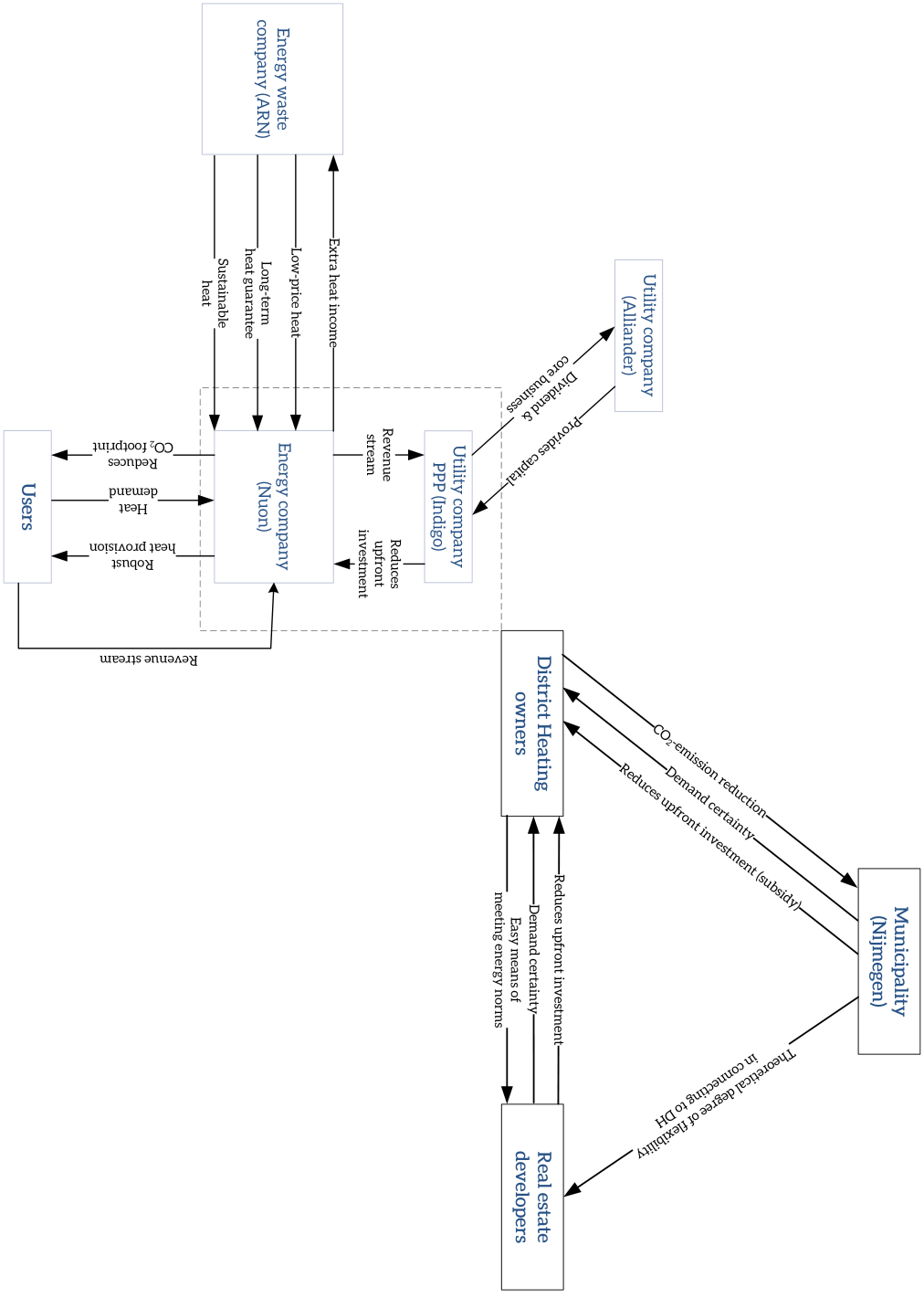


Figure 4-6: the network and business model involvement combined of case Nijmegen.

4.2 Case Westpoortwarmte Amsterdam

Since 2000 the Dutch city Amsterdam has a District Heating grid in the western part, called 'Westpoortwarmte'.

4.2.1 Project description

See Figure 4-7 for the location of the main heat production (green squire) unit and the DH grid (blue areas). As of now, about 22.000 dwelling equivalents are connected, with about 60.000 in the planning by means of concessions (Interview 9, 2016).

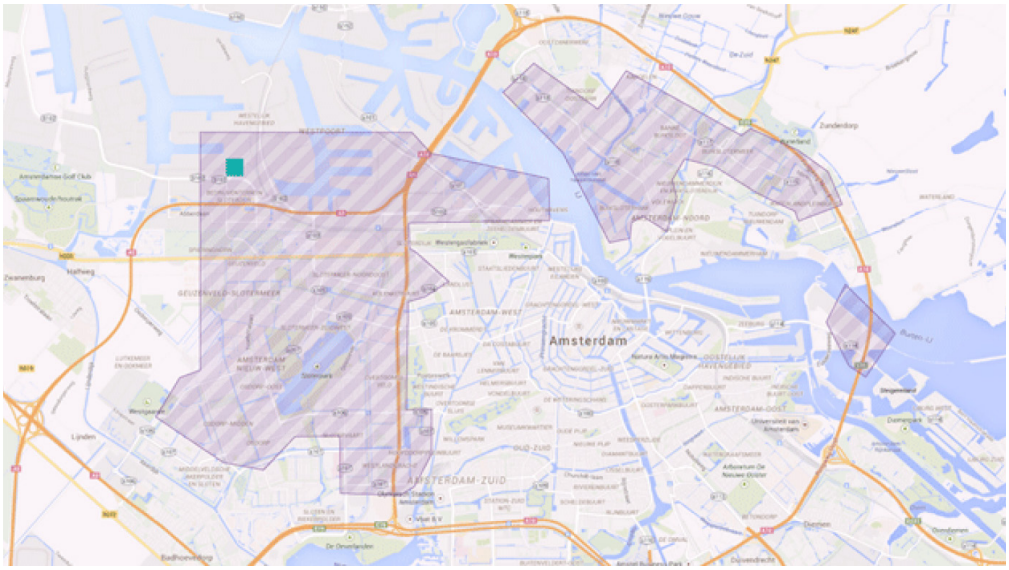


Figure 4-7: The green square is AEB Amsterdam; the purple area is the Westpoortwarmte (WPW) DH area. There is also one biomass plant connected to the grid. The DH part on the north side of the river is currently being built (Niessink & Rösler, 2015).

4.2.2 Development process

Late 1990's, the directors of Nuon and the then still municipal energy company saw opportunities to develop a DH grid around the waste incinerator in the area Westpoort. A project team was set-up by Nuon to perform a feasibility study. Three subjects were studies, namely (1) what assets are needed, (2) the market potential and (3) the economics and financial possibilities (Interview 9, 2016). During development Nuon and the by then liberalised energy waste company AEB came to the conclusion that having a typical client-contractor relationship will result in a no-go of the project because costs were too high. The two directors decided to make a joined plan of approach with the idea to "earn money with each other rather than from each other" (Interview 9, 2016). Having made the plans to form a PPP with 50/50 shares, risks and decision power, they also approached and successfully tempted at least 75 % (that was the requirement of the directors from Nuon and AEB) of the large real estate owners with heat demand within the area Westpoort. They signed a Letter of Intent stating they will connect to the DH grid when it is developed, which would result in 10 % lower energy costs than their incumbent energy costs. In 2000 the PPP Westpoortwarmte BV (WPW) was formed.

Next, in 2006 the consortium Bureau ParkStad of many different parties such as housing associations and the municipality, who performs the redevelopment of the area Nieuw-West Amsterdam, tendered the development of DH grid for their urban development plan (10.000 dwellings to be demolished, 15.000 to be newly built). Essent won from Nuon (solo, not as WPW), Eneco and Electrabel. However, in a later stage they could not get the business case. Then, in 2008, WPW got to an agreement with the housing associations and the municipality, extending the DH grid from the Westpoort area towards the Nieuw-West area. Later on in 2010 the grid was to be extended to Amsterdam Noord. This time, no tender was used; the municipality provided the concession to WPW which was found legally possible. However, due to a decrease in building tempo this was suspended to the beginning of 2016. In the meantime, the already build buildings were connected to a DH grid with a temporary gas fired boiler within the area (Interview 9, 2016).

4.2.3 Background involved actors

This paragraph will analyse what part of the actors' business model plays a role in the district heating project, following the conceptual framework (Figure 2-19).

Municipality (Amsterdam)

The municipality of Amsterdam is full shareholder of both AEB and Waternet. Important is

that municipality Amsterdam has private ownership over its land, often providing a land-lease to real estate developers. This gives them a strong position (Interview 10, 2016).

Heat producer 1 (AEB Amsterdam)

Afval Energie Bedrijf (AEB) Amsterdam with about 400 employees. It is 100 % owned by the municipality Amsterdam. They collect waste from the region Amsterdam and some imports from the UK. Among others, they produce heat by waste incineration for the DH grid. In addition, they are 50 % owner of the PPP Westpoortwarmte BV with Nuon.

Heat producer 2 (Waternet)

Waternet produces biogas from their sewage cleaning system that AEB burns in a small CHP for among other heat production for the DH grid.
Heat producer 2 (Orgaworld)
Orgaworld has a small biomass-fired CHP that among others produces heat for the DH grid.

Energy Company (Nuon)

Nuon N.V. is an energy company that produces and distributes electricity, gas and heat. It came into existence by a fusion of PGEM and PEB Friesland with the VNB in 1994. In 2009 Nuon was taken over by Vattenfall, a Swedish energy company fully owned by the Swedish state. Nuon holds 50 % shares of the PPP WPW, which owns the main heat production unit, the transport pipes and distribution networks. The other shareholder is AEB.

Housing associations / real estate developers

Concerning this case it suffices to know that many housing associations were joined with the municipality and certain other actors in a consortium to redevelop the area Nieuw-West Amsterdam. During the development of the DH grid in Nieuw-West in 2006, the housing associations had to a large extent the same role as commercial developers (Interview 11, 2016).

PPP as integrated energy company: Westpoort Warmte B.V. (WPW)

A PPP from AEB and Nuon of which the shares are 50/50. WPW owns the whole DH grid, both production, transmission and distribution networks. The PPP has no employees however; the work is done by the shareholders for the PPP against cost-price. For instance, most customers are not aware of the existence of WPW, only of Nuon. Currently, they are thinking whether this should be changed with regard to the image and social acceptance issue (Interview 9, 2016).

4.2.4 Business model involvement per actor

Each actor involved in the project has certain business model elements connected to the project. In this paragraph this will be analysed.

Business model energy company (Nuon)

For value creation, in terms of resources, Nuon invested for 50 % in the PPP WPW. In total so far, WPW invested about 150 million euro, of which around 5 % were subsidies (Interview 9, 2016). For the rest of value creation, they provide the same as in the case of Nijmegen, other than that they now also commercially and technically exploit the transmission pipes. As the project leader of Amsterdam said: "this is not following the ideology of the energy liberalisation, but it works really well" (Interview 10, 2016). This is an activity they do in the name of Nuon but for the PPP WPW, because WPW has no employees. Also, they convinced the first customers from the Westpoort area to connect, which can be seen as an activity (Interview 9, 2016).
For value capture, in terms of revenue streams, WPW has so far got around 15 million euro of revenues. Nuon will in the end get 50 % dividend. For the rest, WPW has the same revenue streams as Nuon has in Nijmegen other than that they got certain subsidies of about 5 % of the total investment so far (Interview 9, 2016). In terms of cost structure, as was said before, they contributed for 50 % in the investments required for WPW. The cost structure of WPW is (1) investment in technologies to utilise the waste heat from AEB (e.g. a large heat buffer), (2) investment in the transmission pipe, delivery network, back-up gas boilers and (3) commercial and technical exploitation of this whole system.

For value delivery, Nuon does all the work for WPW, which is same as in the case Nijmegen. The customer has contact with Nuon, not WPW. They were thinking about changing the name for value delivery tasks to something that represents WPW. However, this was too costly to implement at that particular moment (Interview 9, 2016).

For value proposition, in terms of benefits to customers, it is the same as in Nijmegen. For benefits to actors, it could be said that their ability to invest for 50 % in WPW and their ability to commercially and technically exploit the transmission and distribution network is an important value proposition.

In seems the business model of Nuon plays the same role for the development of the DH project as in the case of Nijmegen, however in this case they also provided the resources for the exploitation of the transport pipe and provided a customer base by convincing many building owners with a lower price than the gas alternative.

Business model heat producer 1 (AEB Amsterdam)

For value creation, in terms of resources, AEB invested the other 50 % for WPW. In addition, they provide for WPW the commercial and technical exploitation of the heat production unit at AEB, which stems from their waste incinerator.

For value capture, in terms of revenue streams, they should in the end get 50 % dividend from WPW. Also, WPW buys their heat which is an additional income to their core business (Interview 8, 2016). The pricing method of the heat is based on the potentially sold electricity when producing heat instead of electricity. Therefore, an energy buffer is built so that heat could be produced and stored during night hours when the electricity price is low, resulting is low heat prices for WPW (Interview 9, 2016). A clear example of creating synergies with the electrical grid.

For value delivery, in terms of customer relations and customer segments, AEB has no contact with current or potentially new customers. For value proposition, in terms of benefits to customers, there is none as they have no direct contact. For benefits to actors, it could be stated that their ability in invest for 50 % in WPW, provide sustainable heat for a long-term and commercially and technically exploit the heat production is an important value proposition.

Business model heat producer 2 (Orgaworld)

For value creation, it is as of now not clear how they exactly create value, other than that they provide the investment for their heat producing technologies, and commercially and technically exploit that system. For value capture, it is as of now not clear how they exactly capture their value, other than that WPW buys their bio-based heat, which requires them to invest in a system that enables them to technically and commercially provide that heat. For value delivery, in terms of customer relations, they have no contact with customers of the DH grid. For value proposition, in terms of benefits to customers, it could be stated that they provide fully renewable heat, which provides the customers with sustainable heat. In terms of benefits to actors, the same could be said; the actors are due to their bio-based heat able to deliver more sustainable heat to their customers. They are able to increase the networks sustainability level.

Business model heat resource producer (Waternet)

For value creation, Waternet produces biomass which they sell to AEB. AEB can then burn this biomass to produce bio-based heat for the DH grid. For value capture, it remains unclear how they exactly capture value, other than that they create a revenue stream by selling the biomass to AEB. For value delivery, in terms of customer relations and customer segments, there is none as they have no contact with the customer. For value proposition, the same can be stated as for Orgaworld. Their most important business model role seems to be within the value creation as they provide biomass from their sewage cleaning system.

Business model housing associations / real estate developers

For value creation, in addition to the same creation as in the case Nijmegen, this is that they have searched for ways of the most efficient way of planning the buildings and the heat infrastructure. For value capture, it is all the same as with Nijmegen, but the connection fee was agreed to be a little higher than normal so that the customer would have to pay less than the gas alternative. Also, there is an optimum with regard to isolation measures and sustainable heat from the DH to meet the energy norms. The DH grid provided in meeting the energy norms. For value delivery, one of their complaints towards the DH grid was that the grid is developed without putting the customer at the centre. Still, they have no contact with the customer regarding the DH grid (Interview 11, 2016).

Business model municipality (Amsterdam)

AEB and Waternet are fully owned by the municipality, however in this paragraph only the public administrative body municipality Amsterdam will be regarded. For value creation, in terms of resources, Amsterdam could provide a concession to WPW for the DH grid. They could do this as they own all the land. In terms of activities it could be stated they actively participated in developing this project and that they are also involved in this project through Waternet, AEB and the consortium Bureau Parkstad (Interview 8, 2016).

For value capture, in terms of revenue streams, they will get dividend from AEB, which is an indirect link to the 50 % ownership of WPW. For cost structure no particular costs can be distinguished other than time from employees. Other intangible values however are of importance, as the municipality has degreed to phase out gas in its city, of which this DH project is large contribution (Interview 8, 2016). For value delivery, in terms of customer relations and customer segments no direct contact with the customer can be distinguished.

For value proposition, in terms of benefits to customers, there is none coming from the municipality. For benefits to actors it could be stated that the concession given to WPW (in both Amsterdam Nieuw-West and Noord) has been their main value proposition for the development of this project.

It seems that the municipality, when excluding their ownership of Waternet and AEB, played their role mostly through their resources, providing a concession. Value capturing is mostly the CO_2 reduction and phasing out the gas infrastructure.

4.2.5 Network

The network will be analyzed along the elements key agreements and organizational structure.

Key agreements

The following agreements of importance to the development of the DH grid can be distinguished.

Letter of Intents Westpoort area.

The first customers (mostly offices) of the DH grid signed a Letter of Intent to connect their buildings when it would be built. In this way, the customers would know that in the near future, their energy costs will decrease with 10 % and Nuon and AEB had a sufficient customer base for a viable business case (Interview 9, 2016).

Concession 30 years in Nieuw West and Noord.

The municipality as full land owner provided a concession for 30 years in these areas that decreed a connection obligation to the DH grid for newly developed buildings. This provides, in combination with a real estate development program, a customer base for WPW (Interview 8, 2016).

10 % freedom in concession.

In Amsterdam Noord, the first five years, 5 % of all developed buildings have the freedom to implement another energy system than connecting to the DH. After these five years this increases to 15 % freedom. The alternative should have at least the same energy performance as when they would be connected to the DH grid. In this way, real estate developers will have some degree of freedom. As the project leader of AEB said: "by now we had learned that there should always be the possibility for exceptions" (Interview 8, 2016).

The formation of the PPP Westpoort Warmte BV (WPW) with Nuon and AEB.

By forming a PPP on 50/50 basis, they eliminated many costs that would otherwise have been incorporated when there is a typical client-customer relationship. It also brought together each other resources to make the development and exploitation of the whole system possible. The project director of Nuon said: "the essence of this collaboration is earning with each other rather than from each other" (Interview 9, 2016). In addition, the same project director noticed that this formation lead to an integration of the energy business and the municipality, which helped in the further development of the grid (Interview 9, 2016).

WPW purchases heat from AEB based on foregone revenues.

AEB and Nuon have agreed that AEB would sell their heat to WPW based on foregone revenues resulting from producing heat instead of electricity. In this way WPW can buy heat at a low price and AEB has an additional income (Interview 8, 2016).

Heat purchase Orgaworld & biomass purchase Waternet.

WPW buys bio-based heat from Orgaworld, providing WPW with sustainable heat and pro-

viding Orgaworld with an additional income. The same applies for the agreement with Waternet, be it that they do not provide heat but biomass for WPW to produce heat with (Interview 8, 2016; Interview 9, 2016).

Real estate developers pay higher connection fee than normal.

It was agreed that the real estate developers would pay a higher connection fee than necessary for the business case of WPW so that the energy bill for the consumers would be 10 % lower than the gas alternative (Interview 9, 2016).

Organizational structure

Combining all the gathered data about the actors and key agreements into a graphical set-up of the organisation, Figure 4-8 emerges. Main actors clearly are the municipality, real estate developers, users, and the DH owner which is a PPP of the energy waste company and energy company. In addition, there are now two heat producers, and one actor who provides adequate biomass for heat production to the energy waste company. Noteworthy is that only the energy company delivers heat to the user, who is together with the energy waste company 50 % shareholder of the PPP. Also, the municipality has a strong position through their two companies in which they have a share.

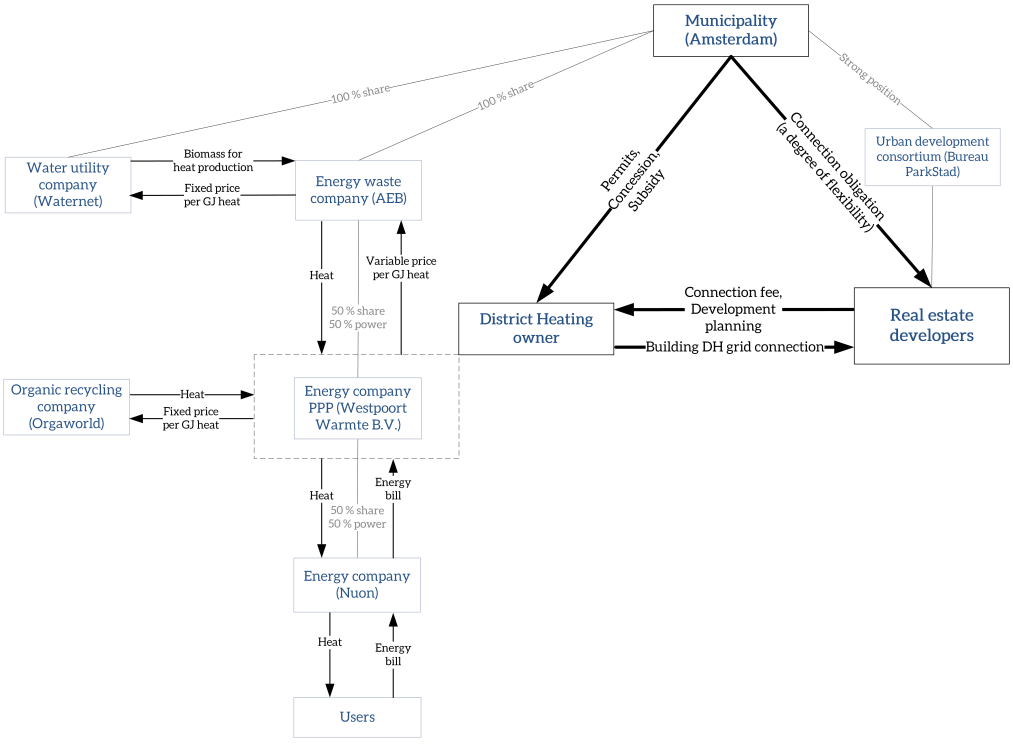


Figure 4-8: the network and business model involvement of case Amsterdam combined.

4.2.6 Collaboration mechanisms

As explained in the conceptual framework (Figure 2-19), when the organizational structure from Figure 4-8 is combined with the value creation and proposition per actor as is analysed in paragraph 4.2.4, it should be possible to identify collaboration mechanisms that enable certain system value creation to be captured by various actors. For now, only the step of combining the value creation and proposition of the actors with the network analysis will be performed Figure 4-9. Only in the cross case analysis, generic collaboration mechanisms will be identified.

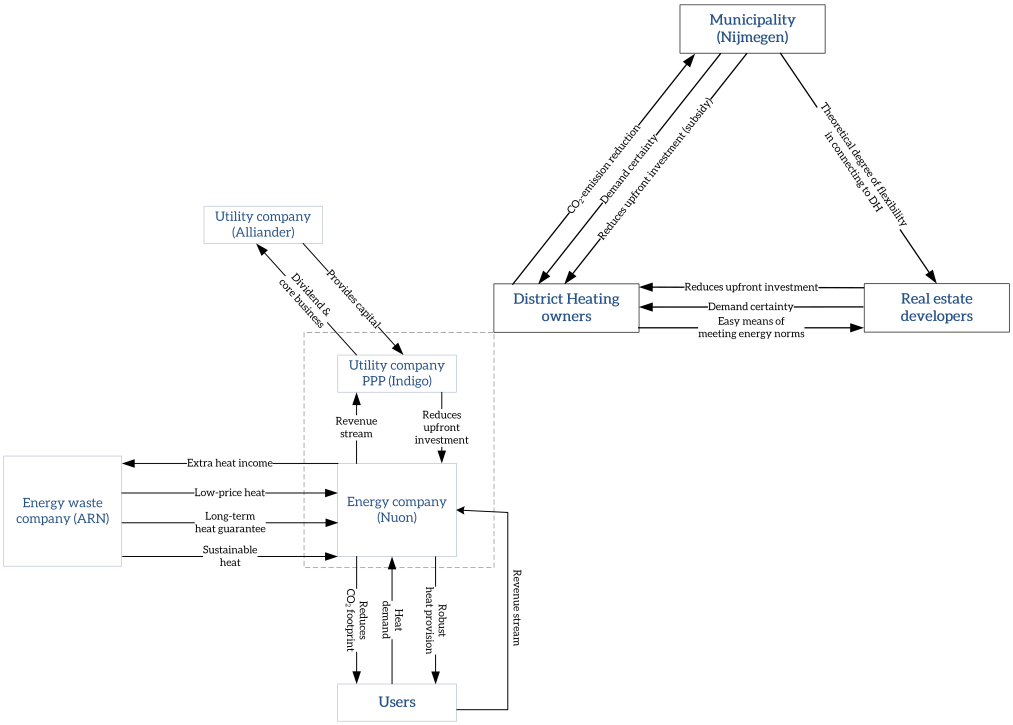


Figure 4-9: the network and business model involvement of case Amsterdam combined.

4.3 Case Paleiskwartier ‘s Hertogenbosch

Since 2000 the Dutch city ‘s Hertogenbosch has a large Seasonal Storage System at the location called ‘Paleiskwartier’, comparable with a small District Heating grid.

4.3.1 Project description

Almost all buildings within the area Paleiskwartier are connected to a Seasonal Thermal Storage System (STSS). The STSS itself has six 80-meter-deep holes to extract and inject groundwater and a distribution network to connect all buildings to the grid. There is no gas infrastructure. Some offices and apartment blocks are both cooled and heated, most dwellings are only heated by the STSS (Interview 3, 2016).

4.3.2 Development process

In 1985 a new city vision was published, of which the area around the railway station (including area now known as Paleiskwartier) was designated as a key area. In 1993 the municipality published a new report about the future of the area Paleiskwartier. In 1998 a PPP as urban development company was formed comprised of two investment companies, a pension fund, a developing contractor and the municipality ‘s Hertogenbosch. In 1999 a feasibility study was initiated by the municipality for the implementation of a STSS. In 2000 an agreement was made between Essent and the PPP for the design, construction and exploitation of a STSS (“Overeenkomst WKI PK,” 2000). In 2001 the construction started. Nice years later, in 2010, a new agreement between Essent and the PPP was made due to various changes (“Aanvulling Overeenkomst WKI PK,” 2010) (Interview 3, 2016).

