IMPLEMENTING DISTRICT HEATING IN AVEDØRE LANDSBY

A TECHNO-ANTHROPOLOGICAL CASE STUDY OF THE IMPLEMENTATION OF SUSTAINABLE ENERGY INFRASTRUCTURE

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Abstract

With the Russian invasion of Ukraine in late February 2022, geopolitical pressures to decarbonize the European heat supply increased, raising the stakes for green energy transition projects. While the success of such projects are often perceived as a result of efficient technological solutions, the present report presents a case for viewing green energy transitions as sociotechnical phenomena. Based on an ethnographic fieldwork among project stakeholders in Avedøre Green City, centred around participant observation and open and informal conversations with informants, this report elucidates, how major human and non-human actors affect the conditions for the successful implementation of low temperature district heating in Avedøre Landsby. Drawing on Situational Analysis and Actor-network Theory, analysis reveals that lacking knowledge about the social processes of structuring collaborative and citizen centred parts of the project disrupts the process, as planning is stalled by the project advisors' disagreements on whose knowledge counts. Through the discussion, the report argues that a perspective of participation and co-creation with citizens should be used as a way of ensuring early, ongoing and inclusive involvement, meanwhile tackling issues regarding absent information. For projects like AGC to succeed, the social nature of technology implementation must be designed for and included into the internal fabric of every project.

Keywords: Citizen Engagement; Renewable Energy; District Heating; Qualitative Research; Information Barriers; Energy Transitions; Case Study; Public Inclusion; Ethnography

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Introduction

Denmark has been a pioneering country since the first emerging energy crisis in the 1970s, both in relation to our wind-turbine industry, but especially for our district heating and its network. The purpose of district heating has been to provide the citizens with reliable and affordable heating, to secure individual citizens' heating demands. Through the years, Denmark has strived to be a frontrunner in the green transition, and with the obligations to fulfil the Paris Agreement for 2050, to become fossil free, the Danish district heating needs to become a part of the transition as well (Danish Ministry of Climate and Energy, 2011). The present situation of the Russian invasion of Ukraine, and skyrocketing energy prices of fossil fuels, make this transition more urgent than ever before (Dansk Energi, 2022; European Council, 2022). To understand the transition from traditional district heating to sustainable district heating we have turned to the literature of technical and historical views, to better understand what district heating was and what it is becoming (Averfalk et al., 2021; Johansen & Werner, 2022). To explore this green transition, the present master thesis presents the project Avedøre Green City, as a case of how the development of new sustainable district heating unfolds, and thus contribute to the literature of energy implementation projects, from a sociotechnical perspective.

Problem Analysis

This chapter consists of an introduction to the development project; Avedøre Green City, the involved actors and the technologies included in the development project. To shed light on the prospects of green transitions like the Avedøre Green City project, the chapter includes a review of the technical report *Low-temperature District Heating Implementation Guidebook* by Averfalk et al. (2021). Finally, the chapter reviews the paper *Something is sustainable in the state of Denmark: A review of the Danish district heating sector* by Katinka Johansen and Sven Werner *(2022)* to include a sociotechnical/socio-political perspective on the process of implementing district heating. This chapter seeks to identify possible obstacles to a specific case of district heating implementation by reviewing relevant scientific and technical knowledge about such processes.

Avedøre Green City

Avedøre Green City (AGC) is an innovation project with the goal of making the City of Avedøre in Eastern Denmark a leading example of how new energy systems can be formed in city areas of Denmark and the EU (Avedøre Green City, 2021). The overall project focuses on sustainable development through the themes of energy supply, mobility, biodiversity, and renovations. AGC is a politically and economically independent association of different actors, such as local companies, organisations, institutions, and citizens in Hvidovre Municipality (Avedøre Green City, 2021). The project began in 2018, as an initiative between three different housing associations in Avedøre Stationsby and Avedøre District Heating, with a goal of making sustainable heating in the area. The housing associations and Avedøre District Heating were both facing extensive renovation on their heating networks, which opened up for rethinking heating as a way to contribute to the green transition. Since then, the project group has grown to Avedøre District Heating, Avedøre Boligselskab, KAB, European Green Cities, EBO Consult, Hvidovre Municipality, Hvidovre Gymnasium, Filmbyen and Avedøre Landsby. The projects, within Avedøre Green City, are centred around the sustainable development goals presented by the UN. The project group has invested 61 million EURO into the project, with the scope of being front-runners for sustainable renovations and green solutions in the EU (Avedøre Green City, 2021).

The physical project area is centred around Avedøre Stationsby and Avedøre Landsby, as shown in **figure 1.**

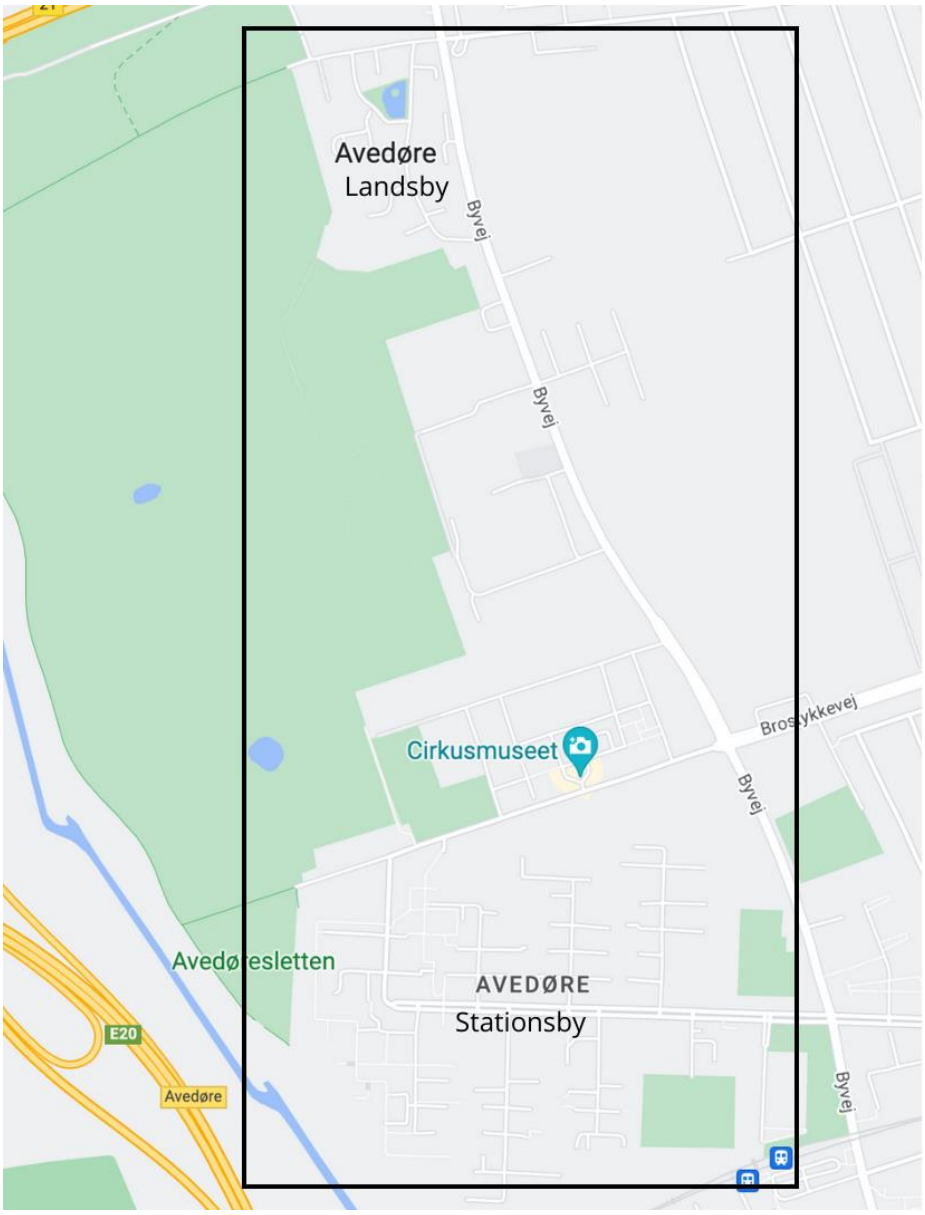


Figure 1 Overview of the Avedøre Green City-project area, spanning from Avedøre Stationsby to Avedøre Landsby. Map scourced from Google Maps.

The AGC project consists of four projects: Renovation Projects, Green Mobility, Biodiversity, Energy Supply (Avedøre Green City, 2022). Under each project are different subprojects, which all fit under the assumption and ambition that the Avedøre district will be frontrunners of sustainable development in suburban areas in Denmark and the EU. In **figure 2**, are the illustration of the different projects and subprojects.

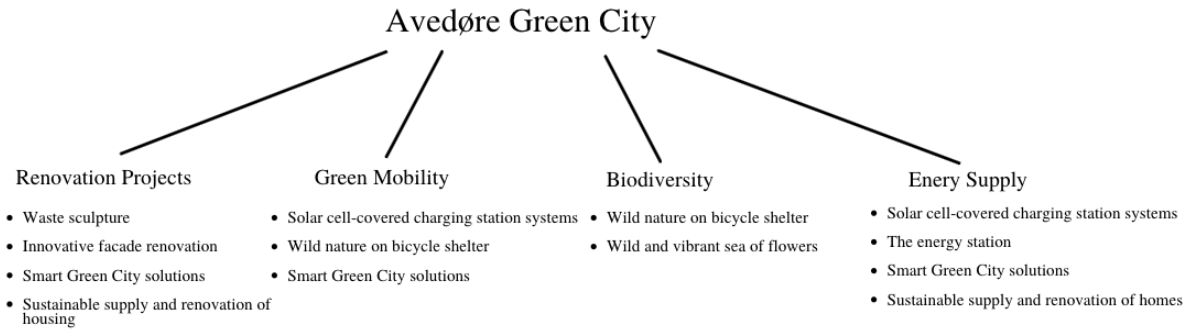


Figure 2 Overview of the Avedøre Green City project with the subprojects: Renovation Projects, Green Mobility, Biodiversity and Energy Supply.

The present report will mainly focus on Energy Supply and Sustainable supply and renovation of homes, as this is where implementation of low temperature district heating (LTDH) in Avedøre Landsby is placed. The subproject, Sustainable energy supply and renovation of homes, aiming to renovate the district heating (DH) network to LTDH in the supply area, and renovations of homes in Avedøre Stationsby, as well as expanding the supply area to include Avedøre Landsby in 2021-2023.

To make sure that the LTDH was possible to implement, the houses in the project area needed an energy labelling to better understand the costs and degree of renovations. This was provided as a free service from the AGC group, to help the citizens with their forthcoming renovations, if required, to get LTDH. The energy label gives an indicator of the energy demand and usage that the house has. The energy labels are divided into nine different categories (as shown in **figure 3**), with A2020 as the most energy efficient label a house can get. The A2020 label means that the house has a low energy consumption, and it is living up to the standards for new buildings. On the other hand, the G energy label describes

Figure 3 Presentation of the nine energy label categories (Energistyrelsen, 2022)

houses with a high energy demand, which means that the energy source or insulation is outdated in today's standards in Denmark (Energistyrelsen, 2022b) b). One of the ambitions of AGC is to improve the energy efficiency in Avedøre by 30%. These optimizations of 30% will come through energy savings via renovating the existing DH infrastructure, and renovating the houses in Avedøre Landsby, with better insulation, replacement of windows and doors, so they can benefit from LTDH (Hvidovre Fjernvarme, 2022).

As mentioned above, Avedøre Landsby is one of the key cities in the AGC-project. Avedøre Landsby is a relatively small suburban city, approximately 10 kilometres from the Danish capital Copenhagen. The city consists of 68 households and approximately 215 residents (Center for Plan og Miljø, 2020).