4.3.3 Background involved actors

This paragraph will provide background information of the most important actors involved in the project.

Some actors, such as an investment company involved in the PPP will not be elaborated, because they did not come across as being of importance for the development process.

Energy company (Essent / Ennatuurlijk)

Essent is a Dutch energy company. It was founded in 1999 and since 2009 it has become part of RWE. Within RWE, Essent is responsible for the Dutch and Belgium market. Thermal grids have been part of Essent portfolio, but they were and are not part of the core-business. That is gas and electricity. In 2013 Essent looked for buyers of their thermal grids.

Ennatuurlijk is an energy company that develops and exploits thermal grids. They are formed by Essent, in March 2014 they became independent of Essent as they were bought by the pension fund PGGM and Dalkia, which is a part of the French Veolia. Ennatuurlijk is as of now the third biggest independent 'heat company'. Nuon and Eneco are the other two.
Neighbourhood cooperative (Wijkbelangen Paleiskwartier)
A cooperative of all users of Paleiskwartier area, both real estate owners and lenders. They all pay a certain contribution when they buy or lend a building at Paleiskwartier which is mandatory. It does the same things as any other neighbourhood association, however they have a NV form, a public limited company so that that may be able to buy the STSS in the future (Interview 1, 2016).

PPP (Paleiskwartier BV)

Municipality 's Hertogenbosch opted for a development company in the form of a private company with limited liability (BV). A decisive factor for this form was that a BV form is the clearest and most transparent form as regards decision-making and liability. It clearly lays down the roles of parties (Wigmans & Hobma, 2007). See Figure 4-11 for the organisational structure.

The Board of Directors is formed by representatives of the participating parties, chosen in unanimity by the supervisory board. One director is skilled in governmental issues and land exploitation, the other in land and real estate development and the last in real estate investment (on behalf of SPS and NIB). Strategic discussions and decision making within the PPP is done by the Board of Director, based on unanimity. This was considered unique (Wigmans & Hobma, 2007).

Delegated plan developer Credo is a subsidiary of Volker Wessels. 70 % shares Volker Wes-

sels, 30 % shares of two partners. Daily management is done by Credo, commissioned by the BV. Credo does the integral project management and so takes initiatives, coordinates and controls all the activities for the stakeholder. This also includes land and real estate exploitation. The Area Development in divided into 18 parts, for which project management is executed by Credo as well. In addition, there are sub-working groups for the urban development, divided per theme. Herein mostly civil servant, employees from Credo and advisors are involved (Wigmans & Hobma, 2007).

Real estate developer (Volker Wessels)

Volker Wessels is the mother company of many subsidiaries. All in all, they are a contracting real estate developer and have a 25 % share in the PPP Paleiskwartier BV.

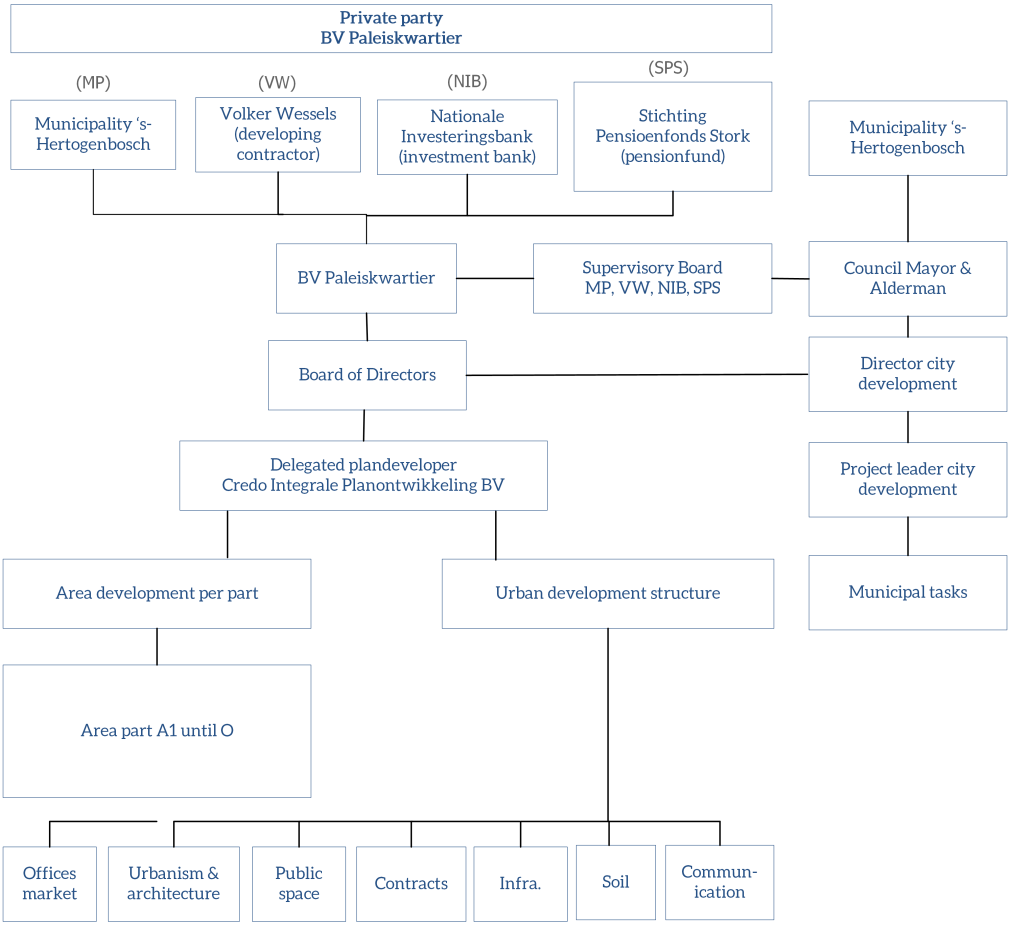


Figure 4-11: organisation structure BV Paleiskwartier, PPP of municipality 's Hertogenbosch, developer Volker Wessels, an investment bank and a pension fund (Wigmans & Hobma, 2007).

4.3.4 Business model involvement per actor

Each actor involved in the project has certain business model elements connected to the project. In this paragraph this will be analysed.

Business Model Essent/Ennatuurlijk

Value creation is achieved through their resources and activities. Essent agreed with the Developer to invest, exploit and maintain the entire seasonal storage system for 25 years. In terms of resources, they own the whole system until the buildings, for 25 years. After these years they are obliged to look if they can sell the system for one euro plus its remaining book value to the neighbourhood cooperation. If they do not want to buy the system, other arrangements have to be made. Furthermore, they 'own' the provincial permits of the heating and cooling system, which makes them more powerful than without. Lastly, they got a free building lease of there where it was needed for the heating and cooling system (Interview 2, 2016).
In terms of activities they need to maintain the whole system, i.e. the six 70-meter-deep holes and pipes as energy source, and the heating distribution network to the buildings. They also have their administrative activities such as billing the consumers at the end of a year.

Value capture is achieved through revenue streams, the cost structure and the pricing method. In terms of revenue streams, we can distinguish three streams that were relevant for the initial business case: subsidies, connection fees and consumption fees. Later on in 2010, a negotiated fee was added. At the start in 2000, the project got a grant from the subsidy program called 'CO_2 reductieplan', to be fully granted to Ennatuurlijk. Also, for every connected building a connection fee (€ 4000 for dwellings) had to be paid by the Developer (Interview 2, 2016). Furthermore, they get a monthly consumption fee from the consumers, which is for dwellings based roughly for 30 % on a fixed price (measuring and fixed costs) and for 70 % on variable costs (consumption of heat in € per GigaJoule). For companies exact figures remain unknown. Bases on these revenue streams, Ennatuurlijk believed in a viable business case. In 2010 however, the Developer and Ennatuurlijk negotiated higher connection costs of all future offices and a one-time fee (€ 400.000) to Ennatuurlijk. This was agreed after a 2-year negotiation process because the building program as defined in 2000 slowed down dramatically. As of now, for Ennatuurlijk the financial return turned out to be lower than expected in 2000, but is still considered appropriate (Interview 2, 2016).
In terms of cost structure, Ennatuurlijk had to pay the design and construction costs of the heating and cooling system until the buildings. Also, they have to pay for the maintenance of the system. This is a high upfront investment, but with low maintenance costs.

In terms of pricing methods, the connection costs are based on negotiation between En-

natuurlijk and the Developer. The heat tariffs for the dwellings were based on the EnergieWet (Energy Act), and are since 2014 based on the calculation from Autoriteit Consument & Markt (ACM, Authority Consumer and Market), an independent organisation that sees that the new Heat Act is properly followed. This price is thus based on the 'No More than Otherwise' principle, as explained in the policy framework paragraph. This does not apply to the offices; this is a free market. However, Ennatuurlijk stressed out that they use the tariffs as provided by the initial study from DWA, thus being it independently priced. For phase two, prices were raised 7.5 % due to the negotiations with the Developer about the building program slowing down since the start. Ennatuurlijk also points out that in this situation, they are of course in a position to impose high costs for the commercial buildings. However, considering the current market and high competitiveness of energy companies, keeping a good image has high priority. Also, if their prices are too high, companies will invest in detaching from the system of Ennatuurlijk and build their own heating and cooling systems. Resulting in less clients and a negative image. It is in their own interest to impose fair prices, even though they have a monopoly position for 25 years (Interview 2, 2016; Interview 3, 2016).

Value delivery is achieved through customer relationships and the channels used. In terms of customer relations and customer segments, at the start of the project the Developer and Ennatuurlijk agreed that when the Developer sells or rents a building, Ennatuurlijk has to provide information to the costumer of how the thermal storage system works, the ownership boundaries, the measurements and yearly accounting. This within three months, according to a certain quality of other brochures the Developer used. Strangely enough this did not include the pricing methods, which brings us to a negative aspect of the customer relationships. Some companies complain about the connection and heating costs being high and not transparent (Interview 1, 2016). One is in the end able to calculate whether prices are indeed not higher than otherwise, but this requires an extensive calculation. Ennatuurlijk here is reproached for their inability to explain the pricing methods simply. Thus to a certain extent some distrust can be seen here. Still, so far no action is taken and all buildings are connected to the grid. In addition, the customer relation is said to be improved by the involvement of the municipality in the PPP construction. Essent states that having an agreement with not only private developers but also a public body improves trust of the customers. Also, the fact that they only own the heating and cooling system for 'just' 25 years takes to a certain extent away the negative status of a monopoly position. Because at the end of the 25 years, the neighbourhood cooperation is able to buy the system thus do with it to their own choosing. This can be seen as a future potential energy cooperation, with all consumers having a share in the cooperative energy system (Interview 1, 2016; Interview 2, 2016).

Business Model Volker Wessels (real estate developer)

Value creation is done by using the STSS they performed even better than the national EPC-norms. In terms of activities Volker Wessels would execute as much as possible. The whole construction of the STSS system is built by Volker Wessels. Hence, subsidiaries of Volker Wessels had work. In terms of value delivery, they used several media and brochures. In the end, Essent has to explain how the STSS works to the customer. In terms of value capture, financially speaking, using conventional energy systems is better for a developer. These new systems are complex, needs a lot of explaining and additional time from employees. So long as it did not cost too much money the STSS would be acceptable. In the end, they cooperated because the municipality really wanted this, it improves their image and the additional costs were acceptable (Interview 3, 2016).

Business model Municipality ('s Hertogenbosch)

For value creation, in terms of resources, they provide a lot of land to the PPP. Also, they provided the land lease for Essent to build the STSS. Moreover, they convinced a company (RICO), that was about to leave from 's Hertogenbosch to Amsterdam, to move to Paleiskwartier instead. So they provided an additional large customer for the STSS. In terms of value delivery, the involvement of a municipality helped for the trust. Now there are not only private parties involved in this project. Also, 's Hertogenbosch could now state they are following their policies. They could claim a frontrunner position, which they did. Value capture is sustainability goals and dividend from the PPP (Interview 3, 2016).

4.3.5 Network

The network is described along the aspects key agreements and organizational structure.

Key agreements

Connection obligation.

All to be developed buildings, which was defined according to a certain program phasing in time, are to be connected to the grid.

Free land lease from PPP to Essent

The PPP owned all the land. They provided a free land lease for Essent necessary for the development of the STSS.

Connection fee from PPP to Essent

The PPP pays the connection costs of the buildings to the grid.

Revision of the contract between Essent and the PPP

10 years after the initial agreement, they came to a new agreement. Essent received a one-time

fee as compensation for the slower building progress and raised the connection costs of offices, to be paid by the PPP.

Organizational structure

Combining all the gathered data about the actors and key agreements into a graphical set-up of the organisation, Figure 4-12 emerges. Main actors clearly are the municipality, real estate developers, energy waste company as the DH owners and the user. Noteworthy is that the energy company is the sole owner of the DH system or STSS, which makes the organization much easier than the other cases.

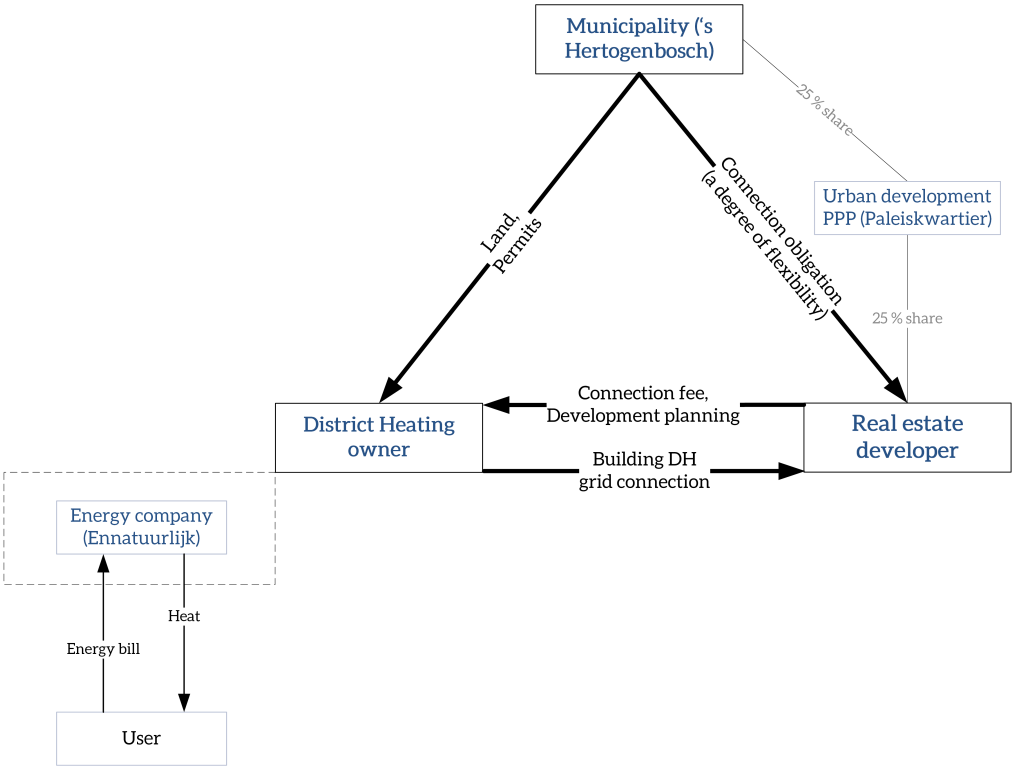


Figure 4-12: organisational structure case Paleiskwartier.

4.3.6 Collaboration mechanisms

As explained in the conceptual framework (Figure 2-19), when the organizational structure from Figure 4-12 is combined with the value creation and proposition per actor as is analysed in paragraph 4.3.4, it should be possible to identify collaboration mechanisms that enable certain system value creation to be captured by various actors. For now, only the step of combining the value creation and proposition of the actors with the network analysis will be performed (Figure 4-13). Only in the cross case analysis, generic collaboration mechanisms will be identified.

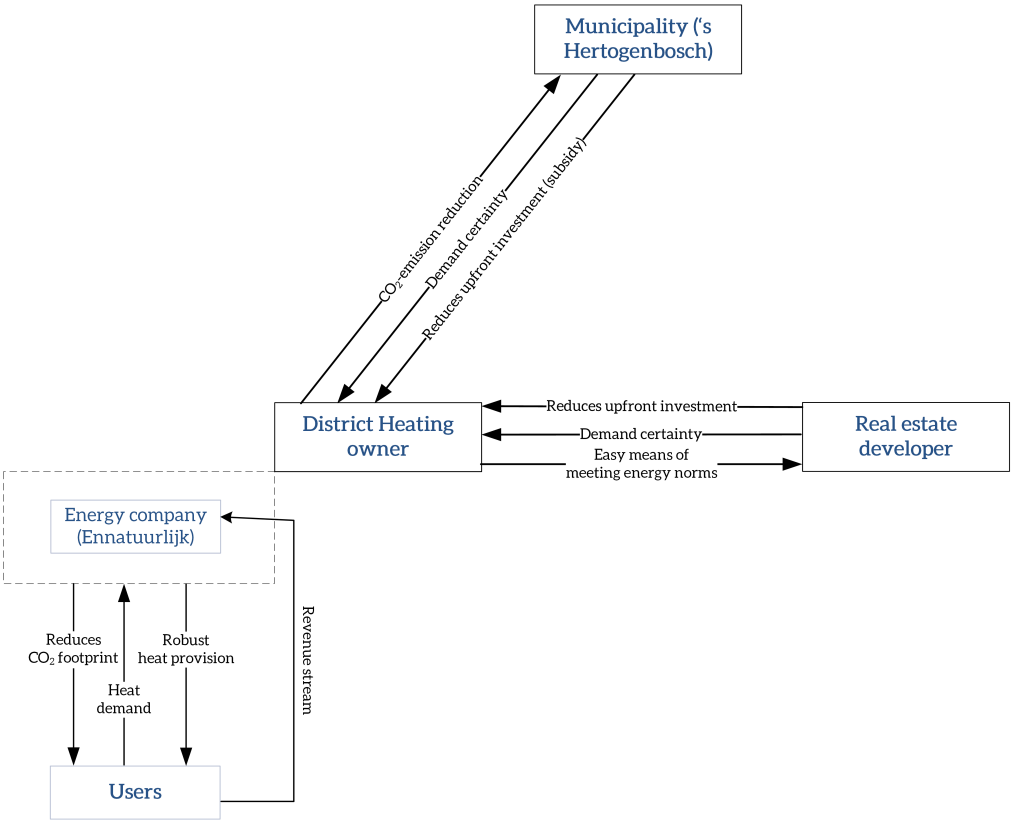


Figure 4-13: the network and business model involvement of case Paleiskwartier combined.

4.4 Cross case analysis

This paragraph will analyse the cases along the topics development process, business model involvement, the network and identified collaboration mechanisms (Figure 4-14).

Figure 4-14: structure cross case analysis.

4.4.1 Development process and drivers

This paragraph will elaborate per case on important factors driving the development process, with the exception of the collaboration mechanisms.

Warmtenet Nijmegen

In Warmtenet Nijmegen it remains unclear how the idea of a DH grid came to be. ARN was at least said to be involved during inception. What becomes clear however, is that the mere perseverance and intrinsic motivation of the Alderman Milieu was of crucial important for the development of the DH grid. He claimed a 5-million-euro-subsidy, vetoed the decision to give Nuon a concession over the real estate developers against their will, had a motion filed to create space for a municipal DH project team and established political support by convincing the financial department and City Council for the need of this project. He went as far as to threaten to resign if this project would fail. Also, the same alderman said the high motivation of the director of ARN was of great help. In addition, all interviewees claimed that the transparency and openness in each other's business case, the will to develop an integral business case, led to enough trust between the parties so that they were all able to engage. Lastly, the fact that the province, the municipalities Nijmegen and Arnhem, Alliander and Nuon signed a Letter of Intent for developing a regional grid was said to be of help for the actors, as this creates a common goal.

Westpoortwarmte Amsterdam

For Westpoortwarmte Amsterdam the idea to utilise waste heat from AEB came from the director of the AEB, which was then (1994) still a municipal energy company. The director of AEB together with a director of Nuon then started to see opportunities to develop a DH grid in the area Westpoort. A project team was set-up for feasibility studies, which almost led to a no-go. The directors of Nuon and AEB now initiated a joint feasibility study, through which they realised they needed to change their relationship from a typical client-customer relationship towards a joint-venture relationship. "I remember well that the director of Nuon told me the essence of this collaboration was earning with each other, not from each other" (Interview 9, 2016). This joint-venturing led to various costs optimisations which was the main reason the project could not be developed, forming the PPP Westpoort Warmte BV in 2000. According to the current project director of Nuon (who also led the feasibility study back in 1994), this principle of 'earning with each other', openness in each other's business cases and bringing each other's resources at cost-price into the joint-venture still lingers in this project. Also, by having AEB in the joint-venture, a strong connection with the municipality Amsterdam was made and important knowledge and a sense of urgency was shared (Interview 9, 2016). This combination of the 'earning with each other' mentality and a strong relation with the municipality is said to have formed the basis upon which the DH grid could extend from the Westpoort Area to-

wards the areas Amsterdam Nieuw-West (2008) and Noord (2015). For instance, the extension towards Nieuw-West was first tendered to Essent, who could not get a viable business case during further development. WPW then applied the same principles as with the Westpoort Area, resulting in an initiated project (Interview 9, 2016). However, it is to be noted that during the years 2000 and 2008, in both the energy and real estate business 'the sky was the limit' as the financial crisis had not yet occurred. This made the decision for Nuon and AEB to invest significantly easier than after the crisis (Interview 8, 2016; Interview 9, 2016). Still, the DH grid in Amsterdam Noord is being constructed at this very moment, which is after the crisis.

Paleiskwartier 's Hertogenbosch

When the urban redevelopment of the area Paleiskwartier came into being, the national government provided subsidies to municipalities for innovative urban redevelopments and sustainability. The municipality wanted to receive this subsidy for Paleiskwartier. Meanwhile, already a STSS was successfully implemented in a neighbourhood nearby Paleiskwartier. Almost logically, the municipality initiated a feasibility study for implementing a large STSS in Paleiskwartier, which was found feasible. Through acquisition Essent got this project and the development went from there onwards through negotiation between Essent and the PPP Paleiskwartier B.V.

Synergy

Noticeable is that the inception of a DH grid seems to be quite simply an idea of certain people that initiate a feasibility study. These people however were at both the cases in Nijmegen and Amsterdam at the very top of their organisation. They had the power to start a project team, backing-up the operational team during development and establish a culture of trust and openness. Furthermore, in both Nijmegen and Amsterdam the principle of working towards an 'integral business case' or 'earning with each other', with transparency in each other's business cases and dividing roles and risks among the actors that are best able in managing those, comes across as an important conditional factor. It seems this conditional factor stems from high placed persons at the key actors, that have the right intentions and a good relationship with each other personally. Nijmegen shows that when the latter is not in order, deals can eventually fail. In addition, it is to be noted that for Nijmegen having an ambitious vision of a large regional DH grid was said to be important for the project development as this provides the actors a common goal to work to. In Amsterdam and Paleiskwartier, it seems joint-venturing created this common goal of the actors involved.

Concluding, certain conditional factors seem to drive initiation and development of DH project. Distinguished factors are (1) key people at key actors having a good personal relationship that create the space and an open culture for initiation, (2) trust between actors leading to transparency in each other business cases so as to be able to build integral business cases so as to earn money with each other instead of from each other and (3) having a common goal for the actors

involved to work towards by means of joint venturing or an ambitious regional DH grid vision backed-up by many actors including the province This is very much in line with the conclusions from RVO (2012).

In addition, Table 4-1 provides an overview of the drivers. This is based on all the interviews taken (interview protocol question two addresses this subject, see Appendix 3: Interview protocol) and the customer research from Nuon ("De waarde van Nuon Warmte," 2016). Clearly, the public parties are mostly driven by environmental goals, while the private parties and users are mainly financially driven.

Table 4-1: identified drivers of the actors. The research into customer satisfaction gave two additional benefits for the users, which is 'low space requirement' for both businesses and citizens, and a 'comfortable heating system' for the citizens. However, these are not considered a driver for them to participate; they are rather an additional benefit. Mostly, as many interviewees pointed out, the driver for both users is mainly financial, with corporate sustainability also being an important driver for the businesses.

	Actors						
Drivers	Public		Private			User	
	Municipality	Utility company	Energy company	Energy waste company	Real estate developers	Business	Private citizens
CO2 reduction	x	x				x	
Contribute to energy transition	x	x					
Corporate sustainability image				x		x	
Financial (new business opportunity)		x	x				
Financial (extra revenues)				x			
Financial (cost reduction)					x	x	x
Low space requirements							x
Comfort							x

4.4.2 Business model involvement

This paragraph will elaborate per case on which part of the actors' business model was of importance to the project development, how they capture value by participating in the project and to whom they propose value. To be able to do so, the separate business model involvement paragraphs per case are put in a table form which is shown in Appendix 4: Business Model involvement analysis. Based on these two inputs, the following can be seen.

Warmtenet Nijmegen

For the energy company Nuon, all elements of the business model come into play for the DH project development. Their value capture shows a financial priority, with less other intangible values. As for the utility company Alliander, also for them all elements of the business model come into play for the DH project development. However, their value capture is less prioritised on finance; they find their future role as innovative company for the energy transition highly important, thus participating in such a project is an other intangible value for them. The municipality mostly create value with a smaller extent of value delivery. Value capturing is solely a cost-effective CO_2-emission reduction and contribution to the energy transition. However, as their role in the GEM, they do need to capture value in terms of finance. Furthermore, the real estate developers provide certain important resources and activities for the project that enable it to be developed, and they do deliver value by means of s small explanation of the heating system. Their value capture is generally low. Lastly, ARN their main contributing role is through value creation, providing and selling the waste heat for a long term. Value delivery plays a small role, as with value proposition to the customers. Their value capture is mainly financial, but also the fact that this project adds to their company vision and image as an innovative energy waste company is a value captured. Value proposition differs per actor, although it can be seen that mainly the energy company proposes value to the user. The real estate developer also proposes values to the user, be it of a lesser nature.

Westpoortwarmte Amsterdam

Where in the case of Nijmegen the energy company provides the investment for and exploitation of only the distribution system, in Amsterdam they also provided the resources and activities for the exploitation of the transport pipe. The rest seem to be same as Nijmegen. The energy waste company seems to play an important role through their value creation, both resources and activities. They adopt no role for value delivery and they capture their value mostly by additional income from selling their waste heat and on the long-term the dividend from the PPP WPW. Apart from the latter value, the energy waste company follows the same value capture as of the energy waste company from Nijmegen. Orgaworld and Waternet seem to adopt a similar contributing role through their provision of a sustainable resource as value creation, while capturing value through additional income from the waste product of their

core business. The real estate developers also to a large extend follow the same business model involvement as in Nijmegen, other than that they paid a higher connection fee than normal (increased cost structure). Lastly, the municipality as public body were involved business model-wise mostly through their resources, using their land ownership and strong market position to provide a concession with a connection obligation. Value capturing is just like in Nijmegen mostly the CO_2 reduction. As full shareholder of the energy waste company and Waternet they however also have financial value capturing through this project. As with Nijmegen, value proposition differs per actor, although it can be seen that mainly the energy company proposes value to the user. The real estate developer also proposes values to the user, be it of a lesser nature.

Paleiskwartier 's Hertogenbosch

In this case, the energy company seems to provide everything of the business model. They exploit commercially and technically both production, transport and distribution. The real estate developers provided the construction of the STSS and the necessary building facilities with their value capturing mostly being an improved image, although that is not a very strong value capturing. The municipality mostly provided land with their value capturing being reduced CO_2 emissions and dividend from the PPP. Value proposition is the same as with the other cases.

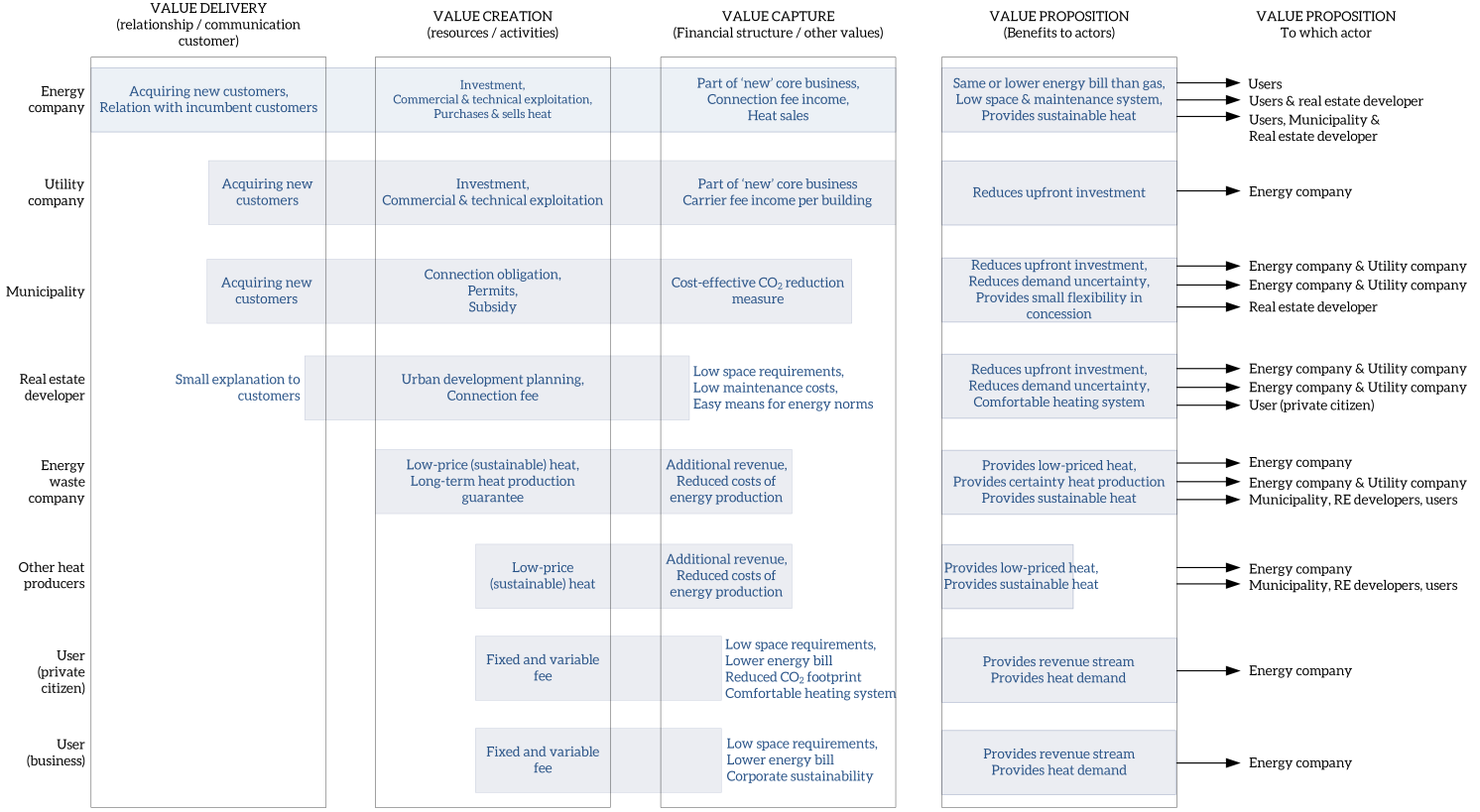
Synergy

Comparing the cases, it becomes evident that the business model involvement of the actors is to a large extent consistent. Therefore, a generic business model involvement model can be made. Figure 4-15 shows how each actor is involved business model-wise and to whom they propose what value. Important is that Table 4-1 provides the drivers of the actors to participate, whereas Figure 4-15 provides among others the value capture and the extent to which the actor captures for them relevant value, i.e. the extent to which their overall drivers are aligned with the value captured. The cross-case analysis and the business model involvement table of Appendix 4 (page 139) formed the input of this figure.

Figure 4-15 (next page):
business model involvement per actor and user. The amount of business model element involvement per actor is shown by the extent of the blue blocks within the element.

Value delivery: the extent to which the actor has a relationship with the user.
Value creation: the importance of the actors' provided resources and activities for the network.
Value capture: the extent to which the actor captures relevant (for them) value.
Value proposition: the importance of the actors' proposed value to the network.

The exact amount is by no means exhaustive; it is filled in based on one's own interpretation and only meant to provide a graphical idea. However, the content of the business model involvement, depicted in text, could be said to be exhaustive.


VALUE DELIVERY
(relationship / communication customer)
VALUE CREATION
(resources / activities)
VALUE CAPTURE
(Financial structure / other values)
VALUE PROPOSITION
(Benefits to actors)
VALUE PROPOSITION
To which actor
Energy company
Acquiring new customers, Relation with incumbent customers
Investment, Commercial & technical exploitation, Purchases & sells heat
Part of 'new' core business, Connection fee income, Heat sales
Same or lower energy bill than gas, Low space & maintenance system, Provides sustainable heat
Users
Users & real estate developer
Users, Municipality & Real estate developer
Utility company
Acquiring new customers
Investment, Commercial & technical exploitation
Part of 'new' core business Carrier fee income per building
Reduces upfront investment
Energy company
Municipality
Acquiring new customers
Connection obligation, Permits, Subsidy
Cost-effective CO_2 reduction measure
Reduces upfront investment, Reduces demand uncertainty, Provides small flexibility in concession
Energy company & Utility company
Energy company & Utility company
Real estate developer
Real estate developer
Small explanation to customers
Urban development planning, Connection fee
Low space requirements, Low maintenance costs, Easy means for energy norms
Reduces upfront investment, Reduces demand uncertainty, Comfortable heating system
Energy company & Utility company
Energy company & Utility company
User (private citizen)
Energy waste company
Low-price (sustainable) heat, Long-term heat production guarantee
Additional revenue, Reduced costs of energy production
Provides low-priced heat, Provides certainty heat production Provides sustainable heat
Energy company
Energy company & Utility company
Municipality, RE developers, users
Other heat producers
Low-price (sustainable) heat
Additional revenue, Reduced costs of energy production
Provides low-priced heat, Provides sustainable heat
Energy company
Municipality, RE developers, users
User (private citizen)
Fixed and variable fee
Low space requirements, Lower energy bill Reduced CO_2 footprint Comfortable heating system
Provides revenue stream Provides heat demand
Energy company
User (business)
Fixed and variable fee
Low space requirements, Lower energy bill Corporate sustainability
Provides revenue stream Provides heat demand
Energy company

4.4.3 Network

For this topic, it will not be necessary to elaborate again per case. When the network set-up of all cases are compared, a generic organisational model can be developed as seen in Figure 4-16.

First, a triangular relation between the district heating owner(s), the municipality and/or higher governmental levels and the real estate developer(s) can be seen. In all cases, the municipality uses some sort of a strong position to oblige the real estate developers to connect to the DH grid. In addition, in all cases they also provide the permits, concessions and in some cases a subsidy to the DH owner(s). Often, they also have a share in one of the companies that acts as one of the DH owner(s). Hence, the municipality is a strong and important actor in DH project development.

In turn, the actors that form the 'group' of DH owners differentiates per case. Therefore, a mix of certain actors is given, that invest in and exploit the heat transportation and distribution system. In some cases, this is a PPP for both transport and distribution, in other cases it might be a PPP for the transport and the energy company for the distribution. The energy company is however crucial, as they are the sole company able to commercially exploit a distribution network. The real estate developers in all cases provide the connection fee and the development planning to the DH owner(s). In return, the DH owner(s) provide the DH grid connection and its maintenance.

In addition, dependant of the case there are one or more heat producers who sell their heat to the DH owner(s). In turn, the energy company of the DH owner(s) sells the heat to the user.

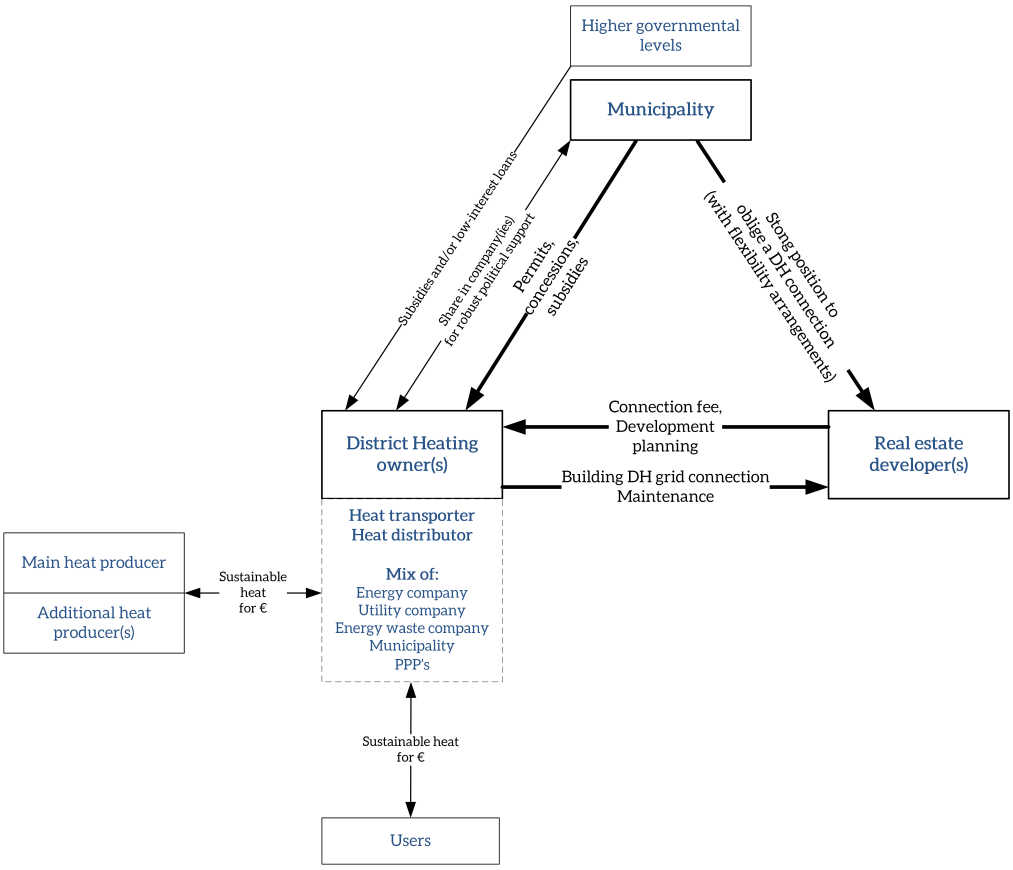


Figure 4-16: synergy of the set-up of the networks.

4.4.4 Identified collaboration mechanisms

As with the network topic, it will not be necessary to elaborate per case. Again, a collaboration mechanism is used to signify something that both triggers and enhances collaborative value creation and capture. In essence, it reflects the part of overall value creation for each company, i.e. its role or function in the system, and value capturing for each company.

When the organizational structure of all cases is combined with the value creation and proposition per actor from their business model analysis, it should be possible to identify collaboration mechanisms that enable certain system value creation to be captured by various actors. It has to be noted that the identification of the collaboration mechanisms and its related system value creation is one's own interpretation of the data. Hence, the steps towards the interpretation and identification phase follows a clear and demarcated path as is seen in the conceptual framework (Figure 2-19) and described above. Hence, the identification of the following four mechanisms is achieved by comparing the paragraphs of 4.1.6, 4.2.6 and 4.3.6 with great care and attention. See Figure 4-17.

Financial integration and dispersion (blue)

(1) The first (blue) is of a financial nature seen in both Amsterdam and Nijmegen. The municipality provides a subsidy, the real estate develop pays a connection fee, the heat producer sells its waste heat resulting in additional revenue and low-price heat for the DH owner(s) and the user pay a fixed and variable price for the heat that is delivered. The overall system value creation it enables is financial integration and alignment, i.e. the establishment of an integral business case based on dispersed investments and revenues that is acceptable for all actors involved. All actors capture financial value except the real estate developer and the users, because they have to pay for a heating system anyway and often this would require the same or even lower investment/price. In the case of Amsterdam, a separate PPP was formed to exploit the transportation pipe, so as to align and reduce the upfront investment of the energy company with their revenues.

Heat provision certainty (red)

(2) Second (red), a rather simpler mechanism identified in all the cases is one that assures heat is always provided to the system. In both Nijmegen and Amsterdam, there is a main heat producer that is a large company with a large heat source able to provide heat certainty for many decades. In addition, in Amsterdam there are more heat producers to ensure reliability. In all cases, the energy company of the DH owner(s) group has one or more backup gas boilers in case of emergency or extreme coldness. For this mechanism only two actors capture value, as the actors are in no way responsible for heat delivery. It is however highly important as the main principle of DH is the production and supply of heat.

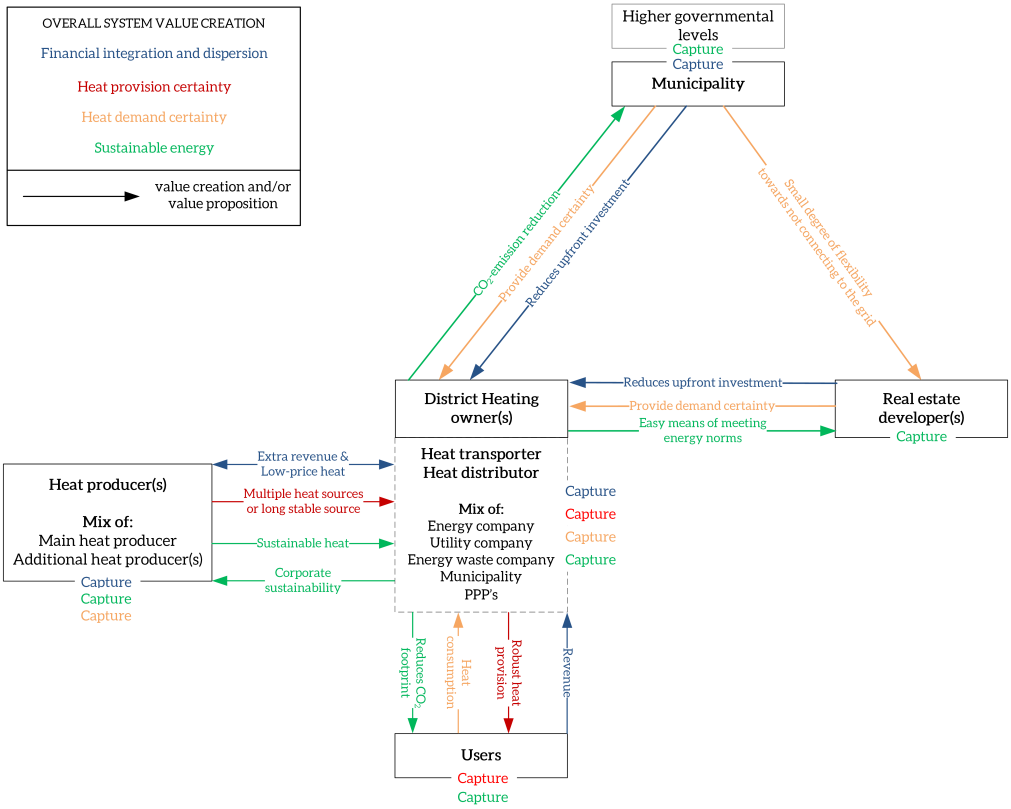


Figure 4-17: generalized collaboration mechanisms and their enabled system value creation and capture per actor.

Heat demand certainty (orange)

(3) Third (orange), a consistent mechanism seen across all cases is one that enables heat demand certainty, to be captured by the DH owner(s) and the heat producer(s). Across both cases, the municipality provides both a concession to the DH owner and obliges the real estate developer to connect to this concession area. Meanwhile, they also provide a certain amount of flexibility within this connection obligation so as to provide the real estate developers a degree of freedom in choosing another energy system. At the same time, the real estate developers provide an urban development planning so that the DH owner(s) know what heat demand can be expected in the future. In addition, the users consume heat which provides the actual heat demand. In return, both the DH owners as the heat producers have a heat demand certainty to base their business case on, because they have to invest in and exploit the necessary DH system facilities.

Sustainable energy (green)

(4) Lastly (green), another consistent mechanism seen across all the cases is one that enables the systems value of sustainable energy. First, one or multiple heat producers provide sustainable heat to the DH owners. In the cases studies this is as of now a simple mechanism, with only the heat producer(s) creating the system value. However, it could be expected that in the near future other actors will also produce sustainable heat, e.g. the users (prosumer) or real estate owners. Interesting about this mechanism is that the value created is captured by all involved actors, be it in different ways. The municipality reduces its CO_2-emission, for the real estate developers it contributes in meeting the energy norms, the heat producer(s) and owner(s) increase their sustainable image and the users decrease their CO_2 footprint.

Noteworthy is that the within the collaboration mechanisms, all the separate value creations of the actors are necessary for the mechanisms to function. Hence, the actors are dependent of each other in creating the network value, while some actors not necessarily capture value of that mechanism.

CHAPTER
05

Conclusion and recommendations

The main research objective of this research is to provide an overview of the drivers and barriers of DH project development, and to investigate the role of business models and collaboration mechanisms in this context. To be able to do so, this concluding chapter will critically analyse the research results from the theoretical framework and case studies, separately elaborated on the subjects of

1 drivers and barriers,
2 business model involvement per actor and
3 identified collaboration mechanisms.

This will provide input for answering the main research question 'what is the role of business models and collaboration mechanisms in district heating project development' and further study recommendations.

5.1 Drivers and barriers

Table 4-1 provides a simple but clear outcome: users (business and private citizens) and private parties (energy company, energy waste company and real estate developers) are mainly financially driven to participate in DH projects, whereas public parties are mostly driven by CO_2-emission reduction and the contribution to the energy transition. Drivers for DH in general as stated in the literature review also mainly concern these two aspects. In essence, the most important or overarching principle of DH is CO_2-emission reduction, while both the private parties and users are mostly financially driven. This could be seen as a barrier per se.

The barriers as discovered from the literature review (Figure 2-9) were all to a large extent recognised in the cases studied. Surprisingly, no additional barriers other than the one mentioned above were discovered during the case studies. This may underline the correctness of the barriers discovered.
A strong finding is that across all cases the development of the DH project hinges upon overcoming the financial barriers, whereas other barriers might not have been overcome and still the DH project could be developed. For instance, in Nijmegen there was a point in the project development where all factors were in place, but still the energy company could not get a viable business case. Because of that, the project at first seemed to stop, were it not that after a totally new financial-organisation set-up the project was finally able to continue. Meanwhile, certain social barriers are still not fully overcome, such as the monopoly position. Also, the barrier 'lack of mutual understanding and cooperation between DH promotors, politician and financial sector' and how this was dealt with comes across very strongly across all cases.

Thus, the financial barriers and the barrier 'lack of mutual understanding and cooperation between DH promotors, politician and financial sector' are crucial to be overcome, whereas other barriers are less essential to be overcome for the project development.

In addition, a table is provided with identified strategies to overcome the barriers, based on the actors´ driver. As stated before, not all barriers are fully overcome, so the table does not include all barriers (Table 5-1). See Figure 2-9 for an overview of all the identified barriers.

Table 5-1: discovered strategies to overcome some of the identified barriers.

Actor	Driver	Barrier	General strategy to overcome barrier
DH owner(s)	Divers financial	Integrale business case hard to close	Reduce costs by bringing in each other's resources against low prices, e.g. by forming a PPP so that the actors are able to provide their resources and activities against cost-price
DH owner(s)	Divers financial	Demand uncertainty	Have the municipality share a particular risk of the DH project so that they are incentivised to seek new customers and steer urban development to DH areas
DH owner(s)	Divers financial	Demand uncertainty	Provide a customer base by means of a concession to the energy company and a connection obligation to real estate developers
DH owner(s)	Divers financial	High upfront investment	Provide circumstances that allows public parties to provide a low-interest loan and/or subsidy, e.g. by having a public party partly or fully own a part or the whole DH grid
DH owner(s)	Divers financial	Demand uncertainty	Provide customer base for energy company by provide an urban development planning/program with building tempo and volume
Heat producer	Extra revenues	Controversial sustainability of the grid	Increase amount of sustainable heat sources
Heat producer	Extra revenues	Integrale business case hard to close	Reduce costs by bringing in each other's resources against low prices, e.g. by utilise waste heat from a company that has heat production not as core-business
Municipality	CO2 reduction	Lack of understanding financial sector, political decision makers and DH promotors	Have the municipality share a risk of the DH project so that the risk of policy changes is covered
Municipality	CO2 reduction	Lack of understanding financial sector, political decision makers and DH promotors	Create workspace at municipality for a project team, e.g. by means of having a motion filed by a political party in the municipality to investigate the development of a DH grid
User (business)	Cost reduction	Demand uncertainty	Convince large real estate owners in an area to connect to the DH grid by means of proposing a cost reduction compared to their incumbent energy system costs
User (private citizens)	Cost reduction	Controversial costs for consumers	Propose a lower price for the user than the alternative

5.2 Business model involvement

Figure 5-1 on the next page shows the way implemented DH projects are generally organized, with what business model elements the actors are connected and to whom, and to what extent the actors' value capture is aligned with their drivers. This figure is a graphical simplification and abstraction of Figure 4-15. Below, the key finding are elaborated in coherence with Figure 5-1.

Key actors in a generic set-up

A clear result is that there are five key actors adopting a key role in DH project development. The key five actors are found to be the energy company, the utility company, the municipality, the real estate developer and the energy waste companies (also known as waste incinerators). These actors have in all cases created, proposed and delivered crucial value to other actors and users so that the project was able to be developed. However, the energy company, the municipality and the real estate developer seem to be the three main key actors in every project regarding business model involvement. The inclusion of an energy waste company and utility company as key actors is dependant of the particular context.

To be able to make a simplified generic collaboration model (Figure 5-1), the actor/role of 'District Heating owner(s)' is introduced. Dependant of the context, the actor(s) forming the role of District Heating owner(s) is a mix of an energy company, utility company, energy waste company and the municipality. In some cases, one actor is the sole DH owner, in other cases a PPP is formed for the heat transport and in other cases a PPP is formed for both heat transport and distribution. An important distinction between different heat producers is the inclusion of a main (large) heat producer and additional (smaller) heat producers.

Business model involvement

Four clear findings can be distinguished considering business model involvement of the actors.
(1) Through various means all actors are to a large extend involved in terms of value creation. Hence, value creation is a very consistent business model element in DH project development from all actors and users.
(2) The same applies for value proposition. Through various ways all actors and users propose value to each other.
(3) Value delivery is underrepresented. Figure 4-15 clearly shows the gap, namely that the energy company is the sole company having a relationship with the current customer and many actors have no relationship with the user whatsoever. Knowing that many barriers such as the monopoly position and controversial costs and sustainability arise due to the bad image of DH, and value delivery is the element that concerns customer relationships and communication,

this business model element should receive much more priority among the different actors. (4) The amount of value capture differs very much per actor, while the value proposition and creation to the network of all these actors is high (Figure 5-1). Here a highly important conflict can be seen. Most of all, the real estate developer and users create and propose a high amount of value to users and actors in the network, while they capture a relatively low amount of value (Figure 5-1). Hence, the successful development of a DH project is for a large extent dependant of the involvement of the real estate developer and the users, but they themselves are marginally incentivized to do so.