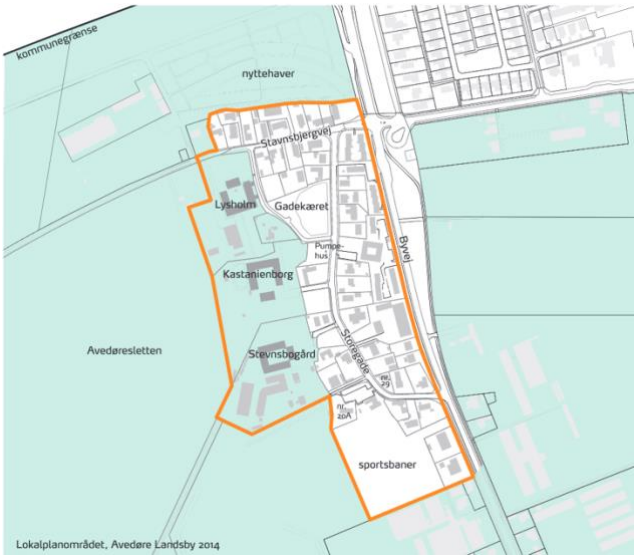


Figure 4 Illustration of Avedøre Landsby (Plan- og Miljøafdelingen, 2015)

As a part of the AGC project, green energy efficient heating technologies will be implemented, as a remedy to keep the cost for heating consumers as low as possible. The area, shown in **figure 4**, will be heated with a mix of different heating technologies, such as solar panels and a central heat pump. A requirement for LTDH to be implemented in Avedøre Landsby is that there are sufficient residents who sign up for DH. Before district heating can be implemented and the infrastructure for it can be laid down (heat pipes, connection links, heat pump, cables etc.) it is necessary for the project to be financially feasible. This means that the citizens of Avedøre Landsby have a decisive role in whether district heating becomes a reality or not. When new DH plant are established, the number of connections determines the price of the heating, and whether it is feasible to build the plant (Hvidovre Fjernvarme, 2021). In relation to the current heating sources in Avedøre Landsby, the majority of the citizens are using natural gases, as their main heating source, as shown in **figure 5**.

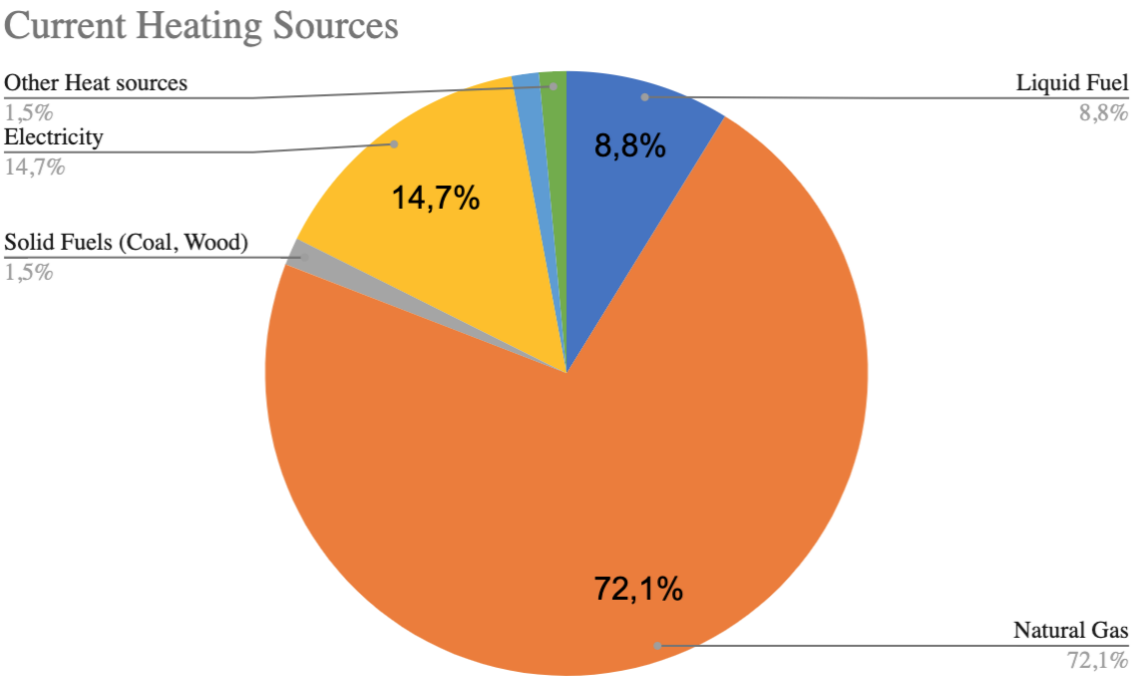


Figure 5 Overview of current heating sources in Avedøre Landsby. Data was supplied by Transition Aps.

District Heating and Low Temperature District Heating

DH is a system used for distributing space heating and domestic hot water generated from different energy sources through a network of insulated pipes. The energy sources most often used are Combined Heat and Power (CHP) plants and Waste to Energy (WtE) plants, but recycled heat, solar heating, heat pumps and geothermal heating are also used. The technological development of DH is generally categorised into four generations of DH, as shown in **figure 6**.

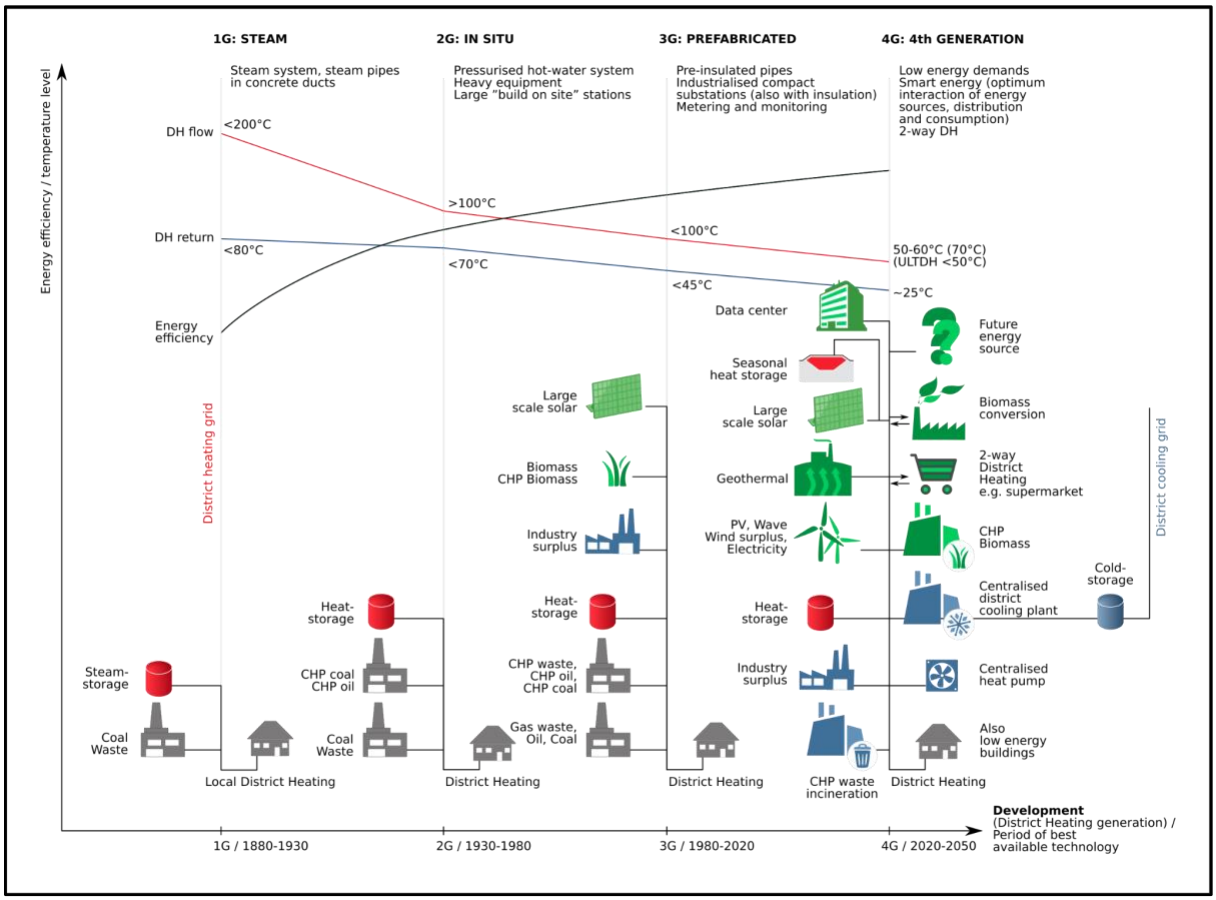


Figure 6 Historical review of district heating technologies through four generations (Lund et al.,2014)

First and second generation DH spanning from 1880-1980 used coal and waste for heating, and distributed steam and pressurised hot water at temperatures above 100 degrees Celsius. These heating systems were not very efficient as they used concrete ducts for distribution.

The 3rd generation of DH (1980-2020), is the most widespread in Denmark. It is best known for centralised power plants such as CHP and WtE. The energy sources for 3rd generation DH are mostly Biomass, Waste, Gas and Coal. From the 1st and 2nd generation of DH, the availability of DH has spread across Denmark, which has made it possible for Danish citizens, both in the cities and in the countryside, to have persistent and affordable heating. The 3rd generation systems also had/have renovated pipes for distributing the heat, which mean that the heat loss, are quite smaller than from the

1st and the 2nd generation as mentioned above (Lund et al., 2014). Besides the biomass and waste burning, the 3rd generation of DH is mainly powered by fossil fuels, as mentioned above. DH we know today has a flow temperature of 80-90 degrees, and a return temperature of 60-70 degrees (Lund et al., 2014).

The 4th generation (2020-2050) of district heating is in many ways different from the 3rd generation of district heating. Both generations have the focus of delivering heat to the Danish citizens, but the way the 4th generation is constructed is quite different. The 4th generation of DH has a larger focus on green transition, with fossil free solutions.

The 4th generation of district heating is based around a low temperature approach, with different heating sources. As mentioned above, the tradition DH plant, is focussing on one or two technologies to provide heating, where the LTDH plants is a combined smart grid of low-temperature technologies such as: Waste heat from processes in industry and commercial buildings, Geothermal energy, Solar energy and Biowaste (Lund et al., 2014). The 4th gen. also differs in its flow temperature, as mentioned above the DH we know today has a flow temperature of 80-90 degrees, and a return temperature of 60-70 degrees. The LTDH has a flow temperature of 30-70 degrees and a return temperature of 25-30 degrees (Lund et al., 2014).

Potentials and Barriers for LTDH

As a state-of-the-art presentation on best practice implementation of LTDH, this chapter includes a review of the technical report *Low-temperature District Heating Implementation Guidebook* by Averfalk and colleagues (2021). This is done to qualify the implementation of DH in Avedøre Landsby, as well highlight any major areas of concern, when developing LTDH.

In working to support the sustainable technical transformation to LTDH, the guidebook aims to provide tangible information, recipes, and advice for obtaining lower network temperatures in both existing and new DH systems. The intended audience of the guidebook is primarily DH practitioners, as they are the ones implementing the technological transformation. The authors also note that both policy-makers and market managers can gain from the insights put forth in the guidebook, as both non-technical barriers, policy implication and the competitiveness of LTDH are discussed in the guidebook (Averfalk et al., 2021). The guidebook is made as part of the International Energy Agency Technology Collaboration Programme on District Heating and Cooling (IEADGC), and it is the result of the combined work of research groups in Austria, Denmark, Germany, Norway, Sweden, and the United Kingdom.

One key perspective from Averfalk and colleagues is that LTDH has the potential of becoming a gateway technology that will allow use of different renewable energy technologies in heat supply. For almost a decade “fourth-generation district heating” (4GDH) has been used to describe DH systems

aiming to be fully decarbonized. A 2014 definition describes the abilities of 4GDH as following (Averfalk et al., 2021, p. 7):

- To supply low-temperature district heating for space heating and hot water preparation.
- To distribute heat with low grid losses.
- To recycle heat from low-temperature sources.
- To integrate thermal grids into a smart energy system.
- To ensure suitable planning, cost and motivation structures.

And so Averfalk and colleagues argue that it is because of these abilities that LTDH will become a key technology in the pursuit of a more efficient DH system. In addition to the general focus on decarbonization, the implementation of LTDH *"will increase the profitability of implementing geo-thermal heat, heat pumps, industrial excess heat, solar collectors, flue gas condensers, and heat storage options into district heating systems"* (Averfalk et al., 2021, p. 7-8). Averfalk and colleagues explain that this is because lower distribution temperatures means that heat distribution losses will be lower because of a smaller difference in temperature between the fluids in the heat distribution pipes and the surrounding environment. Lower distribution temperatures also mean a higher conversion efficiency from solar collectors, better use of excess heat, more heat extracted from geothermal wells, and less electricity used in heat pumps as less pressure is needed in heat pump condensers (Averfalk et al., 2021).