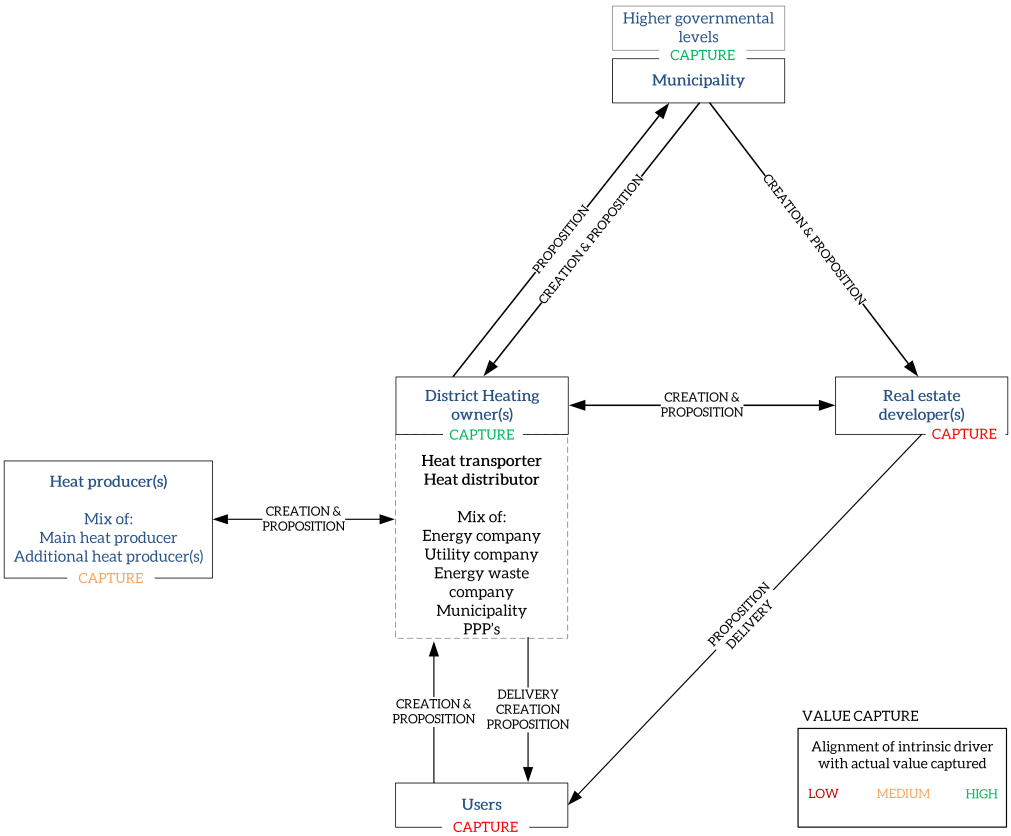


Figure 5-1: Simplified graphic of the business model involvement per actor and their relationships.

5.3 Identified collaboration mechanisms

As stated in the literature review, a collaboration mechanism is used to signify something that both triggers and enhances collaborative value creation and capture. In essence, it reflects the part of overall value creation for each company, i.e. its role or function in the system, and value capturing for each company. Figure 5-2 shows the four identified collaboration mechanisms, the system value creations they enable and which actor captures this value. Below, the collaboration mechanisms will be elaborated.

Financial integration and dispersion (blue)

This mechanism (blue) stems from the municipality and/or higher governmental level providing a subsidy or low-interest loan to the DH owner(s), the real estate developer paying a connection fee per building to the DH owner(s), the heat producer(s) investing in a heat production unit and being able to create an additional revenue stream by selling their waste heat to the DH owner(s), the DH owner(s) being able to buy a large amount of heat against a low price, a utility company investing in the heat transport and the users paying a fixed and variable fee for the heat(connection) to the DH owner(s). The overall system value creation it enables is financial integration and dispersion, i.e. the establishment of an integral business case based on dispersed investments and revenues that is acceptable for all actors involved. However, in current practice not all actors necessarily capture financial value due to this system value creation. In general, both the real estate developer and the users pay either the same of even higher fees/amounts to the DH owner(s) compared to alternative building energy systems. For the municipality DH often is the most cost-effective CO_2-emission reduction measure which could be seen as a financial value capture considering their environmental targets. The heat producers capture financial value by having an additional revenue stream and the DH owner(s) now have various revenue streams.

It has to be clear that when e.g. the connection fee of the real estate developer is not adequate, or the subsidy of the municipality is missing, somewhere in the integral business case mechanism this gap has to be paid for. As was seen in Nijmegen and Amsterdam, when this happens the project will not be able to be developed anymore. Hence, all the arrows of Figure 5-2 have to be in place.

Heat provision certainty (red)

This mechanism (red) stems from the heat producers providing their heat to the DH owner(s) and the DH owner(s) in turn providing this heat to the user. The DH owner(s) also have one or more back-up gas boilers in case of malfunction of severe coldness. The more heat producers,

the higher the heat provision certainty will be. Often, at least one of the heat producers is a large heat producer that is able to provide a heat guarantee for multiple decades. The overall system value creation it enables is heat provision certainty. The DH owners capture value due to this system value creation through a stable supply of heat as they are responsible for delivering the heat to the user. The users also capture value through the certainty of heat supply. It could be said this mechanism is compared to the first collaboration mechanism quite simple, however the value creation it enables is highly important.

Heat demand certainty (orange)

This mechanism (orange) stems from the municipality providing a concession to the DH owner(s) and a connection obligation to the real estate developer(s) in that concession area, the real estate developer(s) providing an urban development planning with building tempo and volume to the DH owner(s) and the users consuming heat which can only be bought from the DH owner(s). The overall system value creation it enables is heat demand certainty, to be captured by the DH owner(s) and heat producers as they are the actors that directly benefit from a certain heat demand.
Also here, when for instance the municipality is unable to oblige the real estate developer to connect, they may choose not to connect their buildings which makes their urban development planning for the DH owner(s) irrelevant, and the whole mechanism collapses. Then, when there is no certainty of heat demand, the DH owner(s) will have no reason to engage in the project.

Sustainable energy (green)

This mechanism (green) stems from the heat producer providing low-carbon heat. The overall system value creation this enables is sustainable energy. Amazingly, all actors capture value through value creation as they all directly benefit. The municipality reduces its CO_2-emmission which contributes in meeting the environmental targets set by the national government and EU, for the real estate developers the sustainable heat contributes in meeting the buildings' energy performance, the heat producers increase their sustainable corporate image, the users reduce their CO_2 footprint or also increase their sustainable corporate image and the DH owner(s) also increase their sustainable corporate image.

Noteworthy is that sustainable energy is the only system value creation enabled by a collaboration mechanism which is captured by all actors involved. It can be said this underlines the conclusion that the most important or overarching principle of DH is its environmental benefit.

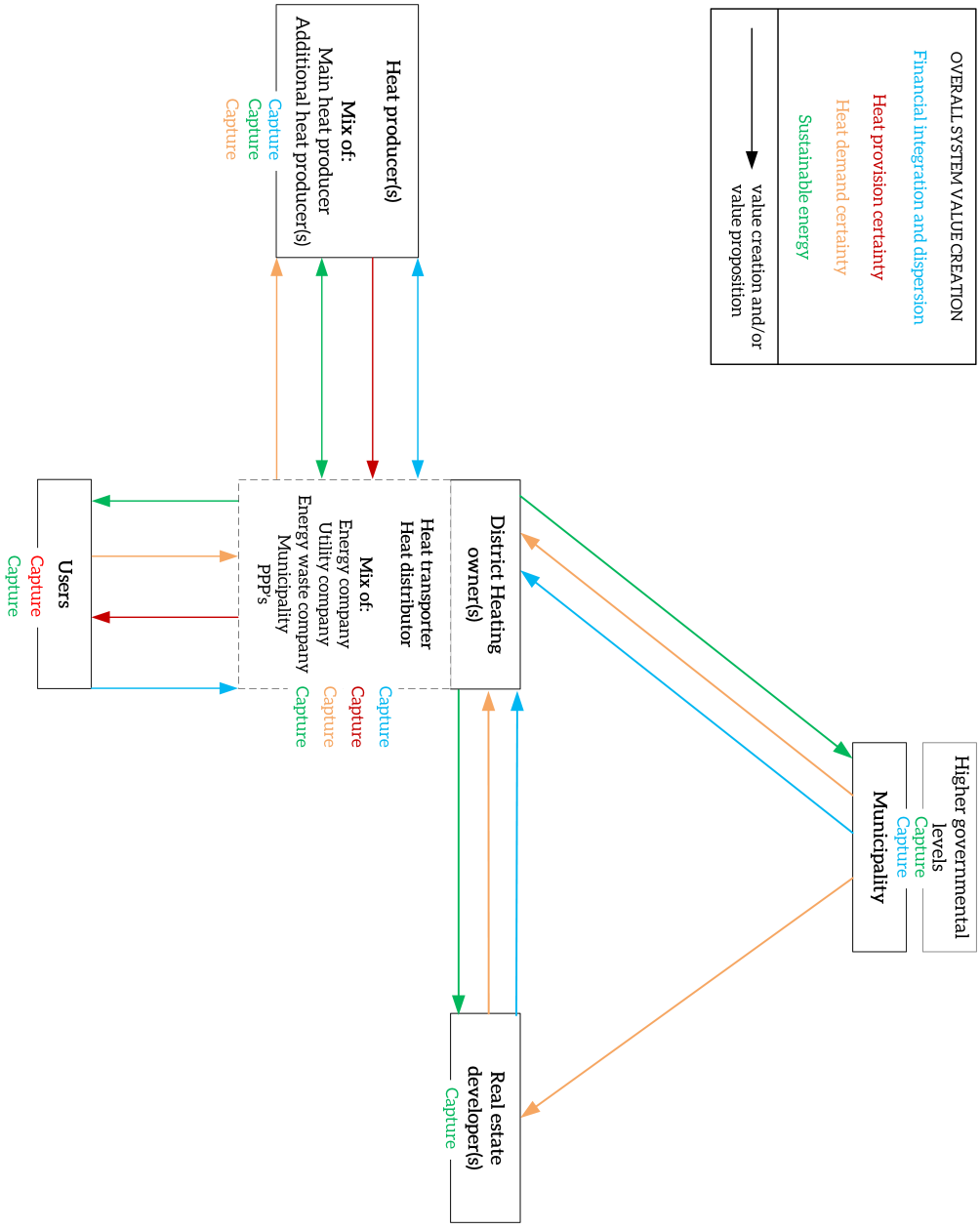


Figure 5-2: the four identified collaboration mechanisms that enable system value creation and capture. The arrows signify the value creation and/or proposition per actor. The colour of the arrow means this particular value creation is part of one of the four collaboration mechanisms and so contributes in a particular overall system value creation, which is captured by one or more of the actors.

5.4 Concluding

Summarizing, four main results came out of this research. First, (1) an overview of the drivers and barriers towards DH project development is provided (Figure 2-8 and Figure 2-9). More importantly, also an overview of the drivers of the involved actors of DH project development is provided (Table 4-1). Second, (2) a generic collaboration model of the current practice of DH project development is developed (Figure 4-16). Third, (3) the business model involvement per actor is extensively analysed (Figure 4-15) and summarized in a simplified graphical model (Figure 5-1). Fourth and last, (4) four collaboration mechanisms that enable the creation of four highly important system values are identified and explained, that have to be in place if the DH project is to be developed (Figure 5-2).

The most important or overarching driver of DH is found to be its environmental benefits and its significant contribution to the energy transition, while both the involved private parties and users are mostly financially driven. Also, the energy company, the municipality and the real estate developer are found to be the three main key actors in every project as they create essential value for the network. At the same time, both users and real estate developers are found to capture a low amount of financial value when participating in DH projects. Hence, the successful development of a DH project is for a large extent dependant of the involvement of the real estate developer and the users, but they are marginally incentivized to do so.

As a conclusion, Figure 5-2 shows the way implemented DH projects are generally organized, what system value is created through the collaboration mechanisms and which actor captures what value due to these mechanisms. This is where the role of collaboration mechanisms present itself. The role of the collaboration mechanisms lies in being the function that enables the creation of the four different types of network values as shown in the figure. Every actor in turn captures different value due to these four network values, which is also shown in the figure. Hence, the collaboration mechanisms per se are not of particular interest; it is their outcome, i.e. the system value creation, and the value capture per actor it generates which is of interest. The role of the business model 'merely' lies in the utilisation of the concept; a means to structurally analyse and understand involved actors' drivers and interests and what they can provide or contribute to the project.
It is found that when one of these collaboration mechanisms is not in place, the project will not be developed. They can however still be improved, requiring a change in value creation and capture of the actors in the network. Their system value creation however will remain the same. In turn, every collaboration mechanism is based on agreements and value creations between two or more actors, of which their combination leads to system value creation. Hence, when even one of the arrows of Figure 5-2 is taken away for some reason (e.g. when the real es-

tate developer is not willing to pay enough connection fee to the DH owners), the collaboration mechanism as a whole can no longer function properly, i.e. the system value cannot be created, resulting in that one or more of the actors will not capture its necessary value, resulting in a no-go of the project development.
This leads to the conclusion that the role of collaboration mechanisms is highly important for DH project development, as it enables the creation and capture of the four crucial values and capture, but the way they are currently set-up makes them, and therefore the current practice of DH project development as a whole, highly fragile. Most of all, the mechanism 'financial integration and dispersion' is such that the DH owner(s) need to capture a lot of financial value and the real estate developers and user are not able to capture financial value, while this is their main driver to participate.

Thus, DH project development is highly fragile, for which five main reasons are discovered. The first (1) is that the current value proposition of the system is not aligned with the drivers of the real estate developers/owners and users. The real estate developers for instance mostly capture environmental value, while their drivers are mainly financial. Second, (2) DH project development is dependant of the participation of these real estate developers/owners and users, who in the current practice capture low value and thus are not intrinsically incentivised to participate. Hence, (3) they have to be obliged by the municipality who then needs the power to be able to do so, which is not often the case as this depends on their land ownership and economical position. In turn, (4) the willingness of the municipality to do so is dependant of the presence of the political will, which is also hard to come by because of the bad public image. Then, (5) when all this is in place, the essential collaboration mechanisms can be designed. However, certain rare soft-side conditions need to be in place before this can be done because this is pioneering and innovative work. The conditions turned out to be (a) trust and openness between the actors and (b) the participation of highly motivated DH promoters at high ranking positions in one or more of the key actors, that have good personal relationships.

Hence, District Heating project development in current practice is a fragile business, dependant of many conditional factors that are either highly rare and/or are otherwise highly difficult to establish. If we want to upscale its development, there is a need to stabilise the collaboration model by significantly changing the collaboration mechanisms, i.e. different value creations from certain actors involved and different value capturing by certain actors that is more aligned with their own drivers. Of which the financial mechanism is the most crucial.

5.5 Further study recommendations

This paragraph is structured around three topics.

Changing the collaboration model

In DH project development, the DH owner(s) adopt a highly central role. In the current network set-up, one of their costliest asset is the heat transportation pipe, to be borne by one or more actors within the network. At the same time, the prices the energy companies (who is in all cases one of the DH owners) are allowed to charge to the user is based on the gas alternative. In the gas financial-organisational system, the costs of the transport pipes are borne by the national government. Hence, in DH project, the costs of the transport pipe need to be paid for (in)directly by other actors in the (local) network, while they have to compete with a system of which those costs are paid by an actor outside the local network, namely the national government.

At the same time, this research concluded that the main driver of the private actors and users to participate in DH are financial benefits. Also, it was discovered that DH project development is dependant of their participation. Hence, the main solution towards stabilising the fragile DH business may in essence be quite easy: nationalizing the heat transport. In this way, the real estate developers, real estate owners and users can be offered a significant cost reduction and the municipality does not need to have the power to oblige them.

However, nationalizing the heat transport will be a large political issue. Engelken et. al. (2016) stated that value delivery is underrepresented in business model research. This research also mainly focused on the value creation and value capture part of a business model. A strong finding of this research is that the social barriers, the bad image of the DH, were the only barriers so far not fully overcome in all the cases. It could be expected that value delivery is precisely the concept that addresses these issues. Therefore, a business model research with a value delivery focus on DH development would be highly relevant. This probably needs a higher abstraction level than project level, as the bad image is a national issue. A connection with social marketing may prove fruitful.

Thus, proposed further research is how to nationalize the heat transport, for which a national scale marketing campaign may be essential, and how this will change the current financial-organisational model of DH projects.

Urban area based energy transition plans

Municipalities need to have the right, and maybe even the obligation, to come up with an area based energy transition plan of how to phase out the gas infrastructure which is legally binding. In theory, the real estate owners and developers then have the following choice: connect to the DH grid for this particular price, go all-electric (building scale interventions) or in case of the inner-city go to (expensive) bio-gas. It will be their choice, but in practice it is expected that in most cities this will lead to bio-gas in the inner city, DH in most parts of the city and in certain low density areas all-electric energy systems. As an example, within now and four years, this will create for real estate owners the question whether to invest in a new gas-fired boiler, a DH connection or an all-electric system.

Thus, the municipalities need to be able to form a legally binding energy transition plan per urban area on how to phase out the gas infrastructure. To create the necessary support, this should be done together with the required actors and users. Still, most likely a financial benefit will be the underlying driver. Further research would be how this can be made legally binding, how to design an appropriate generic process of forming an urban area based transition plan and how this will change the current financial-organisational model of DH projects.

Project development process and phases

As with the drivers and barriers, this research only briefly touched upon the whole DH project development process so as to be able to have a rough overview of this process, which was needed to answer this research main question. This research has found two important (soft-side) conditional factors that need to be in place for a DH project to be developed. Interesting further research would be what the success and/or conditional factors are in other DH cases, and then not only Public-Private model project but also fully public and fully private. In addition, this research has also not performed a proper analysis of the DH project development phases. As it seems, an initiation phase, a negotiation phase and the further development of the DH grid phase can be seen. However, every time the DH grid in Amsterdam was extended, the project went through these phases again. Also because every extension needs its own separate business case.
Hence, it would be interesting what these project phases are and how this relates to the future development of a regional grid. A highly developed regional grid from e.g. Munich or Stockholm would be interesting to compare with e.g. the regional grids around Rotterdam and Amsterdam.

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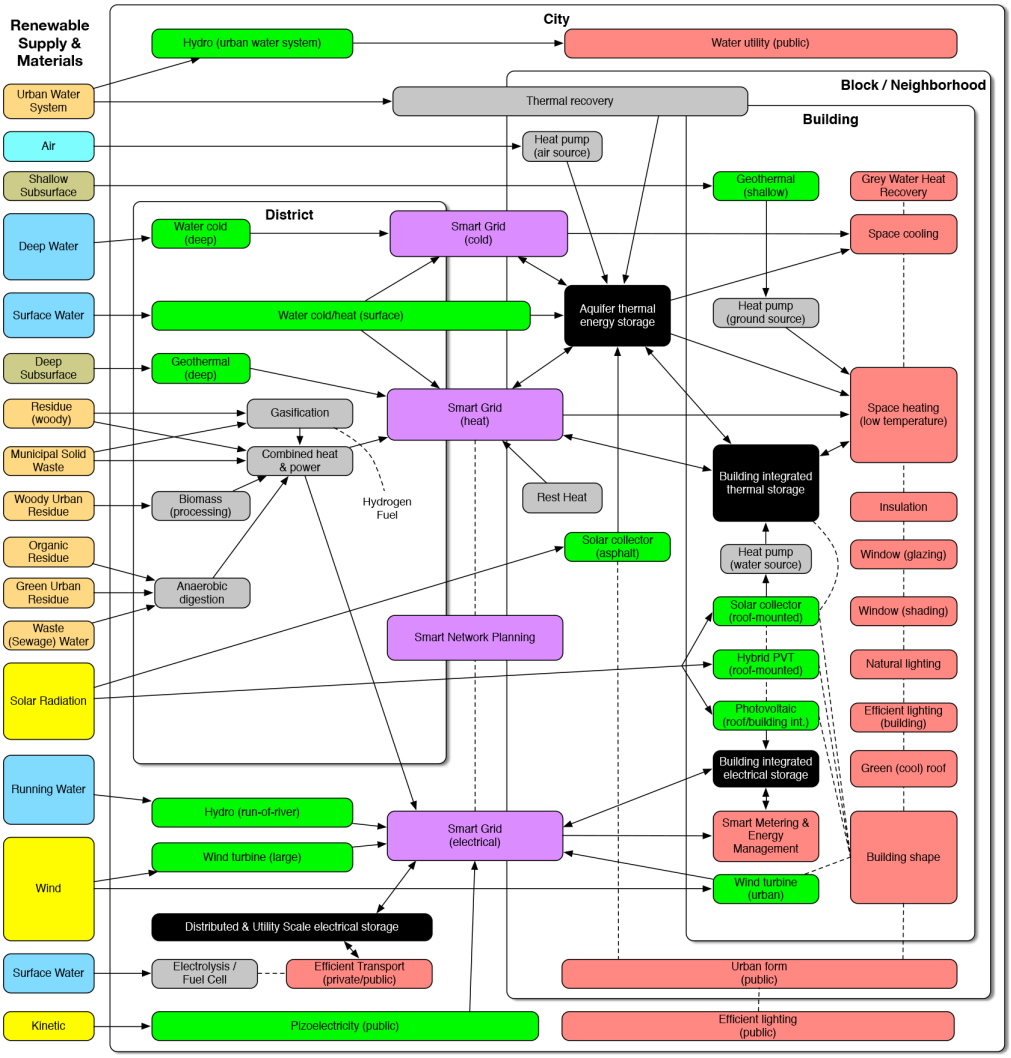
CHAPTER

Appendices

Appendix 1: Graphical model of the urban energy system

The urban energy system: a map of technology pathways based on flows and scale. Left shows harvested and processed resources. A colour represents a resource type (Dronkers, 2015). Smart Grid (heat) is a DH in this figure.



Appendix 2: Key words literature research

Examples:
TITLE-ABSTR-KEY("urban energy system" OR "Urban energy transition" OR "Urban energy strategy" OR "Industrial ecology" OR "Distributed energy" OR "District energy" OR "Community energy" OR "Local energy" OR "Decentral energy" OR "District heating" OR "Smart thermal grid") and TITLE-ABSTR-KEY(Process OR "business model" OR Collaborat* OR Manage* OR Governance OR Organisation OR Organization OR planning OR Barrier*) and TITLE-ABSTR-KEY("urban area" OR "urban development" OR "urban planning" OR "green building" OR "sustainable urban development" OR "city planning" OR "built environment")

("urban energy system" OR "Urban energy transition" OR "Urban energy strategy" OR "Industrial ecology" OR "Distributed energy" OR "District energy" OR "Community energy" OR "Local energy" OR "Decentral energy" OR "District heating" OR "Smart thermal grid") and (Process OR "business model" OR Collaborat* OR Manage* OR Governance OR Organisation OR Organization OR planning OR Barrier*) and ("urban area" OR "urban development" OR "urban planning" OR "green building" OR "sustainable urban development" OR "city planning" OR "built environment" OR retrofit*)

Urban energy system*		**Built environment**
Urban energy transition	Organisation	Urban area
Urban energy strategy	Organization	Urban development
Industrial ecology	Collaborat*	Urban planning
Distributed energy	Governance	Green building
District energy	Planning	Sustainable urban development
Community energy	Barrier*	City planning
Local energy	Manage*	Retrofit*
Decentral energy	Business model	Building retrofit*
District heating		
Smart thermal grid		
Smart grid		

Appendix 3: Interview protocol

Every subject starts with a main question, in which no terms are used that could give the interviewee an idea of the to be gathered information. For instance, terms such as 'monopoly position', 'barrier mitigation' or 'problem' are avoided. Only at the final part these terms are used. After each main question follow-up questions will be asked. If the interviewee in his answer to the main question indirectly gave an answer to a follow-up question, this question will still be asked for validation purposes. See below and the next page a table for the questions to be asked, along the information aim of the questions. Before starting these questions, the aim and setup of this research will be explained.