Technological Development

Future potentials aside, Averfalk and colleagues also review the technological development of LTDH. According to the guidebook, some modifications are required if LTDH is to be utilised compared to current heat distribution, and these include changes to both heat distribution networks, and existing and new building installations. For existing installations, the modifications required are minor, as only a limited part of installations must be removed and exchanged. This is because renovation of existing buildings already have and will continue to have a positive effect on heat demands. This allows for a reduction of the temperatures used in DH. One area of concern regarding existing installations is the risk of legionella[1] in domestic hot water with traditional installations.

Regarding technological development for new buildings LTDH can be implemented with a higher degree of freedom, as new technologies and more diversified configurations are available today, and LTDH can take advantage of redesigned components in new installations. Digitalization and artificial intelligence are also highlighted in the guidebook as technologies that are meant to help facilitate LTDH

[1] Legionella thrives in lukewarm water, e.g. in bathing water or in water pipes in buildings. Legionella bacteria can cause a serious pneumonia called Legionnaires' disease. The bacterium can also cause a flu-like fever called Pontiac fever. https://stps.dk/da/sundhedsfare-og-beredskab/miljoemedicin-og-hygiejne/vand/legionella-i-varmt-brugsvand/#

and ensure high levels of efficiency by ensuring rapid identification and elimination of system malfunctions, and smart control and optimization of heat supply. By summarising gained experiences from early adopters in different European countries, Averfalk and colleagues (2021) conclude that both appropriate methods and technologies exist for implementing LTDH as lower temperatures have already been implemented in existing and new DH networks.

Non-technical Aspects and Policy Implications

Earlier generations of DH contain elements that represent barriers to LTDH, and as such understanding current barriers is vital to the development of LTDH. Non-technical aspects represent a significant part of these barriers, and so the guidebook concludes that the largest barrier to development and implementation of LTDH *"is that it is not business as usual."* (Averfalk et al., 202, p. 168). What is meant by this is that current dominant business models for DH focus on centralised heat supply (e.g. from CHP plants and waste incineration), and applying these models to a LTDH business case makes it look unattractive in comparison to doing business as usual. Averfalk and colleagues argue that business as usual will not be an option in the future as society will be fossil-free and circular, and thus will not have available fossil fuels or waste to incinerate. Future heat demands must be met by other sources like the sea, ground, sun, urban and industrial activities, and this is something that has yet to become apparent to most heat providers and end users. The authors further argue that limited awareness of future conditions together with a short-term profit orientation often results in LTDH being foregone rather than exploited (Averfalk et al., 2021).

Doing business as usual represent another significant barrier to developing and implementing LTDH as doing so requires higher degrees of collaboration between stakeholders to successfully create a diversified heat supply, a DH network optimised for lower temperatures, and long-term visions for decarbonized heat distribution (Averfalk et al., 2021). The authors highlight the necessity of creating awareness about decarbonization visions by communicating these with both customers, staff, suppliers, and the general public.

Regarding the policy implication to LTDH, Averfalk et al. (2021) argue that current policies have often had a conservative impact on the possibilities of LTDH as most policies and regulations are remnants of a "fossil fuel society", and so the demand for revised policies and institutional rules are high. In order to increase the economic benefit and incentive to develop and implement LTDH policy drives such as carbon pricing must be put to use because not having appropriate economic drives pushing for decarbonization remains a momentous barrier to achieving fossil free heating systems. Thankfully, several European countries are already considering implementing carbon taxes (Averfalk et al., 2021).

The Socio-technical Realities of District Heating

In trying to better understand the construction of DH, including a sociotechnical/socio-political history of implementing DH and the fossil fuel society it emerges from, this chapter turns to Katinka Johansen and Sven Werner's paper, *Something is sustainable in the state of Denmark: A review of the Danish district heating sector* (2022). The paper's leading argument is that since the Danish energy system is ranked among world's best and Danish heating is internationally unique, understanding past, present and future perspectives of Danish DH represents enormous value for the development of DH. The publication by Johansen and Werner is the first ever comprehensive review of the Danish DH sector (Johansen & Werner, 2022), and in the present report, this serves as an exploration of the cultural and non-technical genesis of Danish DH.

The first CHP plant in the Nordic region was constructed in Copenhagen, more precisely in the then working class Frederiksberg Municipality, in 1903. This was a Waste to Energy (WtE) plant, and it was built to solve a pressing problem of household waste disposal since the city had no available land for landfills. This problem meant that more and more waste was accumulating in the streets, which had a negative impact on the citizens of Copenhagen. The waste incineration plant delivered heating to the nearby Frederiksberg Hospital and other municipal buildings (Danish Board Of District Heating, 2022). In the decades hereafter, DH technologies improved, and DH facilities were developed across the country, and a Danish culture of cooperative ownership helped realise the district heating sector. Local initiatives invested in cooperatively owned DH plants in order to secure a stable local heat supply, as political wiggle room allowed for experimentation and creative local problem-solving (Johansen & Werner, 2022).

As the public sector grew and the Danish welfare state emerged through the 1950s and 1960s, striving towards equal social rights for both rich and poor, the need for persistent heating got more and more present, and so local councils were pressured to provide a reliant, affordable and publicly available energy supply. This meant that the district heating network expanded throughout Denmark, and since oil was *"readily available, inexpensive and easily transportable"* (Johansen & Werner, 2022, p. 4), it became prioritised as fuel, and by the 1970s Denmark had become almost 100% energy import dependent. As a consequence, the Danish energy infrastructure was paralysed in the 1970s with the outbreak of the Arab-Israeli war, when Egypt and Syria attacked Israel. The Arab states used oil as a tool of war, weakening Israel (Rigsarkivet, 2020). With the threat of an export ban on all countries, supporting Israel, and at the same time increasing oil prices, the first energy crisis started. With the ongoing energy crisis through the 70s, drastic short-term measures were taken, such as car free Sundays (Johansen & Werner, 2022).

Long-term measures included a new-found awareness of energy planning and consumption, and with the wake-up call of the energy crisis the Danish Energy Agency was established to develop energy

planning and policy initiatives towards energy independence. As the anti-nuclear movement of the 1970s grew, so did the call for the integration of renewable energy sources into Danish energy systems. Environmental awareness increased throughout the 1980s, and by 1990 the Danish government published the country's first strategy plan for low-carbon energy transition, Energy 2000 Action Plan. By doing so, the government planned to phase out the use of coal in the energy system, and prioritised the integration of renewables instead, as the global energy crisis and anti-nuclear sentiments demanded an independent and diverse energy production. A countrywide ban on landfills in 1997 then further pushed for the large-scale WtE plants (Johansen & Werner, 2022).

In the year 2020 more than 1,736,668 Danish households were supplied with district heating. In total, this corresponds to 64 percent of all households in Denmark, and approximately 3.6 million people (Dansk Fjernvarme, 2022). The Danish district heating consists of various technologies to create the security of supply required by this system. This mix of technologies consists of the mixture of geothermal energy, solar energy, wind energy, WtE, surplus energy, biogas, and biomass. See **figure 7** for a visualisation of the current energy mix. This combination of different technologies, and heating sources is the district heating as we know it today (Dansk Fjernvarme, 2022).

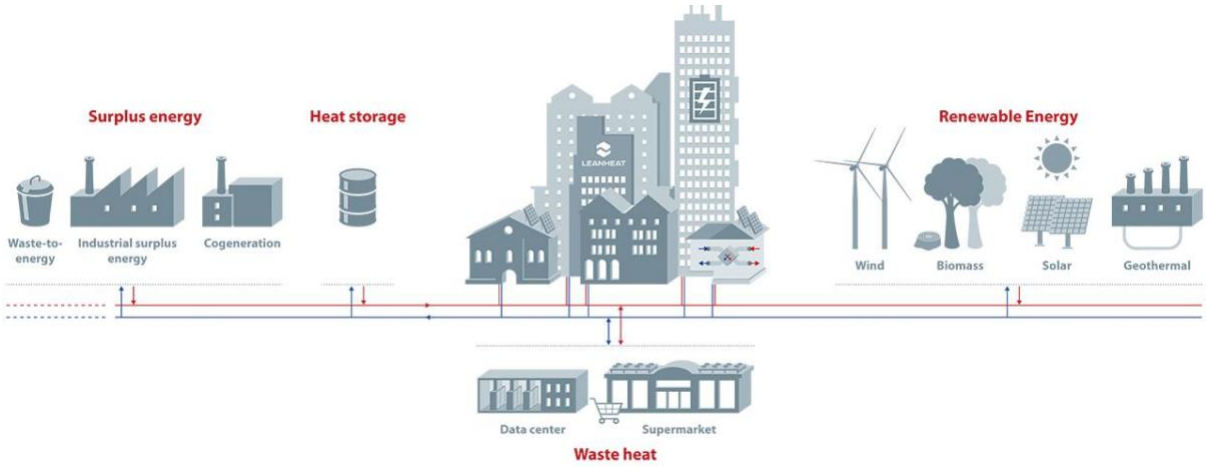


Figure 7 Illustration of the Danish energy scheme (Johansen & Werner, 2022).

As mentioned above, the majority of Danish households are using district heating, as their main heating source. One of the reasons for this is the large infrastructure that makes it possible.

In their paper, Johansen and Werner (2022) list several reasons why present time Danish DH is unique compared to international examples. Among these are the high penetration rate of DH, as the district heating infrastructure consists of more than 60,000 kilometres of heating pipes to provide the Danish households with a consistent energy supply for their homes. This means that DH is available in both low- and high-density rural and urban areas. Efficient integration of CHP, recycled waste heat from industry, WtE, and a high transition rate to renewables (primarily biomass) ensures a cheap and efficient

energy supply. Non-profit principles in the business models of energy supply companies means that the price of heat is near the same across the country.

In a final note Johansen and Werner (2022) emphasise that looking beyond *"district heating and the energy system, issues related to power generation, fuel supplies and fuel use cannot be viewed as only local in nature. These have global trajectories and global ramifications, and thus implications for future generations."* (Johansen & Werner, 2022, p. 13). And so, by reviewing the genesis and history of Danish DH, it becomes clear that DH technologies and institutions cannot be understood as detached entities. Instead, Danish DH can only be seen as a sociotechnical entity continuously intertwined in current and future local, national, and global issues.

Geopolitical Pressures for Decarbonization

In 2022, we find ourselves amidst another energy crisis, as energy prices for electricity and gas have been rising. The reason for this is in many ways difficult to understand, as the prices of the individual energy sources are affecting each other. Since the autumn of 2021, the natural gas prices have more than ten-folded (Dansk Energi, 2022). This is because the market for electricity is structured, so that the most expensive electricity producing unit determines the price. This is affecting both the gas prices, and the electrical prices, as the extraction of natural gases has a high demand of electricity, which means that the gas production gets more expensive, because of the higher electricity prices (Dansk Energi, 2022). As this has happened before, the European countries have often drawn on their own stock of natural gas to keep expenses down for the citizens who have been using natural gas as their heating form. With the outsourcing of other energy sources like oil and coal, the demand for natural gas has been increasingly higher, than the years before, which means that most of the European stocks of natural gases already are nearly drained. The high natural gas demand has also been affected with Russia's downgraded export of gas supplies to Western Europe (Dansk Energi, 2022). Since 2021, the geopolitical state has changed drastically. The world changed on 21 February 2022 with the Russian invasion of Ukraine, and as a result both the humanitarian and energy state of Europe has changed drastically (European Council, 2022). The Danish energy sector has, over the last decade, been dependent on the gas resources from the Russian Federation. As a tool for weakening the Russian economical infrastructure, sanctions towards the Russian import/export of gas and oil have been made. With the cancellation of the Russian gas import, the prices of raw gases have increased more than 500%. To understand how the price has climbed, **figure 8** shows an illustration, of the rising gas prices in Denmark, measured in DKK/m^3 from March 2019 to April 2022.

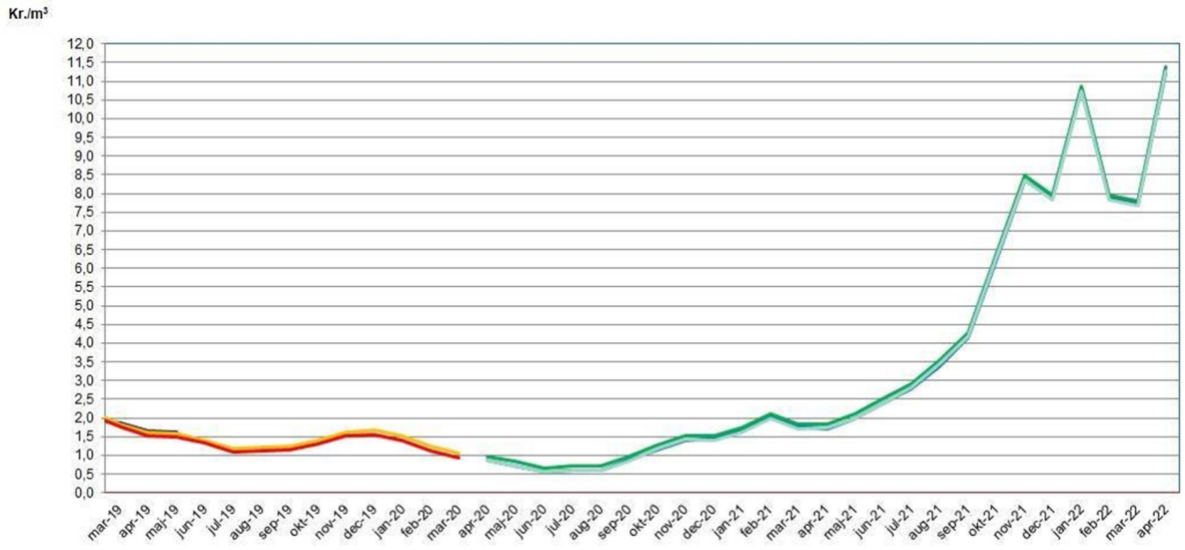


Figure 8 Scheme of the rising energy prices since March 2019 to April 2022 (Forsyningstilsynet, 2022).

The high gas prices have had immense consequences for families with a lower income. Families that use electricity and gas as their main energy source for heating, have experienced days with prices rising by more than 200%. As everyone should be able to heat their homes, the Danish government, has implemented the emergency aid "*Varmecheck"* to help households with individual gas boilers and DH that uses more than 65% of gas to deliver heating, and lastly households using electric heating (Energistyrelsen, 2022a). The law is also used as an aid for households to convert their present fossil heating sources with sustainable solutions, as the aid can make space in their economy to invest in heating pumps or sustainable district heating.

Problem Statement

As presented in the problem analysis, LTDH is displayed as the gateway technology that will allow the use of different renewable energy technologies in heat supply. Doing "business as usual" represents a significant barrier to developing and implementing LTDH as doing so requires higher degrees of collaboration between stakeholders to successfully create a diversified heat supply. With the sociotechnical/socio-political perspective from Johansen and Werner (2022) it is clear that Danish success with the development of district heating has always been heavily influenced by social and political factors. In the light of present time geopolitical pressures to decarbonize the European heat supply, we argue for the value of a case study on the practical realities of implementing LTDH, to create an understanding of how green transitions can succeed. As the implementation of a large-scale energy system involves a broad group of actors, such as municipalities, heating companies, consulting firms and individual households, it is immensely important that the process is agile and made to embrace the diversity of actors. In this way, the problem analysis resulted in the following problem statement:

How do major human and non-human actors affect the conditions for the successful implementation of low temperature district heating in Avedøre Landsby?

As argued by Christian Lund (2014), a case is a constructed piece of empirical reality emphasising and elucidating certain elements while others only appear faded into the background. And so *"a case is not "natural" but a mental, or analytical, construct aimed at organizing knowledge about reality in a manageable way."* (Lund, C., 2014, p. 224). When doing case studies, two specific dynamics make themselves felt, when it comes to determining of what this is a case. First, even with the most thorough planning and design of a case study, the data will always tend to be unwieldy, leaving 'generous surprises', and so having to rethink what the work is a case of, is common practice to the social scientist. Secondly, during the analysis, when breaking the data corpus into smaller parts, realising that the research can potentially be a case of multifarious things, all depending on their specific configuration (Lund, 2014). These dynamics came into play in the case presented in the present report, as early data collection and fieldwork revealed the AGC-project to have run into difficulties, mandating a change in the initial case study design. The data collected was of something else than originally intended, and so the case shifted from a focus primarily on citizen engagement and onto planning and implementation of green transitions, in which citizen engagement is only one part.

Additionally, constructing the narrative for the present report, we have to make several demarcations that allow us to tell the story of our case. Even though Avedøre Landsby has been chosen as the focal point, in social science we cannot control for context (Lund, 2014), and thus, we cannot exclude everything from the larger AGC-project. But contrary to the perspective of natural science, context is not an uncontrollable variable clouding the results, but an essential element in trying to understand local

or specific issues. It is precisely in the way the context of our specific case relates to the larger themes put forth in the problem analysis that this case becomes interesting from a larger social science perspective.

Theoretical Framework: Situational Analysis

The following paragraph is a presentation of the theoretical framework that has been assembled to analyse the empirical data gathered in trying to address the problem statement mentioned above. Our Theoretical framework is mainly centred around Situational Analysis (henceforth, SA) by Adele Clarke and Carrie Freise (Clarke & Friese, 2007; Clarke, Friese, & Washburn, 2016), which will be presented underneath. In addition to Clarke and Friese's definition of discourses, perspectives from Louise Phillips (2015) on the construction of discourses has been included. Lastly, theoretical concepts such as *Black Boxing* and *Translation* from Actor-network theory (henceforth, ANT), by Bruno Latour (2005), has been utilised to further the analysis.

To study our case of green energy transitions as sociotechnical phenomena, where both social and material realities are subject to change, we have chosen to utilise the cartographic methods of Clarke and Friese's Situational Analysis (2007; 2016) to better grasp the complexity of the case in Avedøre Landsby. Situational analysis, derived from Grounded Theory by Glaser and Strauss, seeks to elucidate different actors and actions taken within a given situation (Clarke & Friese, 2007). The situation of concern may span over several events or specific "situations" experienced by actors participating in them, but the situation of concern is not experienced by any one actor, as, much like a case as described by Lund (2014), "the situation" ultimately refers to a constructed piece of empirical reality emphasising and elucidating certain elements. And in line with Lund's perspectives, SA offers the unique perspective that the conditions or context of the situation; organisational, community, national and international, do not merely surround the situation of concern. Instead, they are viewed as part of the situation, constitutive of it, and thus should be dealt with in the analysis as more than a framing or context of the situation. In this way, exploring *"how these conditions make themselves felt as consequential - inside the empirical situation under examination"* (Clarke & Friese, 2007, p. 365) becomes fundamental when doing SA. In the present report, this results in a combined analysis of the experiences of the broader network of actors engaged in planning and performing the green transition to LTDH in Avedøre Landsby.

SA has a strong emphasis on the use and construction of discourses through different empirical material (Clarke et al., 2016). Different ways of speaking about the world are organised into discourses. These discourses create representations of reality that do not merely mirror an already existing reality, as the discourses and their representations shape realities, including identities and knowledge. Discourses are ways of adding meaning to the world in a way that undermines other perspectives (Phillips, 2015). As SA focusses on empirically constructing a situation by mapping out actors and discourses within the situation of concern, it allows the researcher to cast a wide net, when it comes to data collection. The data collected for the present report is mainly sourced from an ethnographic fieldwork centred around participant observation, but it also includes documents, email correspondence, reports and presentations, and descriptions from websites.

Clarke et al. (2016) highlight how SA can play an important role in policy research, as its mapping strategies can help delineate *all* the actors whom policies may affect. Even though the AGC-project does not revolve around policy implementation, experience has shown the authors of the present report that large-scale energy development often fails to consider the full range of actors affected by an implementation. SA allows for the capture of unintended consequences and is thus a fitting analytical strategy for the project at hand.

The cartographic methods of SA provide the opportunity to visualise the complexity of the situation of concern. The three methods of cartography are *Situational Maps*, *Social World/arena maps* and *Positional Maps* (Clarke et al., 2016). The **situational map** is used for outlying the major human and non-human elements and discourses in the situation of concern. Before mapping the situation, you need to ask yourself and the empirical material "*Who and what are in this situation? Who and what matters in this situation? What elements 'make a difference' in this situation?*" (Clarke & Friese, 2007, p. 372). Here different actors are mapped out, to initiate analysis, and through that, see the relations among actors (Clarke & Friese, 2007). In the analysis in the present report the situational messy map was used to lay out all the actors, discourses, and partial elements of the situation in AGC, through the messiness of the situation, ordered maps were used to categorise the different elements, for an overview of the situation. Lastly, relational maps were used to display relations and actions taken within the situation.

The second map used in the analysis is the **social world/arena map**. This map is used for utilising the different negotiations that happen between the actors in the situation. The social worlds and arenas are unstable entities that describe how "*things can always be otherwise, and may be so soon"*(Clarke & Friese, 2007, p. 364). With that in mind, the collective human actors and non-human actors are mapped out, to show their commitments in relation to the subject (Clarke & Friese, 2007). The subject in our social world/arena map circles around how sustainable development shares different opinions and commitments among actors.

Lastly, we have used the last map of SA, the **positional map,** to analyse and describe the situation of the AGC. The positional map is used for outlying the major discursive positions taken or not taken by

the actors in the situation (Clarke & Friese, 2007). The map is constructed around two axes showing how different positions are placed in relation to each other (Clarke & Friese, 2007). The positional map was used as a collection of the different positions found through the analysis and were constructed to show how the different actors positioned themselves in relation to their discursive practices and give all actors a voice in the situation of concern.

SA has its roots in Grounded Theory, but it also borrows from the work of Latour and ANT. Clarke has used concepts and ideas from ANT in trying to understand how networks can be constructed and how human and non-human actors or "things" make a difference in the situation of concern (Clarke & Friese, 2007). Latour argued that all human and non-human elements who make a difference in the situation or network are called actors and therefore all have agency to act (Latour, 2005). The present report uses this definition of what makes an actor throughout the analysis.

Latour's perspective of studying and understanding how different processes can lead to temporary order in the form of stabilised phenomenon, such as technologies, organisations etc. has also been used to better understand the dynamics of actions taken within the situation; how elements have been black boxed, and where translation happens (Latour, 2005). **Black boxes** are stable uncontroversial entities, like scientific facts or functioning technologies, that are taken for granted in the networks they interact with. But the truth about every such black box is that behind its stable outer exterior lies a complex creation story that has been driven by uncertainties, hesitation, and controversy. Opening or unfolding a black box can be the subject of ANT (Justesen, 2017). **Translation** is about understanding precisely how connections and similarities appear between elements in a network that are not connected by themselves and look nothing alike; how are heterogeneous networks able to appear as a stable and coherent order? It is through translation that specific phenomenon take shape and a temporary order is established. The connections created cannot be taken for granted as they could have been different, and in this way, translation is always about understanding the processes that have shaped the stability of a network (Justesen, 2017).

Methodological Approach

This chapter outlines and elaborates the different methodological approaches used in collecting the empirical data for the present report and includes discussions on different choices made while conducting the research. This includes thoughts on doing field work, participant observations, talking with informants, and ethical implications of doing research. As mentioned in relation to the problem statement, the case at hand shifted during the early phases of data collection and fieldwork, as the AGC-project was delayed due to certain complications. This meant that the case and underlying events unfolding during the course of the semester changed, and as a result, some access points were closed, and new ones opened.

As the authors of the present report have been positioned both as consultants of Transition Aps as well as students at AAU, the original study design was based on engaging the actors in the situation of concern on two different levels. First on the level of the individual citizen engaged in the processes of energy renovating their home where the authors, as consultants of Transition, would have the means to help sort out uncertainties by facilitating contact between citizens and different technical experts to help their process. Meanwhile, both as consultants and students, trying to understand the barriers and motivations for different citizens after having received their energy label. This would have been done through a continued dialogue with citizens in the months after they received their energy label. However, the energy labelling process was halted, leaving the authors without access to citizens. Secondly, the original study design also tried to capture the surrounding network of actors and incentives. The complications to citizen access curved the focus of the present report, and directed it further in this direction, and so the members of the AGC-project group were engaged in a continued conversation around their experiences with the implementation of LTDH in Avedøre Landsby. Where the original study design was centred around action research and its cycles of continuous action and joined reflection (2008), the present report is based on an intensive field work centred around participatory observation in Avedøre.