Subject	Main question	Follow-up questions	Aim
Introduction	What was your personal role in this project?	1 When and why did you as person got involved? 2 What was your function at that time? 3 What was your expertise at that time?	Get a profile of the interviewee and his/her role in the project
Introduction	Can you describe the project development process and when and why you got involved?	1 How and by whom was the project initiated? 2 When did you as an actor got involved and why?	See how the project was initiated and developed and know their drivers to participate
1. Actors' business model	What were your main reasons for participating in this project?	1 When exactly did you got involved? 2 Any particular reasons for this timing? 3 How did you capture value with this project?	Know the value drivers of the actor and why at a certain moment in time
1. Actors' business model	As a first general question, can you say anything about your contribution to the development of this project?	1 In terms of value creation, what do you do and what resources do you provide that are necessary for the development of this project? 2 In terms of value delivery, the customer has a certain relation with the project/you. How do you contribute to this relationship? 3 How do you communicate with the customer?	The value from the actor to the network/project. Done through value creation and delivery
2. General barriers - financial	How is the finance of the project arranged?	1 What factors resulted in a viable business case? 2 How is money for the high upfront investment secured? 3 How is demand certainty secured?	See how they mitigated the financial barriers
2. General barriers - political	To what extent was regional, provincial and/or national policy of help for the development of this project?	1 To what extent were the consumers willing to connect thanks to policy measures? 2 To what extent were the heat producers willing to use their heat for this project thanks to policy measures? 3 How is tariff protection and transparency secured?	See how they mitigated the barriers caused by the inadequate policy framework

2. General barriers - social	How is this project percieved by the commmunity?	1 How are the contractual agreements percieved by the consumers? 2 How is the sustainability-level of the project percieved by the consumers? 3 How are the heating costs percieved by consumers (both home-owners, companies and others)?	See how they mitigated the social barriers
2. General barriers - technical	How is the technical setup of the project arranged?	1 Were some technologies new and/or considered innovative? 2 Were there lessons-learned regarding technical aspects?	See whether there were technical issues, among other due to novelty
2. General barriers - cross-sectoral understanding	To what extent did actors of multiple sectors work together in this project?	1 To what extent did these actors of different sectors understand each others interests?	See whether a lack of cross-sectoral collaboration exists and whether it is indeed a barrier towards STG project development
3. Collaboration mechanisms	Who are you collaborating with and why?	1 Could you summarise the different agreements made between you and other actors? 2 How formal were these agreements?	Get an overview of the agreements made
3. Collaboration mechanisms	How do these agreements contribute in the development of the project?	1 How did these agreements added value for you and other actors? 2 To what extent did these agreements mitigated the issues we discussed? 3 To what extent did these agreements created problems?	Investigating the collaboration mechanisms that mitigated and/or created the barriers
Ending	Have we missed certain drivers and barriers towards the development of this project?	-	-
Ending	If you could do this project again, what would you do different?	-	-
Ending	Finally, is there anything we have not discussed yet which is important regarding the development of this project, or district heating projects in general?	-	-

Appendix 4: Business model involvement analysis

Actor	Case	Value creation		Value delivery		Value capture			Value proposition	
		Resources	Activities	Incumbent customers	Acquiring new customers	Revenues	Costs	Intangible	Benefits to actors	Benefits to customer
Energy comp-any	Amsterdam	T & D investment	exploitation	management / billing / CSI	Account manager seeking new customers	financial priority	Large investment	core business	Low space & maintenance	Low space & maintenance, reduced CO2 footprint
	Nijmegen	D investment	exploitation	management / billing / CSI	Account manager seeking new customers	financial priority	Large investment	core business	Low space & maintenance	Low space & maintenance, reduced CO2 footprint
	Den Bosch	P, T & D investment	exploitation	management / billing / CSI	Account manager seeking new customers	financial priority	Large investment	core business	Low space & maintenance	Low space & maintenance, reduced CO2 footprint
Utility comp-any	Amsterdam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Nijmegen	D investment	exploitation	No contact	Account manager seeking new customers	less priority	less priority	core business	Reduces upfront investment	Contributes in keeping price low. But indirect.
	Den Bosch	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Muni-cipality	Amsterdam	Permits, consession, subsidy	networking	No contact	steer urban development to DH areas	cost-effective measure	cost-effective measure	CO2 reduction	Reduces upfront investment, assures customer demand	Contributes in keeping price low. But indirect
	Nijmegen	Permits, consession, subsidy	networking	No contact	steer urban development to DH areas	cost-effective measure	cost-effective measure	CO2 reduction	Reduces upfront investment, assures customer demand	Contributes in keeping price low. But indirect
	Den Bosch	Permits, consession, subsidy	networking	No contact	steer urban development to DH areas	cost-effective measure	cost-effective measure	CO2 reduction	Reduces upfront investment, assures customer demand	Contributes in keeping price low. But indirect
Energy waste comp-any	Amsterdam	P investment	exploitation production	No contact	No contact	Additional revenue	Large investment	sustainable image	Low-priced heat, cenrtainty heat provision, sus. Heat	Contributes in keeping price low & reduced CO2 footprint. But indirect
	Nijmegen	P investment	exploitation production	No contact	No contact	Additional revenue	Large investment	sustainable image	Low-priced heat, cenrtainty heat provision, sus. Heat	Contributes in keeping price low & reduced CO2 footprint. But indirect
	Den Bosch	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Real estate develope rs	Amsterdam	Connection fee	development planning	No contact	Small explanation	No revenures	Large investment	Neutral attitude, energy norms	Reduces upfront investment, assures customer demand	Comfortable heating system
	Nijmegen	Connection fee	development planning	No contact	Small explanation	No revenures	Large investment	Needed to be vetoed, energy norms	Reduces upfront investment, assures customer demand	Comfortable heating system
	Den Bosch	Connection fee	development planning	No contact	Small explanation	No revenures	Large investment	Neutral attitude, energy norms	Reduces upfront investment, assures customer demand	Comfortable heating system

	strong contribution/connection		medium contribution/connection		no contribution/connection
N/A	Not Applicable	D	Distribution	T	Transportation
P	Production				

Actor	Case	Value creation		Value delivery		Value capture			Value proposition	
		Resources	Activities	Incumbent customers	Acquiring new customers	Revenues	Costs	Intangible	Benefits to actors	Benefits to customer
User (businesses)	Amsterdam	Finance per month	Energy consumption	N/A	N/A	10 % discount compared to alternative	Monthy fixed and variable fee	Corporate sustainability, low space & maintenance	provides heat consumption, provides revenue stream	N/A
	Nijmegen	Finance per month	Energy consumption	N/A	N/A	No revenures	Monthy fixed and variable fee	Corporate sustainability, low space & maintenance	provides heat consumption, provides revenue stream	N/A
	Den Bosch	Finance per month	Energy consumption	N/A	N/A	No revenures	Monthy fixed and variable fee	Corporate sustainability, low space & maintenance	provides heat consumption, provides revenue stream	N/A
User (private citizens)	Amsterdam	Finance per month	Energy consumption	N/A	N/A	10 % discount compared to alternative	Monthy fixed and variable fee	Reduces CO2 footprint, low space & maintenance	provides heat consumption, provides revenue stream	N/A
	Nijmegen	Finance per month	Energy consumption	N/A	N/A	No revenures	Monthy fixed and variable fee	Reduces CO2 footprint, low space & maintenance	provides heat consumption, provides revenue stream	N/A
	Den Bosch	Finance per month	Energy consumption	N/A	N/A	No revenures	Monthy fixed and variable fee	Reduces CO2 footprint, low space & maintenance	provides heat consumption, provides revenue stream	N/A

	strong contribution/connection		medium contribution/connection			no contribution/connection	
N/A	Not Applicable	D	Distribution	T	Transportation	P	Production

Appendix 5: Interviews case Paleiskwartier 's Hertogenbosch

Interview 1: chairman neighbourhood corporation – 8 February 2016

Korte schets ontstaan en activiteiten van Wijkbelangen Paleiskwartier en uw rol hierin

Jaren 80, gebied liep leeg. Gemeente koopt grond op zonder concreet plan. Eind jaren 80 Ontwikkelel maatschappij Paleiskwartier BV opgericht. PPS van gemeente, Volker Wessels en investeringsbank. Personen van deze partijen werken al 25 jaar nu met elkaar samen, dat werkt heel goed. Door deze PPS was de ontwikkeling los van het politieke bemoeienis. Is een voordeel, maar een nadeel kan zijn dat het Paleiskwartier niet heel bekend was. Paleis van Justitie vestigde zich toen daar, dit was aanjager gebied.

Wijkbelangen doet wat een algemene wijkvereniging verder doet. Sociale activiteiten, verkeersproblematiek / parkeervraagstukken.

Loop der jaren, in de jaren 90, ergens coöperatieve vereniging opgezet.

Alleen voorzitters van VvE's zitten in ALV. Deze ALV gaat over overname WKO systeem, niet alle particulieren eigenaren opzich. Maar die voorzitters praten niet namens de VvE, het is geen democratisch proces. Dat is wennen. Bewoners zelf moeten niet het idee krijgen dat ze wat te zeggen hebben.

Waarom is WM geïnitieerd en hoe tot stand gekomen? Wat was aanleiding? Wie werkten samen met wie?

Weet initiatie redenen niet.

Paralell aan ontwikkeling PK ontstond het idee een WKO-net te implementeren. Toen was er nog geen Warmtewet. Gemeente wilde niet volledige monopolie, dus bedacht dat het WKO-net overgenomen kan wordenna 25 jaar door de cooperatieve vereniging. Alle eigenaren van gebouwen zijn lid van de vereniging. Zodra men iets koopt in PK wordt je sowieso lid, je kan geen nee zeggen. Betalen klein beetje contributie. 60 % is van bewoners, 40 % bedrijven. Na die 25 jaar kan je het overnemen als Wijkbelangen, en doorverkopen aan nieuwe partij en tarieven opniew vaststellen. OF je zegt tegen Ennatuurlijk, doe wat aan je tarieven. Maar kan dus ook zo zijn dat het te veel gedoe is, dan blijft Ennatuurlijk kan aan.

Tweede iets minder dominante reden was dat beheer goedkoper zou zijn als één organisatie dat doet. Maar alle VvE's willen het toch allemaal zelf doen, geen behoefte aan gemeenschappelijk beheer.

Kopers tekenen voor verplichte afname tot 2020. Erna mogen ze swichen, maar dat zal praktisch niet te doen zijn.

Hoofdrolspelers zijn BV Paleiskwartier, Essent/Ennatuurlijk, Coöperative Vereniging Paleiskwartier.

Welke barrieres/moeilijkheden tegen gekomen en hoe mee omgegaan?

Mogelijk zou geweest zijn dat de bedrijven dachten/denken dat de tariefstelling van Essent te hoog zou zijn. Bij hun zijn de vaste kosten relatief hoog tov conventionele installaties. Van bewoners krijgt hij geen klachten omdat hij denkt dat daar de vaste kosten relatief lager zijn en variable kosten hoger. Hij kan zoch voorstellen dat het voor Essent interssant is bij de grote panden vaste bedragen te hebben en woningen meer op het variabele.

Verder merk je dat bij nieuwe gebouwen het lastig is het in te sluiten bij koude levering.

Bijzondere is dat Ennatuurlijk en Wijkbelangen elkaar nu ' gegijzeld' hebben. Als Wijkbelangen het overneemt is Ennatuurlijk het over een tijd allemaal kwijt, als zij verder gaan schept dat geen klimaat om verder zaken te blijven doen.

Geleerde lessen wat beter kan qua samenwerking / verdienmodellen?

Wat beter had gekund had Essent transparanter om kunnen gaan met tariefstelling. Dat had een prettiger klimaat geschept voor wat nu gaat spelen, de overname. Stukje communicatie. Aan de andere kant hadden dat moeten/kunnen vragen.

WKI leiding icm infrawerk, is dat gelukt?

Ja volgens mij wel.

Opstalrecht Essent van grond klanten en gemeenten tbv leidinging ging goed?

Nee niks bijzonders.

Gebouwen ontwikkelaar aansluitplicht, ontwikkelaar betaalt. Ging dat goed? Betalen gebruikers dit uiteindelijk?

ZIE ELDERS (JA DUS)

Ontwikkelaar betaalt aanluitkosten, zit wellicht verkapt in kosten koper.

Essent garandeert tarief niet hoger dan conventioneel. Is dat goed gedaan? Hoe benchmark?

Dat kan hij niet zeggen, maar hij heeft het idee dat het niet transparant is. Je krijgt keurig de tarieven binnen en dat zal vast wel kloppen, maar hoe ze het berekend hebben en gebenchmarked hebben met conventionele prijzen zit er NIET in. Je weet het niet. Hij wilt niet gaan wijzen, maar je weet dat Ennatuurlijk in een positie is om een hoge prijs te hanteren.

Prijzen gaan over warm tapwater. En koud water dan?

Gewoon BrabantWater, water leverancier.

Gebouw M 2.5 miljoen aanluitkosten, hoe zit dat? Eigen systeem?

Eigen put.

Incentive 100 euro korting bij vloerverwarming. Voor wie? Werkt dat?

Weet ik niet.

Subsidie nog gekregen?

Weet ik niet.

A1 niet door Ontwikkelaar, ook niet op WKO. RIVA ook niet door Ontwik., wel op WKO?

Stond al voordat WKO systeem plan opkwam.

Waarom ging uitbreiding naar Paleis v Justitie niet door?

Stond al voordat WKO systeem plan opkwam.

Was er een regeling bij minder aansluitingen hogere kosten oid?

Niet echt gevraagd.

Publiciteit/uitleggen werking WKO/communicatie naar klant toe belangrijk geweest?

Geen idee

Rol van gemeente?

Zij hebben de grond. Door in PPS te gaan blijf je een partij.

Interview 2: commercial manager Ennatuurlijk / Essent – 9 Februari 2016

Waarom is WM geïnitieerd en hoe tot stand gekomen? Wat was aanleiding? Wie werkten samen met wie?

BV PK heeft onderzoek geïnitieerd vanuit CO2 reductie plannen. Gedaan door DWA, die adviseerden Paleiskwartier te koppelen aan een

WKO systeem. Ontwikkelaar binnen Essent had contacten bij gemeente en gezegd dat Essent hier een rol in kan spelen. Want ze liepen tegen het probleem aan dat de ontwikkelaar op een gegeven moment weggaat, maar iemand moet het WKO systeem wel exploiteren en beheren. Dat was toen, en nog steeds, een markt waar Essent zich op richt.
Exploitatie moeilijk rond te krijgen, DWA had business case gemaakt en ter beschikking gesteld aan Ennatuurlijk. BV Paleiskwartier zocht iemand aan wie ze het hele warmte systeem kon overdragen. Ze wilden het in principe ontwikkelen, ze zagen een besparing in kosten. Ontwikkelaar bouwt het allemaal, dan komende 25 jaar exploiteert en beheert Ennatuurlijk het systeem. Klanten zijn er dan nog niet, maar het gebied zou in 7 of 8 jaar ontwikkeld worden, wat afneemzekerheid geeft. Maar De overeenkomst tussen Ontwikkelaar en Essent moest opengebroken worden omdat ontwikkeling langzamer ging dat gepland. Uiteindelijk heeft Essent alles wat er al was (WKO dingen) overgenomen van Ontwikkelaar, ook betaald voor ontwikkelkosten DWA en vervolgens geïnvesteerd in bronnen, leidingen etc. Maar alles tot aan gebouwen, dat was voor de Ontwikkelaar.

Welke barrieres/moeilijkheden tegen gekomen en hoe mee omgegaan?
Algemeen is dat je je systeem rendabel moet zien te krijgen. En conventionele manieren van energievoorziening is erg goedkoop en daar moet je tegen concurreren. Dat is een lage investering, en wat essent doet hier is een hoge investering maar lage operationele kosten. Terugverdientijd is erg lang. De klantzekerheid zorgt ervoor dat de business case dan rond kan komen. Wat ook helpt is dat de Ontwikkelaar om aan EPC norm te voldoen moet investeren in energiemaatregelen, en dat een dergelijk WKO systeem hierin meehelpt. Ze moeten flinke aansluitkosten betalen, maar dat kan dus worden weggezet tegen het alternatief om aan de EPC norm te voldoen.

Geleerde lessen wat beter kan qua samenwerking / verdienmodellen
Belangrijke leerpunten dat je vanaf begin heel duidelijk maakt welk riciso bij wie ligt. Dus hier risico van bouwvertraging lag hier bij Ontwikkelaar. Dat was in dit geval niet heel duidelijk vastgelegd, maar nu doen ze dat altijd. Al proberen ze daar flexibel in te zijn omdat anders ontwikkelaars niet met je in zee gaan omdat ze dat risico niet willen dragen. Ze hadden nog gezegd, fase twee doen we niet. Maar wij hadden de vergunning in hadden en CO2 reductie was verplaicht voor dit project, dus dan hadden ze ander systeem moeten bedenken. Dus ze zaten aan elkaar vast. [eigen intepretatie: ze hebben volledige commitment gemaakt, Essent goed mee weggekomen, nu de vraag, Ontwikkelaar ook?].
Als het zo groot project is, moet je het meer opknippen. Nu fase 1 en 2, maar volgende keer meer knippen en tegen de tijd dat iets nieuws ontwikkeld is mogen wij een aanbieding maken. Want tijden veranderen, vana 2020 is alles energieneutraal, dus zijn andere oplossingen nodig. Dan moet je met elkaar iets anders bedenken. Ook: ontwikkelaar wilt dat je flexibeler bent.
Eigenlijk wil je ook meer de afnemers betrekken. Aandelen uitgeven, of andere bepaalde opties. Dan krijg je ALV enzo over wat te doen met financiën. Dit is uiteindelijk dan gewoon een manier van financiering: kapitaal van consumenten gebruiken en tegelijktijd hen erbij betrekken en monopolie gevoel wegnemen. Hier zit wel een toekomst, dat een community wordt gebouwd om een warmenet heen. Zeker nu is bij 2 of 3 % rendement het al interessant voor particulieren om hier in te stappen. En je geeft ze mogelijkheid om hier in mee te gaan en je heb besluitmomenten waar hun stem wordt meegenomen. De mensen in dat model houden elkaar zo ook scherp: het wordt dan duidelijk dat als je eruit stapt, andere mensen meer moeten betalen.

Barrieres die ik schets, kan je je daarin vinden?
Energielabels is grotendeels gerepareerd, maar nog niet bij huurhuizen. Dus daar inderdaad nog in ontwikkeling. Warmtenetten worden weggeduwd, vooral vanwege prijs. En dat komt vooral omdat gas te goedkoop is. Dus wij zijn blij dat er geluid komt dat gas uitgefaseerd wordt. Toekomst is hopelijk dat bepaalde gebieden simpelweg geen gas meer is en zie maar iets anders te bedenken.
Jou barreire hoeft niet persé bottleneck te zijn. Je moet in ieder geval in het begin heel duidelijk maken wat iedereen zijn rol is, wat hij wil en

dus welk rendement je wilt maken. De eerste twee zijn zeker wel barrieres tot grootschalige ontwikkeling.
Ook, transitie van gas naar warmte, dat zijn gigantische investeringen. Hier moet echt geld voor zien te komen.
Verder, energieprijzen zijn nu zo laag, dat maakt het lastig. Nu is er de energiebelasting, dat werkt wel. SDE krijg je op warmte, dat helpt ook.
Uiteindelijk Business case rondkrijgen is meest lastig. Manieren om mee om te gaan is zorgen dat energieprijzen gas niet te laag zijn, subsidies, lage temperaturen (restwarmte kunnen benutten als goedkope warmtebron en minder energieverlies) en technologische vooruitgang om investering naar beneden te brengen. Wordt soms al gecombineert met grootschalige renovatie van woonblokken voor woningbouwcorporaties. Dit kan dus niet in een woonwijk omdat niet idereen dan meedoet. Maar hij gelooft wel dat meeste woningen de lage temperaturen al aankan.

Essent garandeert tarief niet hoger dan conventioneel. Is dat goed gedaan? Hoe benchmark?
Dit tarief stel je van tevoren met de ontwikkelaar af. Toen was er Energiewet, daar houd je je aan. Dat is een moeilijke berekening, veel parameter en moeilijk uit te leggen. De kunst is om dit dan op een simpele mnier te kunnen uitleggen. Nu ook nog met Warmtewet, door ACM wordt het vastgesteld, dat uitleggen is nog altijd erg lastig. Dit is voor bewoners zo, voor grotere gebruikers, vnl kantoren ed is het een vrije markt. Maar hier berekent Essent ook wat het alternatief zou kosten omdat ze anders niet op een warmtenet aansluiten natuurlijk. Dit is zo omdat kleinverbruikers beter beschermt moeten worden, die kunnen zelf niet iets regelen. Grootverbruikers kunnen zelf kiezen. Wil Essent hun meekrijgen, dan moet je natuurlijk goede prijs aanbieden.

Was dat in dit project een probleem?
Nee want DWA had dat al uitgerekend, die hebben wij gehanteerd en daarmee dus laten zien dat tariefstelling klopt. Zoals we al zeiden, Essent heeft business case gemaakt door DWA volledig overgenomen.

Aanluitplicht goed gedaan?
Ontwikkelaar beluit in dit geval eigenlijk voor alle toekomstige klanten watvoor systeem hun gebouwen verwarmt. Klanten zijn er nog niet. Een ontwikkelaar dit kan je nog wel eens mistrouwen, terwijl gemeenten in principe wel te vertrouwen zijn. Maar tegenwoordig zie je dat ook ontwikkelaars aan het lijntje worden gehouden door imago dingen, veel concurrentie etc. Dus een algemeen probleem dat je moet laten zien dat er een overheidsinstantie is dit achter het plan staat. Dat is het probleem van monomolie positie. Onze uitdaging is dan de klant het gevoel geven dat het klopt en fair is allemaal. Het heeft geen zin tegen klanten te zeggen: je moet bij ons blijven. Dus proberen we het zo te brengen dat als de helft van de klanten weggaat de rest van de kosten bij de anderen terecht komt. Ze hebben het wel zo geregeld dat dat mensen wegkunnen, maar dan krijg je de vraag: wat dan? Dat kost erg veel geld.
Aansluitkosten in addendum zijn verhoogd. Waarom?
Fase 1 lichte vertraging oplevering gebouwen. Fase 2 zware vertraging. Dus onderhandeld over hoe gaan we dit met elkaar regelen omdat in contract staat dat je aan die planniong zou houden. Dus aansluittarieven fase 2 verhoogd omdat dat kosten zijn voor Ontwikkelaaren niet voor gebruikers. Koude grootverbruikers hebben ze wel klein beetje verhoogd, dus herberekenen. En uiteindelijk die meerwerk van 400K afkoopsom uit onderhandelingen. Ook nog: contract is tot 2020. Dus Fase 2 is 2035 geworden.
Gebouw M 2.5 miljoen aanluitkosten, hoe zit dat? Eigen systeem?
Incentive 100 euro korting bij vloerverwarming. Voor wie? Werkt dat?
Werkt niet echt, niet van doorslaggevende werking.
Subsidie nog gekregen?
Ja, CO2 reductie plan. Dat helpt in de business case. Naar wie dat gaat ligt maar net aan welke afspraken je maakt.

A1 niet door Ontwikkelaar, ook niet op WKO. RIVA ook niet door Ontwik., wel op WKO?

Had al eigen systeem. Essent had toen in Overeenkomst 6 bronpalen en bepaalde levering gecontracteerd. Paleis in 2008 pas gezegd, kunnen we ook aangesloten worden? Maar dat is voor het huidige systeem te veel vermogen. Extra bron was niet meer mogelijk door grondwatervervuilding door Brouwerij Heiniken in de buurt. Dus je krijgt geen vergunning meer voor nieuwe bron. Dus keuze was van Ennatuurlijk dat voor één nieuwe klant gaan we niet heel zo'n vergunningstraject doorlopen.

Publiciteit/uitleggen werking WKO/communicatie naar klant toe belangrijk geweest?

In principe verteld

1 prijs, als Ontwikkelaar woning verkoopt moet duidelijk worden gemaakt welke tarieven harneert worden.

2 en Essent laten weten wat het nou precies is, CO2 reductie ed uitleggen.

Rol van gemeente

Aanstichter geweest. RWA onderzoek laten doen. PPS gemaakt. Gemeente kan dus dus eis bij nieuwe ontwikkeling stellen aan CO2 reductie iets. Of je legt t uit als consessie gebied en tenderd het geval en dan moet de private partij dus aan de eisen van dat gebied voldoen. Je ziet nu dus meer dat de gemeente het opleggen aan ontwikkelaars.

Interview 3: project manager Aveco de Bondt / Volker Wessels - 26 February 2016

Projectmanager bij ingenieursbedrijf Aveco de bondt. In 2000 had Volker Wessels klein aandeel, inmiddels volledig overgenomen.

Hij adviseert in randvoorwaarden die de omgeving voor gebiedsontwikkelingen.

Hun rol was toen in de grond: afstemming tussen alle partijen om de grond voor PK bouw- en woonrijp te krijgen. In opdracht van BV PK.

Hij is net voor de overeenkomst van Essent met BK PK begonnen aan dit project.

Hoe is het project tot stand gekomen?

Eind jaren 90 was CO2 reductie hot. Kon je subsidie voor krijgen, als je een bepaald programma opstelde kan je subsidie krijgen. Gemeente had subsidie aangevraagd voor een nieuwsbouwwijk. Toegekend. Ontwikkeling van de nieuwbouwwijk werd maar uitgesteld. Toen kwam PK ontwikkeling. Toen was het idee de subsidie over te zetten van de nieuwbouwwijk naar PK. BV PK vroeg toen aan Aveco de bondt om te kijken of WKO systeem voor PK ontwikkeling technisch zou kunnen. Dat was dus zo. In de buurt was er al een WKO systeem voor een bepaalde toren, dus vandaar dat men al snel dacht aan een WKO systeem, en niet zozeer andere CO2 reductie mogelijkheden.

Vervolgens haalbaarheidsstudie gedaan door DWA, bleek dus interessant te zijn, ook in economische zin.

Vervolgens werd er een heel plan van het PK gemaakt, inclusief te ontwikkelen m2. Toen kon gedetaileerde haalbaarheidsstudie gemaakt worden, ook gedaan door DWA.

Vervolgens is het de vraag, wie gaat het doen? VolkerWessels werd gevraagd, het zou in principe kunnen. Maar die zeiden, we kunnen het wel technisch maken, maar dat is er het volgende probleem: wie gaat dat dat exploiteren? Want zij wilden gewoon gebouwen ontwikkelen en verkopen. Er is even gekeken naar of exploitatie zou kunnen, maar werd geconcludeerd dat de hele administratieve ontbreekt, dat het te lastig zou zijn om dat ook te gaan doen. Toen werd er contact opgenomen met Essent, die zagen het wel zitten. VolkerWessels ook. Gemeente ook.

Vervolgens was het de vraag, wie bouwt, wie investeert in wat, waar leg je de knip. VW kon wel investeren, daar werd aan gedacht. Maar het bleek, Essent kon beter gebruik maken van allerlei fiscale voordelen zoals aftrekposten. Fiscalisten werden erbij betrokken. Dus het moest zo zijn dat Essent de initiele investering en exploitatie doet in het systeem, en de bouw uitbesteden. Ook heeft Essent al die administratieve dienst, VW niet.