Participant Observation

In general, participant observation is used in qualitative research to create an appreciation for the lived human experiences within a specific situation or social world (Mogensen & Dalsgård, 2018), and it has been described as the kind of focused attention through which ethnographers study the situation of concern (Siegel, 2018). For the present report this has been done by participating in different social groups and settings while observing the social as well as physical arenas where people have their experiences. The different physical arenas for observation have been Transition's main office in Aarhus, Avedøre Landsby, the offices of EGC and EBO consult at Hvidovre Gymnasium, physical meetings

with the project group, online meetings and local Facebook groups. The significance of participant observations for the present paper comes from its interplay with SA. As SA seeks to explore both social and material aspects of the situation of concern, it becomes important to have methods for exploring the materialities of the situation through more than descriptions from our informants. Participant observations provide precisely that.

As both authors of the present report have been employed as student assistants at Transition during the timeframe of this study, access to the company office has been easily obtained. While a professional relation to one of the main organisations in the project group raises some obvious ethical concerns about the objectivity of the research, it also provides the opportunity to study the organisation and their part in the project from the inside-out. This dynamic also has the advantage that it makes promoting changes to the Avedøre-project easier, as the authors of the present report are viewed as co-workers and collaborators on the project instead of outsiders merely observing the process. Furthermore, studying Transition's part in the AGC-project from within has allowed the authors to observe any differences between what actors say they do, and what they actually do.

An additional effect of the change of focus in the present report was that concerns about the authors positions as consultants from Transition shifted. Initial concerns had circled issues relating to having to be both proponents for the citizens' perspectives as well as Transition's. The shift meant that the present report was no longer both a master thesis and consultant report ordered by our employers. And so, the format of and perspective of potential insights of the final report were liberated. In turn, this raised new concerns regarding access, as access to documents and meetings were originally given as a necessary part of doing a job/delivering insights. By explaining that the changed focus was, in fact, due to the AGC-project itself, it was renegotiated that the new focus would still generate insights relevant to Transition and so our level of access was unchanged, even if they were no longer the primary recipient of the final report. As access was granted through Transition, a possibility remained that the other actors in the AGC-project would misinterpret our presence, as merely representatives of Transition appointed a specific part in the project. To counteract this, it was made clear when we were initially introduced to the project group that we were first and foremost students at Aalborg University and then employees from Transition. Being sensitive to the identities of our informants, while still wanting to maintain some specificity to the case, informants are presented as representatives of their organisations and not by name.

Webnography

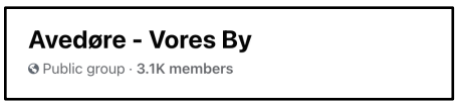
An increasing amount of social life takes place online as people communicate, organise, and participate in public debates on platforms like Facebook. Recognizing this, ethnographers have to adapt their methods and move focus to these online spaces to accurately capture the dynamics of a specific situation or social interaction (Albris & Wahlberg, 2018). As argued by Albris and Wahlberg; where

ethnographers in the past had to defend including online interactions in their fieldwork, ethnographers of today, must defend not doing so. In trying to capture the actions taken by different actors in relation to the AGC-project, the authors of the present report have chosen to include webnographic methods in the data collection. However, doing so did not yield the intended result.

Webnography or digital ethnography describes the use of traditional ethnographic methods such as participant observation and friendly conversations reconfigured to online interactions (Albris & Wahlberg, 2018). Here, the kinds of interactions that can be had and observed are different, and so the ethnographer must be ready to be, virtually mobile, be able to distinguish between the "virtual" and the "real", prepared to have short interactions with informants, reflect on how mediated interaction adds a new ethical dimension to the fieldwork, adapt to the circumstances of the digital world (Albris & Wahlberg, 2018).

In the case of participant observation, this raises an important ethical concern, as observing online life allows the observer to do so without ever letting the observed know that someone is watching. In closed forums this issue is less relevant as the ethnographer must be admitted entrance by an administrator, providing an opportunity to state his/her intentions. For publicly accessible sites such as public Facebook-groups, the dynamics of consent are quite unique. Here, people come to take part in or observe public debates knowing that everyone will be able to see their contributions, but it is fairly safe to assume that most people do not consider that someone could be studying how people interact on the site. To accommodate this dilemma, the authors of the present report have made contributions to the included sites in the form of posts with a personal introduction and a clear statement regarding purpose.

These are the included sites:



"Avedøre - Vores By" is a public group where everyone can contribute things relevant to people who live in avedøre.

"Avedøre Landsbylaug" is a site with 505 followers. The authors of the site are the only ones that can post, but everyone can comment on posts made.

One of the primary purposes for including these sites in the data collection was that it might have enabled us to establish contact with people in the physical field of Avedøre Landsby without being physically present. Unfortunately, the attempts to engage the citizens of Avedøre Landsby through Facebook did not result in any established contact, as the contributions made on each site saw little to no interaction from other users. When searching the sites for posts or comments related to AGC or DH in either Avedøre Landsby or Avedøre Stationsby, we discovered that in general these topics had less

interaction than posts relating to other topics. As the reader will later come to understand, the lack of interaction with the topic of AGC, was an early tell of the prospects of the AGC-project.

Talking with informants

One of the ways that we can explore the realities of our informants is through conversation. These conversations are often happening through interviews, but for the present report, our interactions with informants seldom had the structure of a traditional interview. The interview allows us as researchers to ask questions and explore the realities of informants. The main inspiration for the interview methods for the present report are found in James P. Spradley's work *Asking Descriptive Question*, (1979), and Mikkel Rytter and Karen F. Olwigs *At snakke om det: Måder at interviewe på* (2018). Both texts circle the relations between interviewer and interviewee and the structures of an interview. This relationship is described by Spradley as *rapport*. The term describes the notion that informants can have towards you as an interviewer and vice versa. Rapport can be divided into four categories as, apprehension, exploration, cooperation, participation. It describes how relations with informants can grow in different stages (1979). Our wish has been to reach the collaborative and participating stage, so we in direct relation with the informants can elaborate on the project.

Rytter and Olwig (2018) present us with four different approaches; friendly conversations, semi structured interviews, structured interviews and focus group interviews. These different interview techniques provide us with different strategies. The friendly conversations provide a more open-minded way of speaking, with a more informal way of speaking. The semi-structured is a more formalised way of interviewing where the interviewer is more or less in control of the interview situation and leads the interview in a certain direction. For most of our interactions with informants outside formal AGC-project meetings we have used a combination of the semi-structured interview form and the friendly conversation, as this fits the more formal conversations of a professional work setting, without letting the informant feel like the "subject" of an interview. Here, it was possible for us to direct the conversation, to obtain specific knowledge, but it also allows the informant to go beyond the topic of concern.

When conducting an interview, we are seeking to break down the barrier of *the Other* because we want the informants to be an active part of the research project, and not mere subjects of our research. Therefore, we turn to Lars Bo Henriksen's paper *Language Games, Dialogue and the Other (2019)*. Henriksen sees the normal interview situation as something alienating for the relationship between you and *the other* and therefore wishes to emphasise on the importance of dialogue instead of a monologue. We see dialogue as the space where new possibilities form, and it is through dialogue that we can construct new realities, which speaks into the original action research perspective of the study design.

Analysis

In this analysis, the results of our fieldwork will be unfolded and analysed through the lens of SA. The analysis is structured so that each chapter of the analysis generates new insights and can stand alone, while still building on previous chapters.

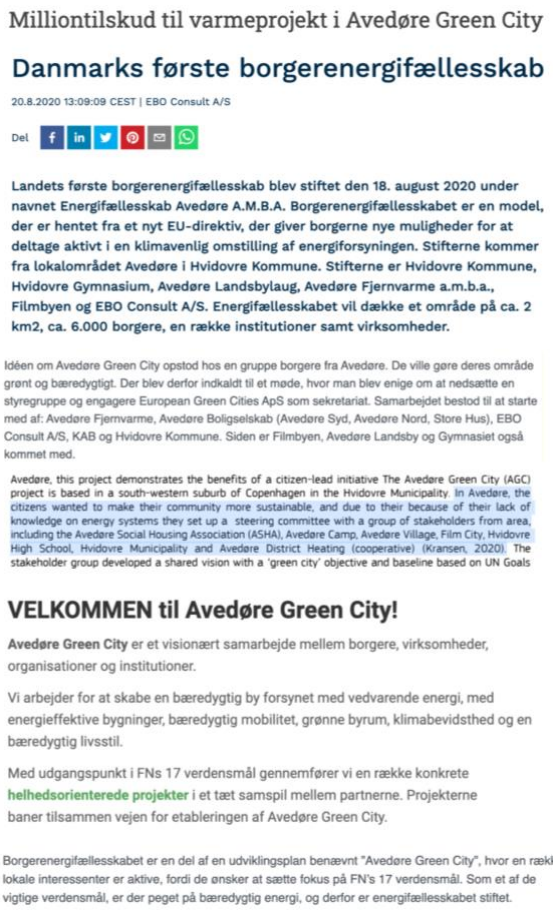
Even though LTDH has been used to describe a certain type of DH in the present report so far, from this point onwards the more general term DH is used instead. This is done, as central human actors did not explicitly distinguish between versions or generations of DH in the empirical data.

Chapter 1: The Vision of Avedøre Green City

This chapter is a presentation of the initial visions for the AGC-project as presented by key actors surrounding the project. The first subchapter showcases different discourses used to describe the AGC-project in newspaper articles, on official project websites and in in-person presentations of the project. This is an outsite-in presentation of the project to give the reader an understanding of how ideas about citizen engagement and technological development were present at the genesis of the AGC-project. In the second subchapter, insights from the initial phases of fieldwork are then presented to give an inside-out presentation of the project as we found it, illustrated through the use of situational maps.

1.1. Visions Towards a Sustainable Avedøre

Reading newspaper articles and official project website descriptions, the AGC-project was presented as the greatest citizens-driven energy transition project in newer times with the vision of a strong collaboration between citizens, companies, public institutions and organisations. **Figure 9** is an illustration of different clippings from the material that was found and presented to us. These articles presented how different stakeholders, with help from the citizens in Avedøre, had created a platform for making sustainable improvements in the area, and how much funding the project had got. This presents a story of how the project started through a group of active citizens, who saw a need for a new energy infrastructure and new ways of heating, to create a new sustainable community. This group of citizens from Avedøre reached out to different stakeholders to take the project from an idea to reality. The group of stakeholders was composed by different actors with knowledge and experience in energy



Milliontilskud til varmeprojekt i Avedøre Green City

Danmarks første borgerenergifællesskab

20.8.2020 13:09:09 CEST | EBO Consult A/S

Del

Landets første borgerenergifællesskab blev stiftet den 18. august 2020 under navnet Energifællesskab Avedøre A.M.B.A. Borgerenergifællesskabet er en model, der er hentet fra et nyt EU-direktiv, der giver borgerne nye muligheder for at deltage aktivt i en klimavenlig omstilling af energiforsyningen. Stifterne kommer fra lokalområdet Avedøre i Hvidovre Kommune. Stifterne er Hvidovre Kommune, Hvidovre Gymnasium, Avedøre Landsbylaug, Avedøre Fjernvarme a.m.b.a., Filmbyen og EBO Consult A/S. Energifællesskabet vil dække et område på ca. 2 km2, ca. 6.000 borgere, en række institutioner samt virksomheder.

Idéen om Avedøre Green City opstod hos en gruppe borgere fra Avedøre. De ville gøre deres område grønt og bæredygtigt. Der blev derfor indkaldt til et møde, hvor man blev enige om at nedsætte en styregruppe og engagere European Green Cities ApS som sekretariat. Samarbejdet bestod til at starte med af: Avedøre Fjernvarme, Avedøre Boligselskab (Avedøre Syd, Avedøre Nord, Store Hus), EBO Consult A/S, KAB og Hvidovre Kommune. Siden er Filmbyen, Avedøre Landsby og Gymnasiet også kommet med.

Avedøre, this project demonstrates the benefits of a citizen-lead initiative The Avedøre Green City (AGC) project is based in a south-western suburb of Copenhagen in the Hvidovre Municipality. In Avedøre, the citizens wanted to make their community more sustainable, and due to their because of their lack of knowledge on energy systems they set up a steering committee with a group of stakeholders from area, including the Avedøre Social Housing Association (ASHA), Avedøre Camp, Avedøre Village, Film City, Hvidovre High School, Hvidovre Municipality and Avedøre District Heating (cooperative) (Kransen, 2020). The stakeholder group developed a shared vision with a 'green city' objective and baseline based on UN Goals

VELKOMMEN til Avedøre Green City!

Avedøre Green City er et visionært samarbejde mellem borgere, virksomheder, organisationer og institutioner.

Vi arbejder for at skabe en bæredygtig by forsynet med vedvarende energi, med energieffektive bygninger, bæredygtig mobilitet, grønne byrum, klimabevidsthed og en bæredygtig livsstil.

Med udgangspunkt i FNs 17 verdensmål gennemfører vi en række konkrete **helhedsorienterede projekter** i et tæt samspil mellem partnerne. Projekterne baner tilsammen vejen for etableringen af Avedøre Green City.

Borgerenergifællesskabet er en del af en udviklingsplan benævnt "Avedøre Green City", hvor en række lokale interessenter er aktive, fordi de ønsker at sætte fokus på FN's 17 verdensmål. Som et af de vigtige verdensmål, er der peget på bæredygtig energi, og derfor er energifællesskabet stiftet.

Figure 9 A collection of cut-outs from various websites and newspaper articles about AGC.

infrastructures and sustainable heating. Among the stakeholders were, Avedøre Fjernvarme, Avedøre Boligselskab, EBO Consult, KAB, and Hvidovre municipality. Through conversations, the impression was that everything was possible in the AGC project, as the project was largely citizen-driven and had the support from all the residents in the area. The most important result of the project was to better the living conditions for the citizens in the area and help them start a new sustainable way of living. In this way, publicly available information around the project contained a discourse, presenting how ***the project is by the citizens, for the citizens***. The discourse was composed and constructed, because of the narratives and descriptions of how the citizens were in charge of what would happen in Avedøre, and that their needs were most crucial to the process.

When the AGC-project was presented to the authors of the present report by contacts at Transition, in relation to doing a master thesis on the subject, the initial impression was that ACG was a visionary new way of inviting the citizens to sit around the table and be the ones making the decisions, on the same level as the stakeholders. The roles of the authors as both employees and students were laid out as a central part of the citizen engagement. The master thesis was proposed in a phone by a contact at Transition in mid-January 2022. In his presentation of the AGC-project, he spared no energy on emphasising its importance. As he said: "*This is a master thesis with the potential of impacting the course of the industry for the next ten years"*. Here, he was talking about the DH industry, but also the industry of consultancies facilitating sustainable transitions, that Transition itself is part of. He was specifically talking about the master thesis, providing key insights into how citizens can be helped to improve the energy efficiency of their homes. Energy labelling was the method of the AGC project group to start the dialogue with the citizens of Avedøre Landsby. By providing a free energy label, the house owners could be willing to engage in an open dialogue about what this means for them, and by that inviting them into the process of implementing the new energy infrastructure. The homeowners were supposed to be offered an ongoing dialogue focussed to ensure that the citizens were not left behind in the implementation and decision phase. As mentioned in the problem analysis, the AGC was a development project, which meant that their reason for making this project was to contribute to the sustainable energy sector and set an example and new standard for other

EU countries. If the stakeholders could succeed in making a new method for implementing a new sustainable energy infrastructure, and a collective heating system, without the use of fossil fuel, the project could be replicated to all small villages around Denmark and Europe. On the other hand, the wish for creating new methods, to help citizens moving from energy labelling to renovation and being an actual partner in the implementation of new energy structures, it would be possible to make faster processes, to solve the ongoing problems in the energy sector. Considering the above, the significance of AGC was perceived to come from the project's scalability. With this vision and the descriptions of the AGC project, the discourse, ***the promise of scalability,*** has been constructed. It became visible through the conversations and descriptions mentioned above, with the promise of making a citizen-driven project, with the citizens' needs as the driving factor. On the other hand, the promise of making new standards in the industry and reaching other small communities in Denmark and all over the EU, made the achievement of success even more important. The scalable elements of ***the promise of scalability*** were the new technological development of the new generation of DH, combined with a new approach and methods to involve citizens in the process.

1.2. The Messiness of the Situation

Within new implementations of large-scale energy infrastructures, a vast field of actors is assembled, and when different actors are gathered, with their different assumptions and opinions, the situation can become more complex. The following paragraph will show the first iteration of the messy map of the elements surrounding AGC because it allows us to get an overview of all the actors in the case. The initial mapping, seen underneath, was how we meet the case of AGC.

The goal of the first initial messy map of the situation was to get a grip of the situation, before entering the physical field in Avedøre. When mapping a situation, you need to ask yourself, "*who and what are in the situation, and who and what matters in the situation?*" (Clarke et al., 2016). The map of the situation shown in **figure 10** is a composition of all the human and non-human actors, discourses that were present in the empirical data from the initial research, meeting notice, project documents and conversations with actors from the AGC-project. An invitation to an advisor workshop held in April 2022 was central to the author's understanding of the AGC-project, as the meeting notice laid out the actors of the advisor group.

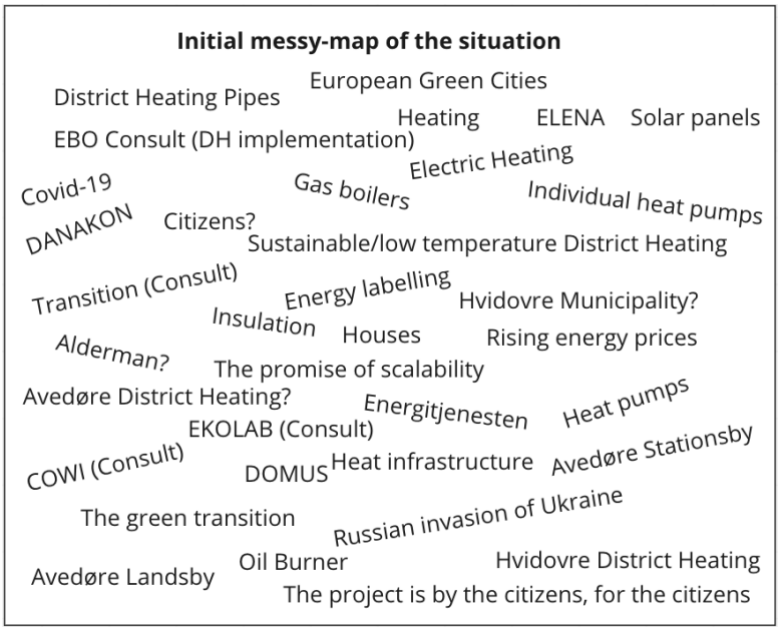


Figure 10 Initial messy map made during initial phases of the fieldwork.

To better understand the complexity, the elements seen in **figure 10** were ordered into categories. When situations are complex, the ordered map gives a better understanding of who and what matters in the situation, and by categorising the different elements, the different elements become more visible and tangible (Clarke & Friese, 2007).

INITIAL ORDERED MAP

Collective Human Actors/Elements
(e.g., particular groups; specific organizations)

- EBO Consult (DH implementation)
- Transition (Consult)
- COWI (Consult)
- DANAKON
- EKOLAB (Consult)
- DOMUS
- Energitjenesten
- Hvidovre District Heating
- Avedøre District Heating?

Discursive Constructions of Individual and/or Collective Human actors
(as found in the situation)

- Citizens?
- Alderman?

Discursive construction of non-human actors/elements
(as found in the situation)

- Sustainable/low temperature District Heating
- Individual heat pumps

Spatial Elements
(e.g., spaces in the situation, geographical aspects, local regional, national, global spatial issues)

- Avedøre Landsby
- Avedøre Stationsby

Other Kinds of Elements
(as found in the situation)

- Covid-19

Non-Human Actors
(e.g., technologies; material infrastructures; specialized information and/or knowledges; material "things")

- Energy labelling
- District Heating Pipes
- Houses
- Heat infrastructure
- Heating
- Insulation
- Oil Burner
- Gas boilers
- Electric Heating
- Solar panels
- Heat pumps

Related Discourses (Historical, Narrative and/or Visual)
(e.g., normative expectations of actors, and/or other specified elements; moral/ethical elements; mass media and other popular cultural discourses; situation specific discourses)

- The green transition
- The project is by the citizens, for the citizens
- The promise of scalability

Political/Economical Elements
(e.g., the state; particular industries; local/regional/global orders; political parties; NGOs; politicized issues)

- European Green Cities
- ELENA
- Hvidovre Municipality?
- Russian invasion of Ukraine
- Rising energy prices

The ordered map helps unfold the empirical material that was gathered before entering the physical field. By mapping and visualising the elements of the situation, different questions started to occur.

At this point, the AGC project had been going for 2 years. This gave the impression that the project was running according to the plan, and that the technological plans were finished. The only thing missing in the project was the implementation of the new energy systems. With that in mind, one question kept circling after the mapping: Where are the citizens? When we were invited to meet the project group of AGC, we were met with a large group of actors, but no representative from Avedøre Landsby. The collective group of actors were: European Green Cities (EGC), EBO Consult, Transition, COWI,

DANAKON, EKOLAB, DOMUS, Energitjenesten, Hvidovre District Heating. When the ACG-project was initially introduced to us by our contact at Transition, the alderman of Avedøre Landsby was described as the citizen's representative that created the connection between Avedøre Landsby and AGC. He had the responsibility of spreading the word about the project, and giving the citizens of Avedøre Landsby information about energy labelling. And yet, he was not on the meeting invitation.

The non-human actors who were mapped and structured consisted of the known technologies that occurred in the documentation of the project. The discursive constructions of the non-human elements became clear in the documentation of the project, as all the technologies around the ***Sustainable/low temperature District Heating*** and what the technologies should do were mentioned, but the DH was never defined as the goal of AGC. The other mentionable discursive construction of the non-human elements is ***Individual heat pumps***. Together with the political/economical implication of the Russian invasion of Ukraine and the Rising energy prices, it was described by our contact at Transition as the biggest threat to the successful implementation of DH within the AGC project.

Lastly, the construction of the related discourse, ***The green transition***, became the overshadowing line of the project. Everything in the documentation of the project was mentioned in relation to green transition and sustainable living. This was also constructed, to describe the different aspects of the project. With the documentation, one theme of sustainability with the great outputs of green transition, was one side of the discourse. The other side of the discourse was what the meeting notice gave. The meeting was structured around predefined lines of planning and scheduling of the further development in the AGC project.

Chapter 2: Collaboration

This chapter covers both the initial conversation we had with Transition and EGC before the advisor workshop, as well as the advisor workshop. The aim is to lay out the project as we found it and build the rest of the analysis from this description of events and actors. The chapter begins with an introduction to the field and is then split into two themes and a final subchapter showcasing our situational maps as an additional layer of analysis. The first two subchapters portray the two major discussions about Avedøre Landsby's part of AGC. The third subchapter identifies a more general communicative issue between the project advisors.

We arrived in Avedøre Stationsby by train from Copenhagen and walked through a local park to get to Hvidovre Gymnasium, where the Avidsor workshop for the ELENA project was to take place. On the way through the park, we walked by a pair of new heat pipes about to be put in the ground. The advisor workshop was being held at EBO Consult's offices on the upper floor of the gymnasium, and as we were walking around the gymnasium, trying to find the right staircase to take, we ran into our contact at Transition, who, just like us, didn't know the way. Together, we managed to find an entrance to EBO Consult, but it turned out that we had found the one entrance that no one ever uses, so when we called our contact at EGC to be led in, she could find us. We were surprised that Transition knew just as little about the place from where the AGC-project was being run. Finally, our contact at EGC came to let us in, and we were let down a long hallway to the EGC office, passing by several doors marked with "EBO Consult". In the office were six desks spaced out along the office walls and a larger table in the middle of the room meant for meetings and having lunch. It was quite apparent that the office had previously been a small classroom, as educational pull-down maps were still installed on one of the walls. The purpose of the conversation was to get a more general introduction to the AGC-project and the role of EGC and ELENA before the advisor workshop.