Vervolgens in contract vastleggen. Wie betaald nou voor wat nog meer? De bouwer heeft normaal kosten voor installaties per huishouden. Nu anders. Hoe daar mee om te gaan? Uiteindelijk besloten dat de ontwikkelaar de aansluitkosten betalen, omdat Essent al investeerd in het hele systeem. Dit hadden ze nodig om de business case rond te krijgen.
Vervolgens hadden ze bij het sluiten van de business case besloten dat het nodig was dat BK PK nog andere stukken grond moeten werven om aan te sluiten bij de BV PK, zodat Essent genoeg afnemers zou hebben. Die verplichting aan te sluiten was goed te regelen omdat BV PK alle grond had, na de vastgoedontwikkeling verkoop je het pand met de verplichting aan te sluiten op het WKO.
A1 werd ontwikkeld door andere ontwikkelaar wilde dit bijvoorbeeld niet, dus die is ook niet aangesloten op WKO. Wat hij zegt, dit is een sociale of culturele barriere: de huidige manier van werken laat dit niet toe. Alles is gestandaardiseerd naar cv ketels. Dergelijke systemen is anders dan normaal.
Bij de betaande gebruikers, die allemaal niet zijn aangesloten, is er geen belang bij de vastgoedeigenaren aan te sluiten op het WKO net. Dat ze duurzame energie uitstralen is mooi, maar verder is het veel te duur.
Tijdens de hele ontwikkeling, halverwege jaren 90, kwam privatisering van energie omhoog. Toen werd er gekeken, hoe kunnen we zorgen dat de mensen toch een soort vrijheid zou hebben? Idee werd toen dat de bewoners het zouden kunnen kopen over 25 jaar. Dit was niet echt in het belang van een actor, maar men vond dat het nodig was gezien de discussie die er speelde.
Er was geen verplichting voor BV PK om aan de planning te houden. Dus daar was de aansprakelijkheid vaag. Door crisis stagneerde de planning. Op een gegeven moment was er wel erg veel achterstand, waarop Essent ingreep. Beide hadden geen belang er een rechtzaak van te maken. Dus ze zeiden: laten we elkaar belangen respecteren, kunnen we er samen uitkomen. 2 jaar later is eea aangepast. Dus toen een knip gemaakt, alles wat oud is daar 400K van terug. Van wat nog nieuw wordt maken we nieuwe afspraken.
Bedrijven aansluiten op WKO net is goed voor imago, kost wat meer maar is ook makkelijker betreft installaties.

Ontwikkelaar heeft alleen maar meerkosten voor WKO net. Zij moeten alle bouwkundige voorzieningen maken voor WKO systeem, is gewoon minder VVO. WKO was ook
Essent kan waarschijnlijk goedkoop stroom inkopen voor het aandrijven van de warmtepompen.

Welke barrieres/moeilijkheden tegen gekomen en hoe mee omgegaan?
WKO is lage temperatuur. Dus vloerverwarming. Maar dat is voor consument lastig. Ook de bouwers zagen dit als een enorm obstakel. Toen was vloerverwarming echt een afwijking van standaard bouwproces. Dus toch maar radiatoren, maar dan krijg je gigantische radiatoren. Uiteindelijk toch klein radiatoren, maar dit vergde wat gedoe met consumenten, die moesten wennen aan langzaam opwarmen en dat ze ramen niet open konden doen. Dit is dus ook weer cultuur van bouw actoren barriere.

Een barriere in toekomst is aanscherpende EPC normen. Dan is er nog te weing warmte over om het systeem rendabel te krijgen.
Geleerde lessen wat beter kan qua samenwerking / verdienmodellen
Dit lukt je alleen als je maar één ontwikkelaar hebt, en één partij die alle grond heeft. Zelfs als er dan andere ontwikkelaars komen, kon BV PK de grond verkopen met een clausule erin dan opstal moet worden aangesloten op het WKO net.
Iemand die het trekt. Hier is het gemeente geweest. 'Project champion' dus. Dat is toch vaak de overheid.

Wat is nou van wie?
Van installatie tot aan overdracht aan klant is van Essent. Bronnen, leidingen in grond, leidingen in gebouw tot aan overdrachtspunt per appartement. Overdrachtspunt is de verwarmingsunit van het appartement, deze unit is dan van de vastgoedeigenaar.

Bij kantoren is het alleen tot en met warmte en koude + centrale warmtepomp. Leidingen in gebouw is van gebouw eigenaar. Dat doen ze omdat per kantoor de indeling van leidingen totaal anders is, daar waar leidingen in woningen hetzelfde zijn.

Aanluitplicht goed gedaan?

Ja. Bedrijven hebben zoiets van 'het is zo'. Het zijn wat vorse bedragen, de aanluitbijdragen, aan de andere kant hoeven ze geen installaties en dergelijke te bepalen.

Aansluitbijdragen voor bedrijven is bepaald obv afname

Aansluitkosten uiteindelijk bij gebruiker

Waarschijnlijk wel, maar bij conventionele installaties was dat ook zo geweest. Gaat er vooral om, tov bestaande bouw, er wordt niks vervangen. Het is direct het warmtesysteem.

Appendix 6: Interviews case Warmtenet Nijmegen

Interview 4: business developer Alliander - 24-03-2016

What was your personal role in this project?

Half the time I work at Liandon Marketing & Sales as account manager. The other half I work as Business developer for Alliander DGO, specifically in the region Arnhem-Nijmegen.

Can you give a description of the process of initiation of the project?

Around 2011 or 2012 the municipality Nijmegen asked Nuon if they could provide the residential area "Waalsprong" with sustainable heat from the ARN. The offer from ARN stood already for quite some time. Nuon could not get a viable business case, so then the Province Gelderland asked Alliander if they could get this done. Alliander then decided to give it a try to realise. this project All parties got together to overlook the project and its risks to decide who would be responsible for which investment. This arrangement is based upon the question "Who is best in managing what type of risks", resulting in the must cost-effective option of covering the risks and financing. The solution was found in that Nuon invested in delivering and distribute the heat, while Alliander and the municipality of Nijmegen invested in the transportation of heat from the ARN to the Waalsprong.. For that purpose Nijmegen and Alliander established the company, Indigo BV. Indigo took quite some risks, because the investment in the transportation pipe is "upfront", even before all houses are being build. The investment Nuon has signed for is larger in total, but it generates revenues right from the start after realising the their infrastructure. Now it concerns a number of 3.500 houses, already collectively heated, which total will amount to 14.000 dwellings, somewhere between 2020 and 2030. An relatively fast expansion of the Waalsprong will make the businesscase viable, where as a slowly development of this residential area will lead to a financially non-viable businesscase. In respect to environmental goals, like CO2-savings, it can be stated that there is now no other investment possible which is as cost-effective.

These division of roles and responsibilities, per project this has to be designed again?

As of now, yes. I expect that in future, when district heating has developed further, we will see a somewhat more fixed division between fixed parties.

You said ARN offered to use their waste heat?

Yes, they are quite active in seeking for opportunities to use their waste heat. They state that they are transformed form a waste incinerator into a small energy company. This is a trend which can be seen within the business line of waste incinerators, because the production of heat yields more than the production of Electricity.

What were your main reasons for participating in this project?

The vision of Alliander is to give a boost to the energy transition in the Netherland and that alternative energy infrastructures like heat can play a large role in this. As Liandon District Heating is one of our technical fields of expertise. Even the head of Alliander DGO, Roelof Potters, for instance has an extensive knowledge of district heating. So we knew that we could do it.

The motive was the question we got from the Province as said before.

When was this and why?

Somewhere around 2011. But even about 15 years earlier the Province of Gelderland, together with Nuon, already designedthe prevailing plan for the regional heating network of today. When Nuon was split in 2008 it gave a natural role for Alliander to contribute to this plan.

How did this capture value for you?

This is part of our company strategy, we want to play a part in the new energy infrastructures. Alliander has a proactive attitude in the energy transition and this project contributes in this strategy. Also, we know that the gas infrastructure has to be phased out, so implementing heating districts can be a good alternative. Regarding finance, Alliander invests in the transportation pipe and gets her revenues as a part of the energy bill the consumer pays to Nuon or any other Heat supplier.

As a first general question, can you say anything about your contribution to the development of this project?

Without Alliander, this project would never have happened. We answered the question from the Province Gelderland by trying to get it done. Also, Alliander together with municipality Nijmegen formed Indigo BV, who invests and exploits the transportation pipe. Now, Alliander is owned by several public parties such as municipalities and provinces. This fact made it easier for the Province Gelderland and municipality Nijmegen to invest in this project. Because an investment in an commercial enterprise is (publicly) not acceptable. So in the end, by including Alliander in the project, financing could be arranged in a different way than the classical model of Nuon in which Nuon is the only investor. Now, the municipality and Province could invest as well, with an alternative risk profile and thus rate of return. which is lower than a commercial party like Nuon.

In terms of value delivery, do you communicate with the customers?

Generally Alliander, as DSO and transporter of energy, has no direct contact with the end-user / customer. That role is being played by the distributer of Energy, in this case Nuon.. But in the development of Heat-grids Alliander is very active. As well towards the major end-users and the other stakeholders who are necessary to make a viable businesscase for this kind of expensive infrastructures. But there are some exceptions in which we work together with a neighbourhood association. In our experience the end-user does not just want to pay less than in the case of heating with a gas-infrastructure, but also finds other things important, like comfort and less space requirements. One way or another district heating has a poor image in the Dutch public opinion. So among other things, we need to start the conversation between housing corporations and the municipality. In the end, finance is not the biggest problem; the image of district heating certainly is one of the big issues.

If you have to point out a few factors that resulted in a viable business case, what were these?

The fact that Alliander is used to investing in infrastructure. We are used to long-term investments and long payback periods. Our whole portfolio is built up like this, so risks are being averaged out.

3 What were the most important agreements that resulted in the success of this project?

This business starts with achieving a sound basis of trust between the parties. Enough trust to be open and fairly transparent of each other's business cases, so that everybody knows that the right parties carry the right sort of risks and that there is not one party is not making a lot of money at the expense of the other participants. This takes quite a while to establish. Eventually there was enough openness so that invest-

ments from the municipality and Province could be allowed. This is important because as public parties, you have to justify your investment, so you have to show you are not investing in a bottomless hole. This could only be done through openness of each other's business cases, which initially was difficult for Nuon.

In the end, what was the most important factor for the success of this project?

Alliander DGO getting involved in the project, because Alliander believes in district heating and therefore assumes a leading role in the project.

What was said as side-notes

Extending to the existing housing stock will be the challenge for future district heating.

For new housing areas the municipality can subscribe that district heating is obligatory. For existing housing areas that possibility, within the actual legislation in force, does not exists. Those areas are already being populated, so those people have a say in the way they want to transfer from gas to electricity or district heating. So probably, until legislation and policy is changed, the existing stock will not be connected to district heating. For instance, in Germany, it is decided which parts of cities will be heated by gas, heat of all-electric technologies. We do not have that. Moreover, large consumers of gas pay a low energy tax, while small consumers pay a high tax. This makes the small consumer more interesting in terms of heating tariffs because of the NMTA-principle.

Interview 5: Alderman Milieu municipality Nijmegen - 30-03-2016

Studied political science, worked at municipality Nijmegen as Council member, Alderman Milieu from 2006 – 2010 and Alderman Milieu & Urban Planning (part of city) 2010 - 2014.

Can you describe the process of development of this project, from start till now?

In 2006, I started as alderman Milieu. One of the first things I had to deal with was the heating grid. Already in the 1990's, there were plans to develop a heating grid. I do not know exactly anymore, but this was done with among others the municipality (by the then aldermen, ARN and developers). Then, the plans for Waalsprong development were being made. They formed a PPP, the GEM (Gemeenschappelijk Exploitatie Maatschappij Nijmegen BV). Municipality 50 % share, the rest from the developers Bouwfonds, AM and Heijmans and two housing associations, Talis and Portaal.

The amazing thing was, there has never been a contract between Nuon and GEM during the urban development about the ideas of a heating grid. So dwellings were built with a temporary heating solution, without an overarching contract.

So a few months after my entry as alderman, the alderman of urban planning announced that there would be no contract between GEM and Nuon for a district heating grid. Reasons were among others aversion to monopoly position and Nuon was being difficult. But also personal reasons, people from Nuon, GEM and municipality did not connect personally that well. So the alderman asked me, what if we demand the same energy performance as if when the dwellings were connected to the planned heating grid? So in all my naïveness, I accepted. An EPL of 7.2 was agreed, that was then in the 1990's very innovative, in 2006 this was mainstream. Also, the dwellings that were built, had national EPC-norms. So do you want to achieve the EPL-norm, then the remaining buildings of the urban development has to be well below the EPC-norms.

So we as the milieu department agreed to the plan, but with an agreement that the future buildings should have an EPC-norm of about 0.4, which is lower than the current buildings. This was very difficult for the others to accept, and eventually the next building permit request however still had a EPC-norm of national standards. And you cannot refuse that permit. So now I felt quite deceived and had to do something about it, also because I represent GroenLinks and a standard new neighbourhood is unacceptable. I was going to form a new strategy with the team milieu to get this done.

So, I have an alderman of urban planning and the GEM who did not want this heating grid. At the same time, I had the intrinsic willingness to get something done. So I got a motion filed by GroenLinks to the city council that investigating the possibility to establish a heating grid should be reopened. By now, the Province of Gelderland, in the name of Annelies van de Kolk, also said that this heating grid should be realised. So now we had top-down pressure to get started again. By now the alderman of urban planning was a bit more cooperative, and the municipal department Milieu began to calculate again and try to get parties together.

Side-note here is that the development of the project lost time because we wanted to realise a hybrid heating grid (has higher CO2 reduction than normal temperature). This required new technologies, whereby after a market study no parties wanted to get involved. Market parties wanted a normal heating grid with normal temperatures. This was about 2008.

Nico Büskens from Alliander said the Province led the 1990's heating grid plan together with Nuon?

I do not think so. I though the Province only got really involved when they heard that the contract with Nuon about a heating grid was definitely a no-go.

OK, let's continue the story

So now there was a plan to implement a normal temperature heating grid. We got a new project leader. I was happy with that, because people from department Milieu are policy makers, not people who act. So we got a project leader from the land department, who was someone who acted, and we got someone from Over Morgen, a consultancy bureau in urban development and energy transition. Then things speeded up.

Next, in 2010, elections were held. This was a very important moment for the project. I was party leader of GroenLinks and we got to be the biggest party with eight seats. So new coalition with GroenLinks, PvdA and D66 with intensive negotiations. D66 were being difficult about the heating grid, mostly looked at the business side of things. Still, I got to claim five million for the heating grid during the coalition negotiations. There are certain moments a politician can really make a difference. This is one of them, very essential for the heating grid.

Moreover, I was busy with this grid, but no other people of the parliamentary group had an idea about this heating grid. It was and is simply not a sexy subject, so it was very good that I was keen on making this project.

Also, essential in the negotiations, I claimed the position of alderman of urban planning for the parts that were needed for the heating grid. So then I had direct influence on what happened with the GEM, instead of having to deal with the alderman of urban planning who would probably parrot the developers such as monopoly position, too much costs etc.

To continue chronology, at a certain point we had all the parties together. Nuon, Alliander, AVR and the municipality. However, the developers still did not want to cooperate because it was all too difficult, monopoly position etc. But by now I was chairman of GEM because this was now also within my portfolio as alderman. At a shareholder meeting I simply said: we decided that the whole neighbourhood and future dwellings will have to be connected to a heating grid, with the heat source AVR. Done, no discussion. This was very ill received, meeting got out of control. But, this was the only way, otherwise they would have come with problems time after time. Afterwards we embarked on a charm offensive, organising some diners with the account managers / project directors etc.

Their protest was that because the EPC-norm is decreasing, it becomes less relevant to solve this with a heating grid. And, it could well be that in the near future something is invented that is much better. We would then be stuck to this heating grid. I always said this is like: the possible ideal future becomes the enemy of the good thing one can do right now. You do not know that future yet. In addition, they already built 3500 dwellings which I still have to make sustainable, while they are done with the dwellings.

However, I could understand the fact that in future, it could be less relevant to work with heating. So we decided the following. Nuon has a concession for the Waalsprong and Waalfront, in total about 14.000 dwellings. But we also want to extent the grid to the existing stock in the city. When for the existing stock Nuon gets new concessions, the same amount of concessions is subtracted from the area's Waalsprong and Waalfront. In this way, a freedom will come into existence for the developers to then decide to still use the heating grid or not. So imagine, in 2025 they are able to deliver a dwelling that is energy neutral, and in the existing city there are numerous buildings connected to the grid, they

are free to not connect the buildings to the grid and apply their zero-energy buildings. That is a good deal.

So here, both parties are within their rights. We will never develop a heating grid without going to newly built stock. We need the newly developed stock to go to the existing stock. Because with newly built stock you can get a business case through obligation and demand certainty. So this was all very important.

Now, for me internal it was also very difficult. Department finance also saw many problems. So I said, I will resign if this project does not happen. Then they really realised this was important to me. This really helped, threatening with resignation.

To quickly go back to charm offensive with the developers, why did you do so?

I could force the decision down their throats, but it is also the job of an alderman to connect people and get things done. Moreover, I still had to work with these people for the urban development, so I did not want a troubled relationship.

There was another issue. The national building regulation was about to be adapted. Municipalities were able to oblige parties to make use of a heating grid by means of a municipal heating plan, but if the developer has an alternative that performed as well as connecting to this grid, they could not be obliged to connect. This change in regulations was to be commenced somewhere April 2012 or 2013, so we used the APV even before this date to enact the old rule, which is that we can oblige them to connect to the grid in these areas.

And the negotiation with Nuon, Alliander and ARN, how did this go?

The success of this project is that we said to each other: we want an integral business case, with as much as possible transparency, so we can see who is earning how much. Also, everyone has to capture value and preferably also the consumer. So you go and start: the ARN, what do they ask for their heat? Nuon did not want the backbone because its rate of return is too low. Alliander wanted to be active in heating, so they wanted to participate. Nuon was already active (we looked at other energy companies but that is not very logical) with infrastructure in the areas. However, Nuon did not want to open their business case, so we as municipality simulated their business case. Surprisingly enough, it did not deviate that much from the business case from Nuon, so they agreed on that business case. So Alliander about 5 % rate of return, Nuon somewhat higher, ARN a certain amount per GJ. Unfortunately, for the consumer nothing was left, but they are protected through the Heat Act. However, down the line there still was a deficit in the integral business case. So the 5 million euro's I claimed during coalition negotiation (by now 3.8 M because of crisis etc) had to be put in, together with a loan from the Province. Now the integral business case could be closed. So then, I could go to the City Council.

Can you explain about the loan from the Province?

Alliander needed additional funding to get a go, so the Province supplied a subordinated loan of several million euros for Indigo BV. Alliander also wanted involvement of the municipality into the PPP Indigo BV for the backbone. It was alright for them if the municipality only symbolically participated, so just 5 % of the shares. Purely for involvement purposes.

And also this created so much trouble from the municipal financial department, but I dealt with it.

OK clear, so now you could go to the city council..

Yes, I was happy I could say that the Heat Act will protect the consumers. Even more, when gas prices rise (and the price back then was rising) and Nuon is making too much money, the heat price cannot go up any longer even while gas prices are still rising (due to the rate of return monitor from the Heat Act), being in favour of the consumers. Still, I wanted a majority in the Council, so I approached the alderman of the SP. He lives in the Waalsprong, is on the heating grid temporarily heated by gas. I went there informally, beer on the table. He had all these standard issues: monopoly, no freedom of choice, giving the big capital all the opportunities etc. So I said, let's take a look at your bill from Nuon. Then we saw he also gets electricity from Nuon, even though he has the freedom for other energy companies. He did not have an argument (all smiles). I also used this later on in a debate. VVD was in the end in favour of the grid, so I had the majority.

In the end, I really convinced the City Council (to grant the 3.8 million in this heating grid) with a certain study that was made for us. This study gave an overview of what CO2 emission reduction could be achieved with what kind of intervention, provided by that 3.8 M subsidy. This

heating grid was by far the most cost-effective intervention with those 3.8 M, because this is a multiplier from 3.8 M to 100 M (20M Indigo BV, 80M Nuon) and reduced by far the most CO2 emissions. So that was a very clear picture. Then it was accepted by the City Council and I got a ticket to the sauna from GroenLinks.

A few specific questions that may have remained unanswered: to what extent was national policy of help for the development of this project?

I could say that the consumer is protected against monopoly position from Nuon. People now are critical of this Heat Act, which is understandable because it is strange you refer a price to something that you want to get rid of.

How is this project perceived by the community?

People are not that interested. People do not talk about gas or heat, considering sustainable energy it always concerns wind and solar. So no negative, but also no positive reactions.

With who are you collaborating with and why?

A lot has been talked about already.

Once in two weeks I had talk with my civil servants. Also, regularly we had a meeting with the steering committee with ARN, Alliander, Nuon. This was important. Also, the director of ARN was of great help. Henk Dekker from Nuon was also very driven, he really wanted to get this done. Contract Alliander Indigo. Concession deal.

In hind sight, we would have wanted everything in public ownership. That is so because if we want to establish a regional grid with Arnhem and expand to the inner city, we have a part of the pipe that is in ownership of Nuon. That complicate things.

Were there certain barriers we missed?

Not really I think… Department of finance that were reluctant. Developers who did not want to cooperate. Many parties, complex.

Other things that were said

Some things will have to happen if you want district heating to be a success. (1) On the one hand, costs have to go down. That is possible by socialising the heating grids, like the gas and electricity grids. These grids are funded by the government on a national scale, while district heating has to be paid locally by private funding. You then need to have a higher rate of return than when it is a 'nutsvoorziening'. (2) On the other hand, the reference of the costs need to go up. That is, the gas price needs to increase. The third (3) is that municipalities need to have the right, or the obligation, to come up with heat transition plans. Gas has to be phased out and we believe this will be possible for 2035. Government does not yet want to say this publicly, although the phasing out of gas has been announced.

So that means a huge operation for municipalities. So in Nijmegen for instance, you go and look where there are heat sources, such as the ARN, and which parts of the city can be heated with that source. Then, you have all-electric, so building scale solutions. And then, when these two are inappropriate, you have bio-gas. This is mostly for inner-cities. So, then you could say to the people in existing neighbourhoods: in ten years (for instance) the gas infrastructure will not be replaced so you have to come with a solution. Now, we have an offer of this district heating, with this and that propositions, but you can also do something else. Probably, with all those expensive and complex building scale solutions, people will choose the heating district. Much easier and cheaper.

This is only possible when the price is lower than gas. So the gas price has to increase. This then has to be compensated for people living in social housing for instance, but that is than a case for income politics.

People tend to forget the benefits of heating grids, it is not sexy. When people, even Counsil Members, are talking about sustainable energy in Nijmegen, they talk about Wind, Solar etc. But they forget to mention the biggest of them all, the heating grid. Since employment of the heating grid, we saw a 15 % decrease of gas consumption in our city. Give me a city that has the same figure.

Interview 6: business development manager Nuon - 05-04-2016

Business development manager at Nuon. A background in finance, then specialised in marketing and communication, then business development.

What is your profession and role at Nuon?

My role as business development manager is to develop area based district heating with all necessary parties. Then, when the business case is closed, a business manager takes the project over. His role within Nuon is then to improve the initial business case as set by the business development manager. Next, an account manager looks for new customers that can be connected to the grid. We call this 'densification'.

When did Nuon got involved in this project?

Nuon is active in this region for about 25/30 years. We have been using the waste heat from AVR in Duiven (just east of Arnhem) for a heating grid in Duiven and Westervoort. In 2000 people started talking about a collective heating grid in Nijmegen. Back then, certain new neighbourhoods in Lent and Oosterhout were already connected to a local heating grid with a temporal heat source (central gas boilers), with the idea that in the near future these areas would be connected to a large heating grid of Nijmegen. So here was no gas infrastructure placed. This then did not go through, because the municipality wanted something different, a hybrid heating grid. This means low-temperature with heat pumps at the individual buildings. We did not want to work with that technology. Financial-economical this was not attractive for us. This was about 2010. In the end the municipality could not find any party to work with this hybrid heating grid so they accepted a medium temperature heating grid from Nuon. Then in 2012 it all went very quickly.

In the end, it is all about collaboration. These days that is the magic word. We said, it is important that the municipality will participate in some kind of way. When they are participating, they are committed and have the responsibility and bear a risk to establish a successful project. Otherwise it will be like that the risk and responsibility is all for Nuon. Of course, they cannot participate in a commercial manner, but they can participate by subsidising the 'onrendabele top' (could be translated as 'inevitable losses' or 'unprofitable top') or subsidiary loans. So in the end they did just that, form the PPP Indigo BV with Alliander with a low amount of risk for the municipality. In the end, that is why the business case came round. The time of the full investment for Indigo is right at the beginning of the project, while we only invest in a particular part of the heating grid when the urban development is expended. So our investment course is more in line with the expansion of the project. This improves our rate of return.

Why did you refuse the hybrid heating grid?

We do not believe is that technology. The idea is to use free waste heat from 45 degrees Celsius. So we still need to place heat pumps and the buildings. Also, the lower the temperature, the wider the pipes needs to be. That increases the costs significantly. It is not a proven technology. We as Nuon have the obligation to guarantee the heat delivery, so using an unproven technology is our risk. That is also our business.

How is the value capture of Nuon arranged?

Our revenue model is that we buy heat from a heat source, in this case ARN. We agree to a certain fixed purchase price per year (connected to the gas price). Then we have to pay a carrier fee to Indigo BV which is connected to the building program of the urban development. That is unique of this model, because normally we base this on the amount of Giga Joules. That is also the way it goes with electricity: one part is fixed charge, one part is fixed variable costs. With Indigo, we have no fixed variable costs, we settle for amount of dwellings connected. Bottom-line is that Indigo also bears the risk of filling the heating grid with future customers. This was our demand in the negotiations. Lastly, we ask a

connection fee, a fixed charge and a variable cost related to the consumed GJ heat. For the consumer, the last two, the price is regulated till 100 GJ consumers.
Also this first district heating project, the connection of ARN to Waalsprong and Waalfront, has to be a business case on its own. The business case should not be dependent of establishing a whole city grid.