Figure 11 is a visualisation of the advisor workshop with an introduction to the advisors and their responsibilities in the AGC-project, as they presented it themselves.

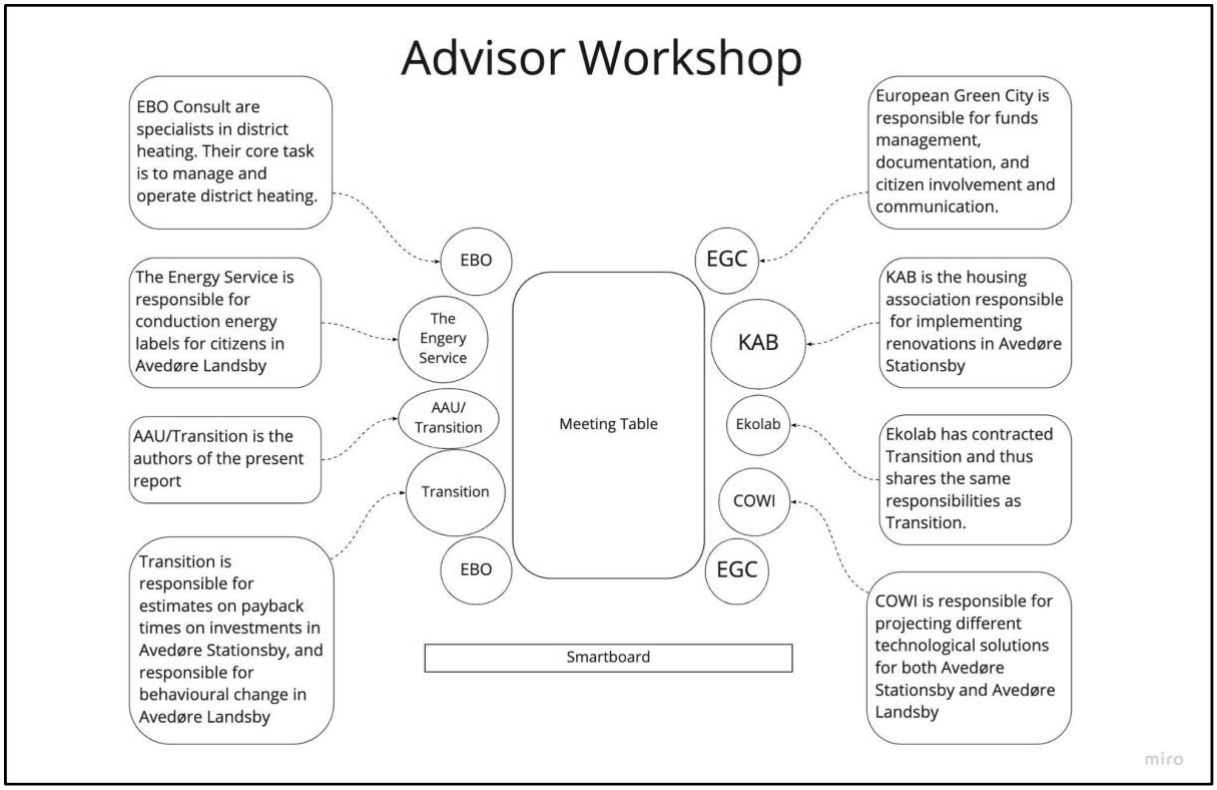


Figure 11 Visual presentation of the Advisor Workshop.

The workshop itself was structured with an initial presentation of purpose, program, and an introductory round of everyone at the workshop, and then a halfway orientation was given by EGC of the status of the investments. The first several points on the itinerary had to do with the progression of Avedøre Stationsby. The advisors discussed the renovations of buildings, different ventilation systems, the implementation of DH, while constantly relating different solutions to the degree by which it pushed the AGC-project closer to its 30% energy savings goal. COWI had prepared two reports for the workshop, one outlining different technical solutions for DH, heat pumps and solar panels in Avedøre Stationsby, the other one presenting possible heating scenarios for the village with different technical solutions.

2.1. It is Simultaneously Too Early and Too Late to Engage the Citizens

When time came for discussing the Avedøre Landsby part of the AGC-project, The Energy Service advisor was asked to share his assessment of the state of the village. He mentioned that according to his preliminary experience, there are fewer possibilities for renovations in the Village, because the buildings are not as bad in constitution as initially expected. This was supported by calculations made by Transition and Ekolab later in the workshop. The Energy Service advisor also mentioned that only 24 out of the village's 68 households have signed up for a free energy label. He explained, to the surprise of all the advisors, that *"people do not believe in anything if it is free".* He elaborated on this comment by saying that most people who have signed up for an energy label have done so because they are

considering selling their house, and so they need the energy label anyway. This way they save DKK 6-7.000.

As introduced in chapter 1 of the analysis, in early conversations with Transition, our contact had hinted that knowledge about the AGC-project and future DH plans might be limited in the village. At the workshop, The Energy Service advisor added to Transition's suspicions by explaining that he was under the impression that people in the village had little to no knowledge about any current or future plans of implementing DH in their area. Conversations about citizens' knowledge around DH plans had been a natural part of any inquiry about household heating solutions, but several homeowners had seemed outright surprised to hear that there were in fact plans for DH in development. Upon hearing this, advisors from EGC, Ekolab and Transition looked to the advisors from EBO Consult for a response to this problem, DH was after all their responsibility.

EBO Consult did not take this concern seriously, as they had a different picture about citizens' knowledge about coming DH. They explained how they were constantly getting requests from citizens all over Hvidovre Municipality, asking when they would be able to get DH in their specific areas. To EBO Consult, this meant that a desire for DH existed among the municipality's citizens, and so this had to be the case in the village as well.

The Energy Service advisor later asked the advisor group what he should say to people about when their energy label will be *"closed"*. Here he was referring to a process where you do not finalise the energy label right away after inspecting the house. Instead, you wait a couple of months before finalising, leaving a window of time for the citizen to make improvements that then appear in the final energy label report. According to the Danish Energy Agency's manual for energy consultants, reporting must take place within two months after the inspection has been completed[2]. He explained that knowing when you will have your energy label can be important to someone thinking about selling their house. EBO Consult responded by saying that they would like this to be as late in the process as possible, as they would prefer if citizens had already signed on to DH before their energy label is closed. In a later conversation over the phone, The Energy Service advisor explained that as the implementation of DH in the village is not projected to start until the beginning of 2023, he will have to do a second inspection of all the houses during 2023, to meet this requirement from EBO Consult and still uphold the rules of the guidebook for energy consultants. In all honesty, he said; *"If you have to go strictly in accordance with the manual, you cannot do this. But you often do that because people want to improve their energy label."*. Ultimately, homeowners can expect their energy labels to be finalised by the end of 2023 unless DH implementation happens quicker than expected.

In trying to solve both the problem of lacking knowledge about the DH plans and the issue of informing citizens about the process of getting their energy label, the advisor from The Energy Service argued that

[2] The Danish Energy Agency: Manual for Energy Consultants (HB2021) valid from 1 July 2021 https://hbemo.dk/haandbog-for-energikonsulenter-hb2021-gaeldende

a citizen meeting was needed as soon as possible. Responding to this, one EBO Consult advisor leaned back in his chair and said, *"well before we can even start talking about citizen meetings, we need to have the project proposal in place"*. He said it, smiling like it was almost silly of the other advisors to suggest. Like it was just so obviously not the time for citizen meetings at the current stage of the project. This difference in perceptions regarding what was needed in the project to overcome different obstacles were apparent many times during the workshop. Even though these examples might depict EBO Consult as being the ones holding back the progression of the project, they were not always the ones pushing the breaks. At the workshop, EBO argued enthusiastically for establishing an energy community[3] as a central part of building the planned solar panels near a riding school located at the northern part of the village. According to the calculations provided by COWI, between 3000 and 5000 m^2 of solar panels are needed to increase the profitability of the DH solution in the village. While an energy community promises to support consumer driven green transitions, Transition and The Energy Service quickly saw a possible complication that this could have for the citizens. They raised their concern, saying that having solar panels on your house positively impacts the rating of our energy label as well as increases the value of your house. So, if a person gets their solar energy from the energy community, they will not get the benefits because they won't "own" the solar panels, even though they will be considered a co-owner of the solar park. As none of the advisors were certain about the specifics of this, they all decided to contact The Energy label Secretariat to settle the impact of energy communities on the homeowners.

These examples show the different and perhaps counterproductive ways in which the different advisors see different elements of the planning as presenting. For some it is clear that the advisor group cannot let the citizens be unaware of the project any longer, and for others it does not make sense at all to talk to the citizens until the advisor group is completely sure of their statements. The examples of lacking citizens' knowledge and energy communities helps to show that it is not always because EBO is reluctant or apprehensive, but it is a matter of difference in how to understand the value that the project should ultimately have for citizens, and why citizens should be motivated to be part of the project when it one day becomes a reality. On both sides of these debates, the advisors stand unsympathetic to the perspectives of the other, and so within the advisor group it becomes simultaneously too early and too late to engage the citizens, and both non-problematic and obviously problematic to implement an energy community. What becomes visible at this meeting is that the advisors have no methods or models for

[3] The Electricity Market Directive defines a citizens' energy community as a legal entity:

1. which is based on voluntary and open participation and is effectively controlled by members or partners who are physical persons, local authorities, including municipalities, or small businesses;
2. whose primary purpose is to provide its members or partners or the local areas in which it operates, environmental, economic or social benefits to the Community rather than to provide economic benefits;
3. which may engage in production, including based on renewable energy sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or services for charging electric vehicles or providing other energy services to its members or partners.
   https://kromannreumert.com/nyheder/energi-faellesskaber-ny-mulighed-groenne-omstilling

integrating citizens into the project. They may want to, bringing up energy communities and citizen meetings, but when it comes to it, it seems they don't know how to.

2.2. One Project Erodes Another

In the meeting with Transition and EGC before the workshop, our contact at EGC told us how happy she was that the advisor group were finally going to meet physically, as they had only ever met through online meetings. She had 10 years experience at EGC and her experience told her that having the advisors meet each other in "real life", would have a positive impact on the project as a whole. To increase the yield of the workshop, she had initially thought of arranging different workshop games at the beginning of the workshop in order for the participants to get to know each other. As she was explaining her ideas, our contact at Transition interrupted saying, laughingly, *"If you do that, they won't come to another meeting ever again"*. With *"they"* she was referring to the other advisors. Our contact at EGC responded by saying that she had had the same thought and thus had decided not to do anything apart from a round of introductions, asking people to mention one personal detail they normally would not say in a similar setting. Both contacts from EGC and Transition agreed that engineers were too "stiff" for such social games. They justified using stereotypes about engineers, as they were themselves engineers by education. Later, while sitting in the hallway going over our notes from this conversation, we heard two men come walking down the hallway, one wearing workwear, the other one looking more business casual. The business casual looking one asks, *"Are you also in the meeting today?"*. The other one answers, *"No, because now you are going to sit around in a circle and talk things out, and that's not for me"*.

When we arrive at the workshop about half an hour later, we are all welcomed quite casually and our contact at EGC directs everyone to a table set up with different sandwiches, as lunch was included in the workshop. After everyone had sat down, our contact at EGC started speaking to the group of advisors. Here she briefly gave an initial presentation of the purpose and program of the workshop, and then she explained how excited she was that they were all meeting in person this time. She then went on by introducing a downplayed version of the workshop game she had originally planned. It was a normal introductory round with an added element, where apart from saying your name and the name of the institution you represented, participants had to include one personal detail they did not usually disclose when introducing themselves.

Our contact at ECG handed off the round to our contact at Transition, as they had already discussed the purpose of this kind of workshop game, our contact at EGC might have felt she had an ally at Transition. As we went around the table, most people related their personal details to what the person before them had said. This way, everyone said something personal without actually risking exposing themselves to the other participants. It was easy to read their anxiousness as apprehension. Halfway around the table from our contact at Transition, another representative from EGC tried to liven up the game by showing

off a personal skill, revealing her to be quite the ventriloquist. Given little warning, the other advisors were stunned. Not knowing what to do with themselves, they continued the introductory round as if nothing had happened, as to clearly state that they were not the kinds of professionals who could be engaged in such playful and silly games. The inflexibility or rigidness shown through this story paints a picture accurate to the advisors' demeanour through the workshop, and so the early indications for the yield of the workshop were not promising.