Are the real estate developers not responsible for a lacking building program?
No, if there is not demand, they do not build. Of course we agreed to a certain building program planning, but they are not responsible for this planning. This risk is fully for Nuon and Indigo. The municipality can however steer real estate developers to develop only at this particular area. So when developers want to develop dwellings at a certain area, the municipality can say: no, first build dwellings at the Waalsprong and Waalfront. That is also why is it good to have the municipality participating in this project.

You have some companies and schools connected to the grid. Do you notice something from the fact that their price is not regulated?
We have fixed tariffs for large consumers, that follow the same line of reasoning as gas prices. So the higher the consumption, the lower the price per GJ. For every region in the Netherlands we have established tariffs for large-scale consumers. The rate of tariffs is among others based on the yield of the heat producer.

What is the contribution of Nuon to this project with regards to resources and activities?
We have the secondary transport network, that comes from the transport pipe from Indigo. This transports heat from the Indigo pipe to the neighbourhood, and then we have the distribution network, distributing the heat from heat from the secondary network into the buildings. Within the building we provide a delivery set with a heat meter to register the heat usage. Then we have at strategic positions a backup gas boiler in case of malfunctions or extreme low temperatures. A HPC. We do not want to use this HPC, because gas is more expensive than the waste heat.

Value delivery, the relation and communication with the customer, is that important?
We are doing intensive research into thing like Customer Satisfaction Index (CSI) and Promotor Score (aanbeveling). For both B2B and B2C customers. We have reports enough, but you clearly see two important aspects. The first is cost perception. The customer that thinks he is paying too much. Second one is no freedom of choice, the monopoly position, so people can only choose semi sustainable heat. So most of all, the pricing and monopoly position are an issue. When we ask people about their heat, they say they like the service and no maintenance, but they have the idea they are paying too much. And they want to have the option to switch. However, this is about the incumbent customers. We also research new customers, so what are their drivers to switch to heat? Then we get the same things. They ask, is it cheaper? If it's cheaper than they no longer think the monopoly position is an issue. So when it's cheaper, freedom of choice is no longer a negative driver. Next they say, I want a different heat source, I want a more sustainable source. Well, in theory this could be possible, but would cost more. Some companies agree to that for their CO2 footprint, some not. So this is our struggle. So when we create a open heating grid, this could all be possible. That is our aim in Nijmegen-Arnhem.

What are the most important factors that resulted in a viable business case?
The fact that our investment is close to the revenues, so the investments going in line with the amount of dwellings connected to the grid. Also, that Indigo was able to get subsidies from the Green Deal, the loan from the Province, municipality subsidy and the rest from Alliander. Also, the carrier fee construction (variable costs based on building program) was important. This all combined made it acceptable for Nuon to

commit to the obligation to invest 85 million euro's over time.

What about demand certainty, how is that arranged?

Through the concession, all buildings are to be connected to the heating district. But we also have the heat source certainty to deal with. If ARN has no waste anymore, due to for instance a zero-waste economy, we have no heat source anymore. So we think of scenario's that ARN detaches from the grid and use the gas boilers as heat source. So for instance, how will the business case look like when ARN drops out around 2022? Or, what if we invest in a geothermal heat source? All these scenarios in addition to the base case are taken into account, otherwise I will never get approval of an invest of 8 M euro.

What about transparency and the relation with the customer?

Let's take our account manager. He goes to a potential large-scale customer (that is currently located near the heating grid) and asks what they pay for their gas system. We have to refer to that price and think about how that price is formed based on the NMTA principle. This is very difficult to explain. We are trying. With incumbent customers we have to explain how our price is indeed no more than otherwise. So we provide them the same reports as we provide the ACM. With companies, it is the trick of the account manager to refer to other projects, other references, the companies their costs and explain our proposition. So we are very on top of things in that regard. We try to be very transparent, but the reference system is hard to explain.

Have you seen some issues regarding different sectors that have to work together?

Well, from the NEN-norms you have the EPC and EMG norms. So the developers have to see how to meets these norms. So we have a lot of contact with developers regarding the added value for space heating, how this effects the energy labelling, the price for consumers. So I have to be able to speak the builder's language. In the end I have to convince the builder to use the heating grid. However, the building only looks at building scale, we look at the area scale.

Now, with regard to a level playing field, we think heat is not sufficiently taken into account in the valuation of an area intervention that also has effect on the building scale. So the buildings can get the same sustainability results with lower costs, but this is not well taken into account. We are currently talking about this with national policy makers. This is also a political issue, so on our lobby strategy we are looking with different ministries 'how do you valuate area based interventions on the building level'?

Can you point out the most important agreements for this project?

Of course, we have the current collaboration form that leads to all these agreements between Indigo, AVR etc. But also very important is the Letter of Intent we agreed to with the municipalities Arnhem and Nijmegen, the Province, Alliander and Nuon. Here we agreed to establish a heating grid with a dwelling equivalent of 90000 in total. Eventually, you do not collaborate just to collaborate. We think, from Nuon, that we can contribute to the sustainable ambitions of municipalities and Provinces, on a commercial basis. Alliander has a societal role in the energy transition from gas to heat. Municipalities and Provinces have their goals, so finally you have a fit. So everyone has their role and this is then the collaboration form you need. This is not only important at the start of the project, but also during the project.

Also, participation in finance is important. Can you also participate by jointly financing?

What have you agreed with ARN?

We agreed to purchase 45 MW per year, for a certain price with an assurance of delivery of that 45 MW per year. We do not want them to produce steam and electricity because that is cheaper at that moment while we are in short of heat. We started with 30 MW, this is now increased to 45 MW. Also, we are looking for other heat sources as well.

And what about the 'trading of concession'?

We have a concession for 12.000 dwellings in the Waalsprong and Waalfront. We have agreed that when in the city a new concession is given to us, say 500 dwellings, this will result in that for 500 dwellings of those initial 12000 concessions, a certain degree of freedom is provided. So here there is then no connection obligation anymore, but a 'heat unless' policy if you will. You then may apply another means of heating, as

long as you perform as well as the district heating in terms of CO2 emission.

And what about agreements with the real estate developers?

The GEM needs to meet the building regulations. We have agreed to a heat connection obligation. This was mostly the role of the municipality, to get the developers and housing associations on board in connecting to this heating grid. The required a lot of convincing from the Alderman Jan van der Meer to the developers, but also to the Council Members, because they are also very limitedly informed and biased by the negative image of district heating.

To Nuon the real estate developers ask about the customer satisfaction, so we had to convince them about customer protection through the Heat Act etc.

Other important agreements?

In the end, this first project is just the prologue. The future is really about the connection to Arnhem, the inner-city of Nijmegen etc.

If you look at this market model, this one is unique in the heating world. Open network, combination of a utility company and a traditional energy company, participation by the municipality. And it is already operational, it not a theoretical model anymore. We proposed to the ministry to apply this market model as much as possible at the places where this is possible, so a place where there is no heat infrastructure yet: a project from scratch. In Arnhem we have the situation that a heat infrastructure from Nuon is already there, but not with this open system. But this is another question, also very difficult. But in the end, this project in Nijmegen is just the prologue.

What also was spoken of

For heating and cooling districts Nuon especially focusses on the regions Arnhem-Nijmegen, Amsterdam and Leiden-Rotterdam. They have several smaller heating districts, but their main focus is on expending these three regions.

New urban development or demolish and then newly built buildings are the only moments when a municipality can have a lot of influence through providing the building permit with certain conditions, in this case that no gas infrastructure is allowed and a heating grid is to be used.

ARN burns waste for the production of electricity. They also want to utilise their waste as efficient as possible, so adding the production of waste heat is a good opportunity. For instance, now, the electricity price is low. However, the price of heat is as of now connected with price of gas, so sometimes it will be beneficial for them to produce heat instead of electricity.

Existing stock is now the main challenge. Why would a customer want to change to heat? Gas is already there. Until it is said gas will be phased out, not much will happen.

We have now about 3 or 4000 dwellings equivalents connected.

Interview 7: project leader municipality Nijmegen - 07-04-2016

Projectleader DH grid Nijmegen, advisor Energy

When did you got involved in this project?

Two years ago in 2014, so this was in the contract management phase. Before that I was, and still am, active in Soil and Energy, so mostly the Seasonal Thermal Storage Systems (STSS).

Can you describe the process of initiation of this project?

In Nijmegen, people have been talking for 12 years about heat. And we had the opportunity to developed a whole new neighbourhood at the Waalsprong. We bought this land from the former municipality Elst, so we as municipality were enlarged at that time. This was about 2002. This was the opportunity for us to see if the urban development could be more sustainable. Studies showed that a hybrid heating grid would be the most sustainable energy system, so a little part of the Waalsprong got this hybrid network. This were about 260 dwellings, in the little neighbourhood Laaweek. These dwellings all have floor heating, heat pumps and get low-temperature water. The disadvantage is that a larger amount of water has to be pumped round, so with regard to the business case, it is not profitable to pump that large amount of water from ARN

to the Waalsprong. So we finally decided that a normal heating grid will have to suffice. Still, Nuon did not want to invest in this transportation pipe from ARN to the Waalsprong, so you know it is not profitable. But still, we wanted that heating grid. In the end it was made possible due to subsidies from us, a subsidiary loan from the Province and investment from Alliander. These transportation pipes are simply very expensive and is unprofitable business. So our philosophy is first the net, then a profitable net, then a sustainable net. This is often the biggest critique: 'it is not sustainable enough'. Especially using waste heat from waste incinerators, in The Hague people think heat from them is not waste heat.

So you hear consumers speak of this?

No, there are mostly talking about the prices. We had this situation, it had gotten in the newspaper, that one neighbour with gas from an old house compared prices with his neighbour in a newly built house with heat from the grid. They found out that the prices did not differ that much, but the one in the newly built dwelling said that if he lived in a new, more energy efficient dwelling, then why is the price still the same and not lower? But we do not get complaints from people that they really want to change to gas.

As a municipality you have to tune district heating with STSS, because where a heating grid is planned, you do not want companies to place STSS's. Because then you have a conflict. From a higher abstraction level, you still need both because we want more STSS's and a bigger heating grid to reach energy neutrality. Sometimes, this can go 'wrong'. An example is the Van der Valk Hotel in Lent. We used an instrument that in every land issue in this area, it has a clause that no gas is to be used, only heat from the thermal grid. That was since July 2012, so every issued land from this date has this clause. For the hotel, the land for this development was issued just before this new clause. So they thought they would be more sustainable with a STSS and did not think the offer from Nuon was worthwhile. So they meet the requirements of thermal energy, but are not connected to the grid. For sustainable purposes this is not a problem, but for the heating grid to become profitable you need these customers, so the people from the heating grid were not happy.

Other companies however are connected to the grid, and now everybody knows of the heating grid and that there is no choice.

Currently we are looking at the possibilities to extend the grid to the inner city and the area around central station. Around the central station many buildings will be demolished and rebuild, so we are looking with Nuon to extend the grid to these areas. Therefore, we are making a heating plan. Building regulations say that when the City Council agrees with this heating plan, we can zone areas in the city with the 'unless principle: the obligation to connect to a heating grid unless you can implement a system with the same CO2 reduction performance. This is not the case in Waalsprong and Waalfront, this new regulation only came into being in 2012.

With this change in building regulation the role of the municipality changed considerably. We now really have to visit companies and talk about sustainability, say that we advocate the expansion of the heating grid because this reduces CO2 on a city level as well. But there are also other possibilities for them. The role changes because now we really have to go to the companies and convince them about the heating grid. Whereas in Waalsprong and Waalfront, they are simply obliged to connect. So now, this also creates a sort of common spirit, sort of 'do you want to join'?

This heating plan is being made at this moment by CE Delft. The difficulty here is that there is a lot of freedom in making a heat plan and not many examples of other heat plans in the Netherlands. There is just one heat plan with this 'unless policy' that is agreed by the City Council and that is in Purmerend. So it is totally new grounds. The world of heat is sometimes called the cowboy-land.

Can you name reasons as to why the Province was crucial to this project?

Finance of course. And they also have an obligation to the national government to meet certain sustainable goals. That is why they support this project that intensively. They support the project financially, but also they helped form the letter of intent with the municipalities Nijmegen and Arnhem, Alliander and ARN to at least connect 90.000 dwelling equivalents. With that they support and promote the expansion of the heating grid. This Letter of Intent asks a certain work responsibility as well. There is a management board that meet once in four months, in which the Province is included as well. Then there is steering group that set goals and then there are working groups to realise these goals. Well, in practice this is quite difficult, because all those parties have assigned a person to work in the groups, but we do not meet that often,

we do not share a working place etc. So collaborating with each other is difficult. The goals set by the steering group are not clear enough and the working groups are managed inadequately to foster a fruitful collaboration. Of course, good things come from this collaboration, but it could be much better.

I have the idea that in Amsterdam, they have a program bureau with actual decisiveness to execute that program. We do not have that. For instance, the working group 'demand' is actually standing still, while the working group 'supply' has been able to do a lot. Every party has the responsibility for one of these workings groups. It requires a lot of hours from the employees, that is difficult.

So this Letter of Intent should be made otherwise?

No, but the execution of the agreement should be done otherwise, we are working on that.

We have already talked about costs and freedom of choice…

Bottleneck for expending the net is the step towards an open net. ARN now delivers to Nuon, Nuon to customers. But it will happen that the heat from ARN is not enough anymore. So we will need more heat. Now Engie is building a biomass plant and would like to deliver heat, but not in the same way as ARN. Engie wants to deliver directly to the customer, because they are an energy company. We are now talking about this, how to establish that. An idea is to form a new (public) company, is independent and non-profit. This company will be from Alliander, to which Nuon and Engie will both deliver their heat. And they will then pay money to make use of the net. The problem in Arnhem is that the whole net is from Nuon, so they are a monopolist. In that way, you do not create an open net. In Nijmegen, the primary net is from Alliander, that is better for an open net. People can then choose between e.g. a biomass plant or a waste incinerator. That is then the only freedom of choice people will have in practice.

Were there technical lessons to learn?

Yes, so the hybrid, low-temperature grid is more sustainable, but financially not really possible. With regard to technology, a lot has to be done with the existing stock. That is still as of now unprofitable. Because e.g. the gas boiler in a dwelling is on the top floor, so you have to replace that with a heat meter which is undesirable. Or adapt the whole heating system, which is also undesirable. So here a lot has to happen still.

Were their tuning or alignment issues regarding different sectors that had to collaborate?

You see that in the existing stock, companies have their own little CHP plants. Now there are companies with the permit to use that plant until 2019. So at 2019 they will have new financial assignment. Will they renew that whole system, or connect to the heating grid? However, the pipe is not yet there. Her indeed there is a tuning problem. The companies want to connect to the grid in 2019 because that is cheaper than other alternatives. For us then the assignment to have a heating pipe near that company at about 2019. If we do not succeed in that, then the companies will ask for temporary systems until the heating grid can be attached to their building. So here there are some tuning issues. So the bottleneck is namely a timing issue. E.g. student housing, they will only connect to the grid when their gas boilers are at the end of the technical lifespan. That is why: first a heating net, then a profitable net.

What also was discussed

One of big parties was the ARN. They are of course also looking at how they can optimise their operational management. Heat in that regard is a very interesting option, because when they produce electricity and heat, they lose only a tiny bit of electricity production in comparison with when they would only produce electricity. So for them it is financially speaking very interesting to produce heat. They still have to invest in certain technical measures, but this was a profitable investment.

The risk of the construction of the pipe under the Waal was covered by the Province. So if the first drilling would fail, the Province would pay for the second drilling.

Appendix 7: Interviews Case Westpoortwarmte Amsterdam

Interview 8: Project leader AEB – 11 April 2016

8 years busy with the heating grid in Amsterdam. First as civil servant from Amsterdam, later from AEB. Currently project leader AEB/WPW district heating network.

Education in urban planning, several civil servant jobs at municipality Amsterdam. Since 2008 involved in expanding the Amsterdam heating grid from AEB, that went together with the privatization of AEB.

Besides this Board member of the foundation Warmtenetwerk.

How did the WPW grid came to be?

Almere, East and South was in 1990's. Then, late 1990's, the then director of AEB (then still municipal energy company) said: hey, that trick they did, I want that as well. So he formed Westpoort Warmte (WPW).

Did that really happen so easily?

He though like, I have a high-end, innovative waste plant. And our waste heat just goes down the drain. So together with Nuon, back then still RWE, he proposed to start a Partnership to provide heat to the companies surrounding the AEB (area Westpoort). He said, I do not want to be involved with customers or pipes, I just want to deliver that heat. So they formed the PPP WPW on 50/50 basis on 1 January 2000. So the municipality and Nuon invests for 50 %, but Nuon does most of the work apart from heat producing. AEB gets money for the heat they produce, bought by WPW. But WPW owned the whole network, except for the heat sources. Lawfully, you could say that AEB is another party, but because we are for 50% in WPW, you could say this is a closed heating grid. Because production, transport and distribution is integrated under WPW. Because of the monopolistic character of the network, we have agreed with the municipally Amsterdam to seek new other parties for both heat production (TPA1) and heat delivery (TPA2). In Nieuw-West we have that, we have a biomass source from the sewage water cleaning facility to burn biogas. AEB burns that gas in a small CHP. So this is 100 % sustainable heat that goes into the heating grid. It is about 3/4 MW while AEB in total is about 150 MW. We also have Orgaworld, they produce bio-based heat to the network as well. So actually, we are an open network. Currently we are talking with a new biomass plant that produces 20 MW. When they connect, we reduce CO2 emission for 80 % to conventional gas-boilers at dwellings. While the gas-fired CHP plant in Diemen has about 50 % CO2 reduction.

In Nijmegen there is quite a complex financial arrangement. Here it simply is 50/50. How so?

First, this was 15 years ago. There was much more money available in the energy sector. However, also, Nuon says to me that when they had to invest in the transport pipe in Nijmegen as well, they would have done that as well.

Who is collaborating with who?

So for WPW it started in Westpoort. Then in 2002 the municipality and all the housing associations had the ambition to become sustainable. This concerned about 80.000 dwellings. How can we do this smart and cheap? So in Nieuw West the connection of new and existing neighbourhoods to the heating grid was tendered for about 30.000 dwellings. All the HA's were united in a consortium, to partly newly develop and renovate Amsterdam Nieuw-West. This consortium tendered the assignment to connect the whole neighbourhood on the heating grid, based on a certain building program. Municipality was also involved to provide the necessary permits etc. Essent did an offer, but they could not get the business case. They could only get it done when AEB would provide heat for free. AEB could not agree. So then, the then director AEB said, why not so it ourselves. So they came to a deal between the municipality, WPW and the HA's. They came to an agreement about building program, which buildings to be connected and prices. So I always talk about the triangle municipality (they have to provide the connection obligation once the parties all agree), the HA's (they have to agree to the connection costs) and WPW needs a business case with certain guar-

antees for the filling of customers with regard to the building program to be connected to the heating grid. So everybody happy. So WPW has invested in the network and now all the revenues are coming in thanks to the connected buildings.

3 years later, in 2008, a new contract for Amsterdam Noord was signed. Here the municipality also enacted a connection obligation, but here it is applicable for the whole area. So when other developers want to develop a building, they have to connect to the grid. So in Westpoort the companies were tempted to connect with a good price, which is often possible with non-residential. In Nieuw-west it is agreed that everything has to be connected to the grid. By now we have learned that there should always be the possibly for exceptions. So in Noord the first 5 years, 5 % of all buildings have the freedom to not connect to the district heating, then about 15 %. So in total, 10 % of the developed buildings has the freedom to implement another energy system, but it has to meet the same CO2 reduction as the heating grid.

Business case wise, was it not a problem to invest in the whole system?

This was in 2000 and 2008, before the financial crisis. The demand risk that goes with the uncertainty from the building program of the urban development is ours.

In Nijmegen it is in the municipalities interest that heat demand increases because of the carrier fee…

In Amsterdam not, only that they are for 50 % in WPW so the dividend will come later when the heat demand decreases. But that is too indirect, the civil servant working on the project will not notice this. In Amsterdam it is totally different. We connect 6 to 7000 new dwellings per year to our grid.

Looking at how a heating grid came to be, stand-alone, that is interesting...

I think, but this is really a personal opinion, that the WPW grid came into being because two directors (AEB and Nuon) thought this a good idea and because they connected on a personal level. Very simple, but you need to enjoy building something new with each other and you need to be able to trust each other. They though, we are going to fix this, the one has good contacts in Amsterdam politics, the other at Nuon. Of course, you can make frameworks such as gasless areas etc, but when there is nothing, it all depends of these kind of people. People at the top, backing the rest up, keeping everybody going. That is about pioneering. But this is the soft side, and the hard side needs to be filled in.

So you see that e.g. tax on gas has been raised, and probably this will rise again.

What also was discussed

It is important that when you look at policy, the municipality, the province and EU have acknowledged the phasing out of gas for many years. Now finally, since last year the national government also acknowledged this, among other thanks to Groningen and the trouble with Poetin. I see that where I 6 years ago were very reluctant to publicly tell about a gasless city, this now seems to be logical to the people. So now, suppose gas will be gone in 2035, situation arise that HA's now have to think about how to replace their energy systems. Because a new gas-boiler also has a business case of about 15-18 years.

Now we are busy with a neighbourhood in Nieuw-West, the Deysselbuurt, 1200 dwelling. Large retrofit by one party. And they say, we are either the last gas neighbourhood, or the first district heating neighbourhood. He also wants district heating (DH), but the renovation continues either way. So we are going into this process of getting all the parties to agree with getting rid of the gas and replace to DH. The HA's will probably choose good isolation and the rest supply with sustainable heat. In that way they meet the sustainable requirements.

We burn 1.5 million tons of waste. We produce about 1 billion kWh. That is about 20/25 % of total Amsterdam energy demand. Because we burn waste, you can say 55 % is green. So we are a huge biomass plant for half.

Socialising

For instance, we will build a transport pipe for 40.000 dwellings. This will not be paid by us, but by the gas utilities, so everyone in Holland will pay about 2 euros to be able to build that transport pipe. The Heat Act has nothing about this. The Heat Act for now it only about customer protection, not about how the market is arranged.

Amsterdam region

Amsterdam has some dispersed small gas-fired CHP networks because at their development the gas price was very low and the electricity production quite attractive. So you could produce well priced electricity and heat with a low price gas. The idea of course is to connect these in time to the city grid.

Amsterdam Noord will be about 4000 dwellings for now. Ambition is 20.000 dwellings once the pipe is there. Whole Noord can be about 40.000 extra. Nieuw-West is connected already.

Hemweg is a coal plant of about 20/25 years old. Also there a new gas plant, but not often used because gas price is low, electricity price is high. Producing heat and elek. from gas costs money at the moment. For AEB as well, but less because we have a paid resource. They have to pay for gas, we get money for our resource. 60/70 euro per 1000 kg waste. So our business case is mostly waste incineration and an added value is selling electricity and heat.

Almere is about 60000 dwelling on the grid. Source is gas-fired Diemen plant. Diemen are two plants, one from the 1990's, one from …

With the 1990's Diemen plant the regional grid all started. Municipal energy company started with the district heating from this Diemen plant, because the Province North-Holland demanded that if Amsterdam would want to build a new power plant, this has to be a CHP-plant. So started a heating grid in Zuid-Oost, under direction of the municipal energy company. The privatization of the municipal energy company was enacted 20 years ago.

We do not say to be the most sustainable energy system, but we do connect whole areas instead of single buildings. And then in the future, when we replace our current heat sources with fully sustainable sources such as geothermal and biomass, then we can still provide 100 % renewable energy. So that is the collective benefit.

A large benefit of Amsterdam is that the heating grid is built together with new urban developments with some exceptions such as large flats with central gas-boilers. With the existing stock these buildings are the way to go: simply replace the central bas-boiler that is placed at the basement, put in a heat exchanger and nobody notices anything. These buildings are mostly in the hands of the 'corporation of owners' (VvE). So there is a contract with the VvE. With that kind of buildings, we can always compete with the gas alternatives. The big issue in existing stock are the individual gas-boilers. If you look at Amsterdam: In whole Amsterdam we calculated that 230.000 DE could be connected. For this we excluded individual gas-boilers and ground-dwellings. So only flats, building blocks with central gas-boilers, non-residential and newly-built.

The municipality said 2 years ago that we want a gasless city. So we also need a solution for the rest. AEB is now negotiating with the municipality for a big deal: AEB will do it all, connect ALL buildings to the existing heating grid in the areas Noord, Westpoort and Nieuw-West. So you have your existing heating grid, then you expend this with many thousands existing stock customers. So we only have to connect new customers from there. Heat sources and the net is already there. So we are talking about a deal of about one billion euro's in 20 years' time. So again that important triangle. Municipality wants to be sustainable, so they will oblige a gasless city. AEB wants to deliver profitable heat and the HA's wants to provide heat in their building stock. So they pay a connection fee. And the customer gets 10 % discount.

In Nieuw West it was agreed that the HA's would pay a bit higher connection fee than normal, so the customer could get a discount of 10 % discount. In the end, because in some places the heating costs for customers was above or below the price from the Heat Act, it was agreed that for whole Amsterdam the price would be 5 % lower than the Heat Act.

Was that communicated well?

We communicate that very well, but they will always think it is too expensive. They will always say, you are a monopolist so you will be too expensive. The image is simply bad. We are working on that, that is why we are a bit below the ACM price.

In the end, when we become gasless, there are three choices for the real estate owners. District heating, all-electric or green gas. This is to be determined on area scale. We have about 400 areas or neighbourhoods in Amsterdam. Inner city will probably be biogas, then everything around the inner city district heating, then the outer parts maybe also all-electric.

So in Noord, in 2008, the contract was signed for 20.000 newly-built dwellings. We are now
talking with the municipality about an expansion for existing stock. The municipality then has to establish an area energy vision with the people, based on those three options. Once that is made for 20 years to come, they can then say, gas will disappear. So people will know, in 10 years there will not be gas, so I will not buy a new gas boiler. Some people can then say, we will connect in e.g. 8 years. Or not, with the chance that it will become more expensive.

Interview 9: Project leader municipality Amsterdam – 21 April 2016

Nu niet meer actief in het project. Samengewerkt met Projectleider AEB. Projectleider (PL) vanaf 2005 tot en met 2013 vanuit gemeente Amsterdam. Achtergrond in bestuurskunde. Wethouder assistent van Volkshuisvesting en Ruimtelijke ordening geweest. Bij bureau woningbouwregie gewerkt vanaf 2002. December 2005 als PL stadswarmte aan de slag gegaan. Gaf aan dat hij dus eerst in een typische bouwwereld zat, en dit een leuke switch was.

Ik heb altijd geconcentreerd op de nut en noodzaak discussie van stadswarmte, waarom willen we stadswarmte. En het organiseren van het collectief; stadswarmte valt of staat bij de organisatie van het collectief, als het collectief sterk is dan lukt het meestal wel, zo niet dan gaat iedereen naar elkaar kijken en gebeurd er niks. Ik deed vaak van die pitches: 'waar is stadswarmte succesvol? In landen waar het koud is, en socialistische landen want daar is de overheid sterk'. En die twee dingen zorgen dat stadswarmte succesvol wordt.

Direct bij mijn aanstelling werd duidelijk dat één van de grootste problemen bij warmtenetten is het collectiviteit organiseren. Hoe doe je dat? Ik had een best groot netwerk via mijn werk als wethouder assistent, en één van de raadsleden was bezig met de motie 'warmte-tenzij'. Ik heb diegene toen erg geholpen met het laten aannemen van die motie. Motie was toen aangenomen, en dat was heel belangrijk. Dat geeft namelijk de ambtenaar de mogelijkheid actief te worden. Dit gaf mij de ruimte hier mee aan de slag te gaan. [hij was erg actief aan het lobbyen voor zijn positie, hield presentaties voor bestuurders en hield bestuurlijke besluiten bij die zijn positie onderbouwen]

Je had al stadswarmte in stadsdeel Nieuw-West. Hoe is dat gegaan? Dat was de eerste keer dat Nuon daar optrad. Het bekende verhaal met de tender en Essent. Toen zijn AEB en Nuon gaan onderhandelen met open boeken, dat was heel interessant. Toen zijn er allerlei kostenposten geschrapt. Bijvoorbeeld de post van Nuon 'gederfde gasinkomsten'. Dat accepteerde AEB niet. Zo waren er nog wel meer dingen. Het grote verhaal is dat de partijen vertrouwen in elkaar begonnen te krijgen waardoor een deal tot stand is kunnen komen.

Toen kwam de vraag, gaan we in Noord precies hetzelfde doen? De vraag werd of we het moeten aanbesteden. Dat was niet helemaal duidelijk. Uiteindelijk wilden we het niet en kunnen de juristen het wel zo rondkrijgen dat we niet hoeven aan te besteden. Uiteindelijk was het argument dat privae partijen (de corporaties en WPW) het initiatief namen stadswarmte te implementeren, dus hoef je niet aan te besteden.

Jannis en jij zorgden vanaf 2006 voor het politiek draagvlak. Hoe was dat voor jullie geregeld?

Ik weet dat de cases Parkstad maar 1 of 2 keer in de politiek is geweest, bij investeringsbesluiten. Dan heb je dus een wethouder die er gewoon mee akkoord gaat en klaar. Maar je kan er ook eindeloos lang over praten. Wat wij merkten, omdat het project groter werd, er meer behoefte aan een structuur was. Dat hebben wij dus gedaan.

Wilde je nog verder gaan in je verhaal?

Het is dus ook gewoon een beetje ijdelheid van Jannis en mij om een dergelijk project te realiseren. Die driehoek is erg belangrijk, om daar een eenheid in te krijgen.

Wat zijn lessen die je hier uit kan leren?

Lessen voor de wereld is dat de gemeente veel duidelijke bevoegdheden moet krijgen. De gemeente moet kunnen zeggen, dit is een stadswarmte gebied en daar komt dus stadswarmte. De onderhandelingen zijn namelijk te complex. Bijvoorbeeld in Noord, bij de onderhandelingen, heb je te maken met grote ontwikkelaars, maar je hebt ook kleine, nog onbekende ontwikkelaars. En hoe garandeer je nou dat er 10 of

15 duizend woningen worden aangesloten op het warmtenet? Uiteindelijk is er tussen gemeente, WPW en de paar grootste ontwikkelaars aansluiting gegarandeerd en dit is min of meer algemeen geldend verklaard. In hoeverre nieuwe ontwikkelaars, mochten zij echt niet willen aansluiten, dan toch moeten aansluiten is nog onduidelijk. Dus de gemeente moet kunnen zeggen dat bijvoorbeeld 80 % van het gebied moet worden aangesloten op stadswarmte.

Dit project was ook nooit gelukt als Amsterdam niet al het grond had, daardoor hadden ze een sterkte positie.

Er zijn een aantal inhoudelijke lessen, zoals warmte moet er zijn, die moet gegarandeerd worden etc. En dan nog een sterk overheid of collectief, zoals Jan van de Meer die alles bij elkaar heeft weten te krijgen. Dat geldt eigenlijk bij Amsterdam dus ook. Bij ons organiseerde Jannis en ik de gemeente; de WPW wilde wel, de gemeente dreigde de deur dicht te houden dus die hielden wij open. De corporatie stonden wel lauw in, sommigen enthousiast, sommige tegen. Maar die laten zich niks vertellen door de ambtenaren. Dus als de gemeente niks had gedaan dan was het waarschijnlijk ook niet gebeurd.

Jannis en ik hadden de politiek wel mee. Wel we misten de steun op directie niveau. Wij wilden graag dat directie mee ging bemoeien. Die hierarchie goed op orde krijgen is lastig. Wij hebben dus maar een eigen hierarchie in elkaar hebben gezet (en dat moet dan dus bij elk project weer?).

Wat waren de belangrijkste afspraken tussen de partijen?

Bouwtempo en bouwvolume waar het risico ligt.

Een killer, die niet heel bekend is, is de leveringsgarantie van de warmteproducent. Heel veel potentiele projecten gaan stuk op het ontbreken van een warmteproductie garantie 24/7 en 30 jaar lang.

Kosten van aansluiting.

Wat kan je gemeente nou doen voor de totstandkoming van warmtenetten?

Het lijkt er op dat het Rijk warmtenetten ook eindelijk heeft opgepakt. Wat je ook ziet is een herhaling van zetten. Het blijven toch lokale projecten die lokale partijen moeten regelen. Nu zie je bijvoorbeeld dat al die thema's waar ik mee geworsteld heb allemaal terug komen. Dat blijft eindeloos een herhaling van zetten, die op een abstract niveau allemaal hetzelfde zijn, maar steeds weer in een nieuwe casus. Principieel is er niet veel veranderd. Het is belangrijk dat de gemeente de bevoegdheid krijgt warmtegebieden te kunnen aanwijzen en regels te stellen.

Wat is de publieke opinie van dit project, hoe kijkt het publiek hiernaar?

Dat is vooral afwezig, maar de waarneming is dat er heel veel weerstand is. Dus dan heb je ambenaren die zeggen: de bevolking is tegen! En dat blijkt dan één actieclubje te zijn. En die clubjes zijn vaak wel heel fanatiek. Maar de meeste mensen interessant het volgens mij helemaal niks.

Waren er nog technische problemen?

Nooit mee bemoeid, alleen maar politiek draagvlak creëren.

Wat verder ter sprake kwam

De gemeente zit een beetje dubbel in dit project omdat ze 50 % aandeelhouder zijn van WPW, omdat ze AEB in bezit hebben. Dus ze vertegenwoordigen het publieke belang als gemeente zijnde, maar heeft ook een privaat belang via WPW. Dat is volgens de ideologie van de liberalisatie niet helemaal zuiver, maar werkt er goed.

Ik moest ook gewoon een beetje actie voeren. Je zit in een formele organisatie. Maar hiernaast is het ook gewoon heel menselijk samenwerken en daar hoort gekluns bij. Er is heel erg een vraag naar wat de formele bevoegdheden zijn van de gemeente bij een warmtenet. Dat blijkt erg erg beperkt te zijn. Aansluitplicht kan, maar dat is nog niet helemaal duidelijk. In Amsterdam heeft de gemeente in gebiedsontwikkeling een hele sterke positie omdat ze privaat eigenaar van de grond is. Partijen willen geen ruzie met de gemeente, dus als de gemeente iets eist dan wordt dat meestal geaccepteerd.

In 2008 hebben Jannis en ik de Schaalsprong stadswarmtenet geschreven voor het bestuur. De jongens van Nuon vond het een grappig kinderlijk rapport, maar dat was juist de kracht van het verhaal. De hele technische wereld en de politiek, dat mengt niet. Als je dat rapport gelezen

hebt denk je, ja, stadswarmte dat is toch logisch. Maar: eind 2005 was die motie aangenomen en november 2008 is dat rapport Schaalsprong door B&W pas aangenomen. Kost kennelijk 3 jaar tijd om alles op een rijtje te krijgen.

Zo'n aansluitplicht werkt ook de andere kant op. Het werkt ook naar de investeringscommissie van Nuon. Die kijkt naar de rentabiliteit en dus naar zekerheden. Die willen dus een juridische zekerheid dat geen nieuwe technologieën in de toekomst mogelijk zijn. Dus de aansluitplicht is niet alleen voor de ontwikkelaar, maar ook voor de energieleverancier. Het risico van een vertraagd bouwtempo is voor hen ook heel belangrijk.

Onze wethouder kon je typeren als genuanceerd meewerkend. Zijn hart lag meer bij zonnepanelen en wind. Hij was niet tegen, wel mee, maar niet trekkend zoals Jan van der Meer in Nijmegen. In Nijmegen zou ik niks te doen hebben gehad.

Wat me vaak verbaasde was dat mensen de stukken niet lezen. Dus dan hadden we een discussie, hadden ze helemaal geen kennis van zaken. Mensen blijven in hun mening hangen. Het is echt moeilijk om iets wat nieuw is …. zin stopte, Jannis kwam langs.

Interview 10: Project director Nuon – 21 April 2016

Nu operationeel directeur van WPW-net. In 1997 begonnen aan dit project als operationeel projectleider. Hij legt verantwoording af aan statutaire directie van WPW.

Hoe is dit project ontstaan?

In 1997 begonnen om te kijken of ze vanuit de AVI (Afval Verbrandings Installatie, nu AEB) warmte konden leveren aan gebied Westpoort. Met een studie begonnen, hij was toen zelf een man van plannen maken en beleid. Hij dacht, twee jaar studie doen, uit laten voeren en klaar. Maar in de loop der tijd het dossier zo leuk gaan vinden dat hij daar uitvoering aan wilde geven. NU dus nog altijd betrokken.

Terug naar 1997. Energiebedrijven begin jaren 90 allemaal losgegaan van gemeenten. Eerst kwamen hier heel veel kleine energiebedrijven uit (stuk of 50), daarna veelal samengegaan. Werden grote bedrijven zoals Nuon, Eneco, Essent etc. Die kleine energiebedrijfjes hadden een sterke band met de gemeenten, met zowel de ambtelijke organisatie als de politiek. Tarieven werden bijvoorbeeld door de Gemeenteraad bepaald. Eind jaren 90 marktwerking en liberalisatie.

Met name begin jaren 90 werden de touwtjes doorgesneden naar de gemeente. We zagen dat we in sommige projecten en processen elkaar toch wel nodig hadden. De gemeente zei soms: we hebben geen toegang meer tot energiekennis, de energiebedrijven hebben geen toegang meer tot het ambtelijk apparaat en de politiek. Voor het warmtenet hadden we inmiddels al best wat dingen voor elkaar, maar we zaten vooral met een klant-leverancier relatie te praten. We lieten niet het achterste van de tong zien. Toen kwamen we tot de conclusie dat als we zo door zouden gaan, dit zou leiden tot geen project. We is hier energiebedrijven, de AEB (toen nog volledig gemeentelijke dienst, nu zelfstandige unit in eigendom van gemeente). Toen hebben we afgesproken gezamenlijk een plan te schrijven over hoe het mogelijk lijkt om het warmtenet waar te maken. Hier kwam uit: ga niet als klant-leverancier hier in, omdat je door de kosten die je daardoor erin rekent het niet rendabel krijgt: de marge is al flinterdun. Toen zijn we het samen gaan doen. Laten we ook 50/50 participeren in het geheel, toen ontstond een joint-venture gedacht. De directeur zei tegen mij: de essentie van wat we moeten doen is dat we gaan verdienen met elkaar en niet verdienen aan elkaar. Klant-leverancier verdienen aan elkaar, met marges. Die hebben wij dus niet. We leveren diensten vanuit beide moeders tegen kostprijs, tegenwoordig kostprijs+ vanwege fiscale en jurisische zaken (een moeder mag een dochterbedrijf niet stimuleren anders heb je oneerlijke concurrentie, dus ook de diensten moeten hier marktconform zijn, vandaar kostprijs+). Maar dat principe van verdienen met elkaar en kostprijs zit er nog steeds in. Dat is de essentie van de samenwerking.

Hoe komt zoiets tot stand dan?

Dat hangt vooral op personen. Personen die iets omarmen, enthousiast zijn en verder willen brengen. Het hebben van een aantal personen die het met elkaar kunnen vinden is dan erg belangrijk. Ik heb diverse statutaire directies gehad. Sommige directeuren konden het goed vinden met elkaar, sommige was die klik er minder en dat ettert door in de organisatie. Voor mijn gevoel: vertrouwen hebben in elkaar en in de parti-

jen. Als dat er niet is, dan ga je bijvoorbeeld een ingestuurd factuur helemaal uitpluizen. Management op basis van vertrouwen en support geven is veel belangrijker. Het is een wederzijds ding, het moet opgebouwd worden. Ik heb dus gezien dat het erg afhankelijk is van de intentie van de personen.

Hoe kwamen die personen er op om dat te gaan doen dan?

In 1994/1995 was een beleidsmedewerker met de directeur van het gemeentelijk energiebedrijf teruggevlogen vanuit een conferentie in Rome. Ze zouden landen op Schiphol en waren al tijd bezig met duurzaamheid van steden. Ze vlogen over de AVI, met er achter kantoren, vlakbij Amsterdam Nieuw-West waarvan ze wisten dat het vernieuwd zou worden. Toen vroegen ze af, kunnen we niet gebruik maken van die AVI? Toen is het balletje gaan rollen, er is een gesprek gekomen met gemeente en partijen. Toen werd er een A4'tje opgesteld: laten we een inventarisatie van de markt maken, welke infrastructuur we nodig hebben en een economische beschouwing. Dat werd aan mij gegeven en ik mocht aan de slag. Waarschijnlijk waren die directeur en beleidsmedewerker hier al langer mee bezig, maar in dat vliegtuig viel dat kwartje. Toen hebben ze er ook direct werk van gemaakt, het maken van dat A4tje en kon ik aan de slag.

Hoe ging jij dat toen doen?

Ik ben toen met die drie aspecten markt, assets en economische haalbaarheid aan de slag gegaan. Klanten bezoeken in het gebied Westpoort, eigenaren kantoorgebouwen. We hadden een team met accountmanagers ed. We moesten voor de directie 75 % van de markt met een intentieverklaring gebonden hebben wil het een positief besluit worden. Accountmanagers gingen toen intentieverklaringen acquireren.

Ik heb eerst op basis van dat A4tje een PvA gemaakt, een project plan. Doelen, resultaten, tijdsplanning etc. Daar stond in hoeveel mensen ik nodig had met zoveel mensen etc. Toen dus studies gedaan naar die drie aspecten. Hoe kunnen we nou zo economisch meest interessant die warmte gebruiken? Daar kwam uit dat de elektriciteit,... de warmte die we afnamen vanuit de AEB, de prijs daarvan is gekoppeld aan de elektriciteitsderving die daar geleden wordt. Er wordt een klein beetje minder elektriciteit geproduceerd om die warmte te benutten. 's Nachts is die prijs lager dan overdag. Het was dus handig om 's nachts warmte in te kopen, dan heb je dus lokaal warmteopslag nodig. Grote buffers van 22 meter hoog. Dit is een voorbeeld van asset studie.

Dat economische haalbaarheid, hier kwam uit dat het geen vetpot is. Ze hadden een scope naar een groter gebied, maar ik wilde eerst focussen op Westpoort gebied. Omdat de infrastructuur was daardoor beperkt en de klanten waren overzichtelijk. Voor een bedrijf in opstart was een groter gebied lastig, dus we hebben we focus beperkt gehouden.

Toen is dus WPW ontstaan. Er bleek al vrij snel dat een aantal dingen al gerepareerd waren. Toegankelijkheid energiekennis gemeente was er weer, gemeentelijk vertrouwen was er weer, ze kregen bijvoorbeeld bedrijfsplannen te zien. Door dat vertrouwen konden we ook doorgroeien naar een aantal andere gebieden.

Nog even terug naar de bedrijven, je hebt ze verleid mee te doen. Hoe?

Ik had zelf een afstudeeropdracht gedaan voor het gemeentelijk energiebedrijf. Onderzoek ging over het investeringsgedrag van eigenaren kantoren/gebouwen in klein zakelijke markt in energiezuinige maatregelen. Conclusie was dat dat met name economisch gedreven is. Dat wetende, we moesten de klanten korting kunnen geven tov de gas-situatie. Dat was rond de 5 tot 10 % korting. De meesten waren hiermee verleid. Sommige zeiden dat gezien de energie liberalisatie, dat ze daar veel meer van zouden verwachten dan dat ze zich nu vastleggen aan dit warmtenet. Ook: sommige klanten die een intentieverklaring hadden getekend zijn nu nog steeds niet aangesloten.. Dat vroegen we ons ook af: hoe hard maak je die intentieovereenkomst? Krijg je een boete als je niks tekent? Dat hebben we niet gedaan, was een morele verklaring. Nu is zo rond 75 % aangesloten.

Toen lag het WPW-net er, en toen ging je uitbreiden?

Toen kwam het stedelijk verduurzamingsprogramma in Nieuw-West. Dat waren de oude stadsdelen Osdorp, Geuveld, Slotervaard, Bos en Lander. Dat waren rond de 60.000 jaren 50 woningen, die waren toen toe aan een upgrade, daar is toen een sloop-nieuwbouw programma tegenaan gegooid. 10.000 woningen slopen, 15.000 nieuw. Daar wilden ze toen een verduurzamingsslag doen. De corporaties en gemeente

waren toen vertegenwoordigd in bureau Parkstad (is Nieuw-West). Dit is een consortium van de gemeente en de woningcorporaties met de rol van een projectontwikkelaar. Zij hadden toen in 2002 wat studies laten doen, waar uitkwam dat stadswarmte het meest kosteneffectief zou zijn. Parkstad schreef toen een tender uit, Essent Eneco, Nuon en Electrabels schreven daar op aan. Essent was lange tijd preferred supplier, maar uiteindelijk toen ze verder gingen concretiseren moest ze toch terug. Kwam vooral door allerlei kostverhogen zaken waardoor het niet lukte. Toen leek het erop dat het stadswarmte in Nieuw-West niet tot stand zou komen. De wethouders van economie en duurzaamheid zeiden toen een slag te willen maken hiervoor met WPW. WPW kon toen in korte tijd een offerte neerleggen, toen nog driekwart jaar onderhandeld over punten en komma's. Contract werd getekend in 2005.

Op dit moment hebben we 60.000 woningen in concessie die we willen aansluiten, waarvan er nu 22.000 zijn aangesloten.

Vervolgens, in Noord was ook een dergelijk vernieuwingsprogramma ingezet. Hiervoor werd toen gekeken, gaan we hier ook weer zo'n tender procedure doorlopen. De les van Nieuw-West was dat dat te lang duurt. Nu wordt het direct gegund aan WPW, daar werden juridische studies naar gedaan en bleek te mogen. Reden precies hiervoor weet ik niet. De corporaties zeiden wederom, we willen stadswarmte in Noord, de gemeente wilde het ook. WPW had een aanbieding gedaan. Toen lag er een contract in 2008, toen kwam de crisis. Er zou een pijp gelegd worden in 2010, die is begin dit jaar pas gelegd. Dus de eerste woningen werden toen maar van warmte voorzien met TWC's (Tijdelijke Warmte Centrales). Dan heb je geen milieuwinst en geen economische winst omdat gas duur is. Dus dan ga je kijken wat een goed moment is de leiding te leggen. Nu staan er in totaal 2500 woningen in Noord, versnipperd over verschillende gebieden. Binnenkort worden de TWC vervangen door de aanvoer van de leiding naar het AEB.

Hoe ziet het verdienmodel van Nuon eruit?

We leggen assets aan. We sluiten woningen aan tot en met meterkast. Die investering zit in de BV. Drie inkomsten, aansluitbijdragen van corporaties, vastrecht per jaar consument en GJ prijs consument. Dan krijg je de badkuip. We kijken met 30 jaar horizon. Het warmtenet in Westpoort zit al verder in die badkuip, terwijl Noord nu in het begin zit. Dus qua totale portefeuille hebben we nu ca. 150 miljoen in de grond liggen, 90 miljoen is lening, rest is aansluitbijdragen. Omzet is tot nu toe 15 miljoen. Dat voel je wel aan dat je sterke moeders moet hebben, die een lange termijn horizon hebben wil je dit soort investeringen kunnen doen. Dat is het moeilijke van onze business. Als je op korte termijn geld wilt verdienen, moet je niet aan de warmte beginnen. Beginjaren 2000 kregen grote subsidies, soms wel tot 5 of 10 % van de investering. In 2005 was dat al niet meer, nu eerst 1 of 2 %.

Wat doet Nuon en wat voor middelen brengt ze in?

De BV heeft geen mensen, dus we brengen diensten in die nodig zijn voor de operatie van het bedrijf. Nuon brengt engineering en realisatie. Realisatie worden aannemers voor ingehuurd via raamcontracten of tenders. AEB doet bijvoorbeeld de bedrijfsvoering van de warmte buffer. Product warmte kopen we in bij AEB. Management doe ik, is dienst vanuit Nuon. Exploitatie en technisch beheer doen we. Nuon brengt facturatie systemen van Nuon in.

Hoe is de relatie met de klant, hoe bereik je ze?

We maken gebruik van de communicatieslagen die Nuon gebruikt. Bijvoorbeeld brief, nieuwsbrief, mailings- en promotiecampagne etc. De klanten zien geen WPW, enkel Nuon. We hadden hier wel eens bedacht, dit doet geen recht aan de samenwerking. Dus misschien willen we wel een aparte naam, bijvoorbeeld Stadswarmte AMsterdam (SAM) zodat Nuon niet zo dominant is. Bleek dat dit te veel operationele kosten met zich zou meebrengen, zeker toen hadden we nog maar 5000 klanten, dat was niet te dragen.

Nu zijn we op een punt dat we de hele samenwerking aan het evalueren zijn: wat moet er beter op organisatorisch gebied, op communicatief gebied, op eigenaar verhoudingsgebied. Vragen als: WPW staat nu al 15 jaar, het is succesvol, moeten we dit nu voor heel Amsterdam gaan optuigen, hoe gaan we verder, etc.

Hoe is met vraag onzekerheid omgegaan?

Intentieverklaringen in Westpoort. Concessie Nieuw-West voor de 15.000 woningen. Zonder die concessie was het waarschijnlijk ook niet

gelukt.

Wat is publieke opinie over dit project

Er was laatst een onderzoek gedaan voor WPW specifiek. We kregen een 7 gemiddeld, vind ik best hoog voor een monopolyde systeem. Sommige waren minder, zoals transparantie, weinig keuze. Sommige vinden het weer helemaal geen moeite.

Waren er technische nieuwigheden

We zijn constant op zoek om duurzame bronnen op het systeem in te voeden. Ik raakte met de mensen van Orgaworld in gesprek. Ik stelde voor om met elkaar te verdienen. We keken bij elkaar in de keuken. Dat werkt inmiddels al vijf jaar. We hebben een contract opgesteld, waarin we hebben gezegd hoe we de investeringen met elkaar delen, taken verdeling etc. Het mooie hieraan vind ik dat de drie dingen zijn gedaan: Partijen hebben de visie ontwikkeld, vervolgens plannetje gemaakt en daarna uitgevoerd.

Zijn er nog andere samenwerkingen die we gemist hebben?

Nee we hebben ze wel allemaal besproken.

Interview 11: Project developer Housing association/project developer – 13 May 2016

Opgeleid in architectuur and bouw management. Sinds 8 jaar werkzaam voor Eigen Haard in deze functie. Daarvoor project manager bij een architectenbureau.

Gaf aan dat relatie met WPW typische klant – leverancier is, terwijl dat eigelijk anders moet. Meer denken vanuit hoe elkaar te kunnen helpen / bijdragen.

Waarde creatie:

Aansluitbijdrage, kijken hoe handig het distributie netwerk aan te leggen is. Zoeken naar het optimum warmtenet en isolatie, omda top een gegeven moment extra isoleren ed. weinig energiepresetatie oplevert verses geïnvesteerde kosten.

Waarde levering:

Zij hebben contact met klant, Nuon levert in begin wat brochures etc, maar zij leggen het uit. Ze hebben alleen niet veel uit te leggen, het is een simpel systeem.

Waarde creatie:

Kost iets meer geld voor hun in aanlsuitbijdrage, maar onderhoud kost niks. En worden ontzorgd. Er is een aansluitplicht, ze hebben toch laten uitzoeken door DWA of dat nou wel zo goed is. Uiteindelijk gebleken dat er niet een reden is om de aansluitplicht aan te vechten.

District heating project development, a fragile business

Towards new collaboration and business models

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