Another story that shows the state of collaboration between the members of the advisor group starts at our initial conversation with Transition and EGC before the workshop. Apart from funds management and documentation, EGC relayed their main responsibilities in the AGC-project as citizen involvement and communication. As mentioned in the problem analysis, one part of AGC revolves around green mobility in Avedøre Stationsby. Both in this part of the project and in the process of implementing more sustainable DH in Avedøre Stationsby, EGC has focussed heavily on communicating every step of the process to the citizens. Here, EGC has spent a lot of time trying to accommodate the different ethnicities living in Avedøre Stationsby. In this work, they collaborate with the housing association, as tenants in Avedøre Stationsby are used to receiving information about their housing arrangements communicated to them from the company who owns the buildings. Collaboration had, however, not been easy as KAB, a non-profit housing association that manages approx. 60,000 public housing units in the capital region, insisted that communication in languages other than Danish was unnecessary. Our contact at EGC also voiced her frustrations around the general collaboration with KAB as she had experienced on more than one occasion that KAB would stop all communication with EGC, not responding to emails or phone calls. This is problematic as KAB were often the ones in direct contact with tenants as the connection between the secretariat and the citizens. Our contact at EGC described working with KAB as *"a thick layer of rock wool we can't penetrate"*. She had tried offering KAB a larger financial incentive towards the project, but they had not been interested. She explained that she had a hard time figuring out the motivations for the different *"stakeholders"* being part of the AGC-project, and the whole project seemed a hassle because of it.

Remnants of this frustration were present at the workshop. It seemed the introductory round had not had the desired effect, and the tone of the room quickly became tense as the advisors continued down the itinerary. The first item after EGC gave a general status of the project following the introductory round was KAB presenting the progress of renovating buildings in Avedøre Stationsby. Apart from communication being suboptimal, the renovation projects had been a strenuous process in and of itself. Avedøre Stationsby is split into a northern and a southern half. The project of renovating buildings in the north had been somewhat problem free and collaborations had run smoothly. This half of the project was expected to be completely renovated by the end of June 2022. The south, on the other hand, had all but derailed, with legal issues arresting the process and as such it would not be completed until the end of February 2023. When presenting these timelines, the advisor from KAB answered the questions from

the other advisors defensively and irritatedly, and not long after he was done presenting, an alternate came to replace him, and the advisor from KAB left the room in a hurry. The alternate that had taken his place was a plumber in charge of overseeing parts of the renovations in the railway town, but it quickly became apparent that his knowledge about the general project did not meet the expectations of the other advisors in the workshop. In both the presentation and discussion of the project in the railway town, the atmosphere continued to be tense, and when our contact at Transition presented Transition and Ekolab's calculations for potential energy savings, the advisors obviously disagreed on how to calculate the profitability of different measures. Their dispute specifically revolved around how optimistic one should be in these calculations. Here, long payback times became the focal point of a discussion that ended with one advisor saying to another, *"Calculating it like that is laughable!"*. It was clear that much of the work in the railway town had been a tiring process, and the mood it sat, was still present in the workshop when the advisors got around to discuss the prospects of Avedøre Landsby.

An almost humorous detail is that the untended discussion and arguing taking place during the workshop resulted in a sliding time schedule with no time for the two last items on the itinerary. One of them being a discussion of the further course of the ELENA project, including discussions about interaction, collaboration, and the advisors' experiences from working together the first half of the project.

2.3. Situational Maps of the Advisor Workshop,

Through subchapters 2.1 and 2.2, different complications in the collaboration and perspectives of the situation have been relayed to give detailed insight into the relations between the actors within the Advisor group. This has been done by yet again asking; *who and what matters in the situation* (Clarke et al., 2016), as the situation became more complex, with the introduction of new actors and elements. Since the first iteration of the ordered map shown in Chapter 1, more elements have been added as a result of the fieldwork. To give a clear overview of the elements and different subjects relevant to the situation, all the elements are shown in the ordered situational map underneath.

ORDERED SITUATIONAL MAP

Collective Human Actors/Elements
(e.g., particular groups; specific organizations)

- EBO
- VEKS? District Heating supplier
- Students/AAU
- COWI
- KAB
- EGC
- EKOLAB
- Energitjenesten
- PBP
- Alderman
- The riding school
- The prison
- 30% reduction of energy
- End-Users
- Citizens
- Transition ApS
- Allotments

Discursive Constructions of Individual and/or Collective Human actors
(as found in the situation)

- Missing contractors
- "We know that people want DH, more than 237 people has already signed up"
- Energy community will solve the problem
- "Everybody knows" (The DH is on the way)
- "Educational effect"
- Engineers are too rigid

Discursive construction of non-human actors/elements
(as found in the situation)

- The risks of individual Heat Pumps

Non-Human Actors
(e.g., technologies; material infrastructures; specialized information and/or knowledges; material "things")

- Radiators
- Flexbooster Pumps
- Two-piped Heating system
- PTV/PV (Solar Panels)
- Heat Pipes
- Heatpumps
- Exterior and interior heating pipes
- Legionella
- COP factor
- Concrete with steel reinforcement
- DH
- LTDH
- Private homes
- Energy Labelling

Related Discourses (Historical, Narrative and/or Visual)
(e.g., normative expectations of actors, and/or other specified elements; moral/ethical elements; mass media and other popular cultural discourses; situation specific discourses)

- Rising energy prices
- A favour for a favour
- The green transition
- The project is by the citizens, for the citizens
- The promise of scalability

Political/Economical Elements
(e.g., the state; particular industries; local/regional/global orders; political parties; NGOs; politicized issues)

- ELENA
- Hvidovre Municipality

● "Energy savings in the Village are of no significance" ● Energy savings are easier than CO2 emissions ● Sustainable/low temperature District Heating	**Spatial Elements** (e.g., spaces in the situation, geographical aspects, local regional, national, global spatial issues) ● Hvidovre Municipality ● Avedøre ● Avedøre Stationsby ● Avedøre Landsby **Other Kinds of Elements** (as found in the situation) ● Covid-19 ● Legionella

The ordered situational map is the representation of all the elements in the situation of the Advisor workshop. Based on the empirical data from the meeting with the advisor group and the ordered map of the situation, the insights from the collected data were mapped out, to better understand the relations among the actors within the advisor group and explore different analytical perspectives. This has resulted in a relational map of the advisor group as seen below this paragraph. It is constructed through particular elements significant to their relations, and as such some elements seen in the ordered map have been left out and preserved for later analysis. To better understand how the map is constructed, some explanation is needed to understand the analytic process of making the map.

As seen in the relational map (see **figure 12**) different entities are mapped out, with different lines, arrows, and circles. The arrows present the relations between one element to the other. Both human and non-human elements have relations and are in some way or another always intertwined (Clarke et al., 2016). The full circles present the constructions of stable elements and discourses. The stable elements can be seen as non-human elements, such as physical structures, politics, and technical elements. The full circles also represent some of the elements that are more impenetrable, where the dotted circles present the more fluctuating elements such as the actors and their statements towards each other, and the constant change of the elements of concern. The *Advisor group*, *Avedøre Stationsby*, *Avedøre Landsby* and *District Heating* are all changeable elements, with different narratives relative to what actor sees it.

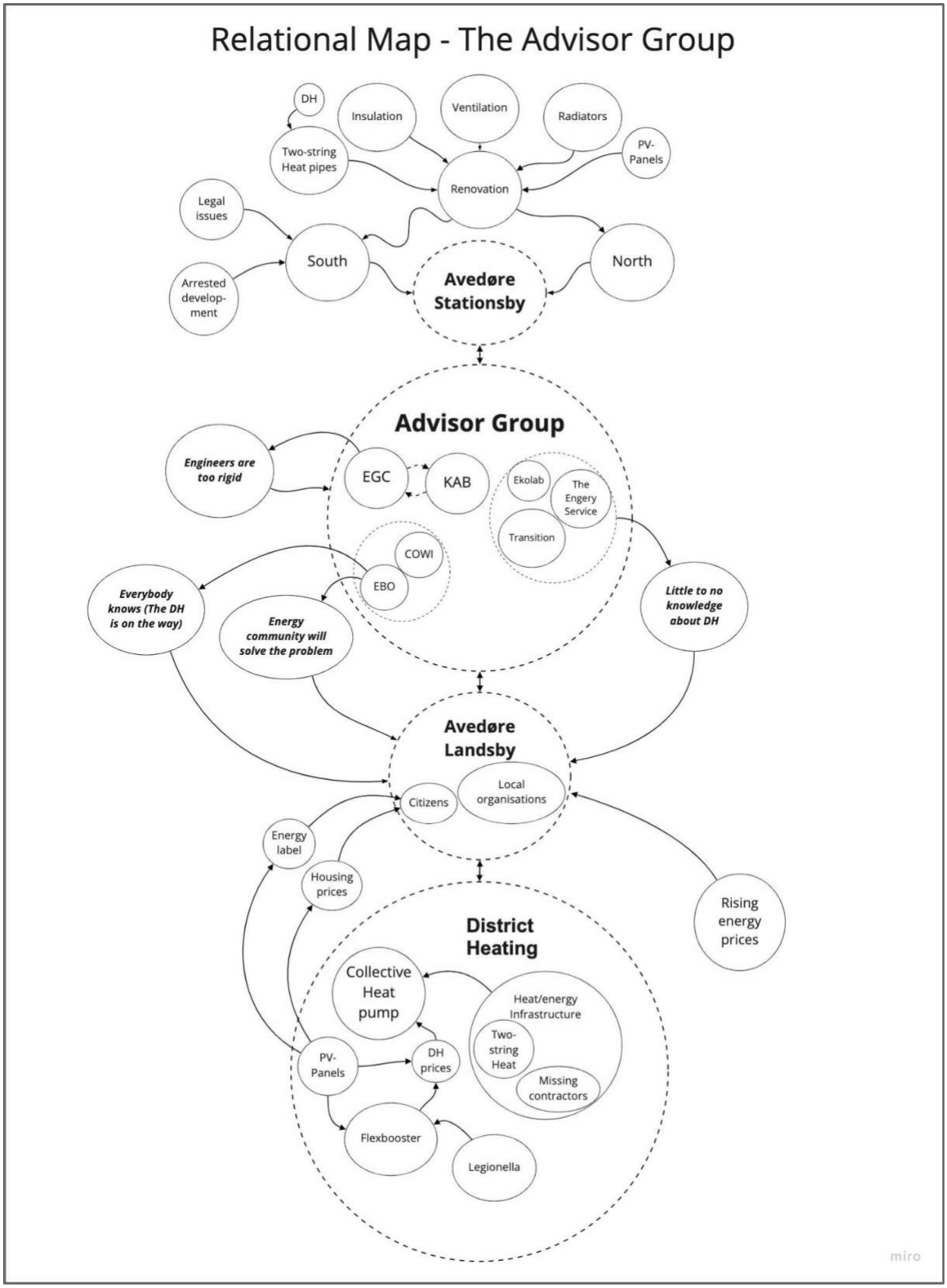


Figure 12 Relational map of the advisor group.

Reading the relational map from top to bottom reveals the first important insight as one regarding the relation between the projects within the larger AGC-project. As introduced in 2.2. the advisor group's

work concerning the Avedøre Landsby is negatively affected by the advisors' experiences from Avedøre Stationsby. Both the materialities of the project and the collaboration between human actors exhausts communication between the advisors before it has become time to discuss the village. The choices enforced by the material realities of heat pipes, degree and type of insulation, building ventilation systems, and different configurations of solar panels constitute a complex landscape in which the advisor group has to navigate. Having to implement these choices into buildings and the lives of several thousand tenants under different housing associations does not ease the process of implementation, as legal issues arrest part of the project. Collaboration becomes something the advisors only do reluctantly.

A discursive construction by EGC, depicting the engineers/other advisors as being rigid, does not help the prospects of the workshop, as it reinforces an already existing division of the advisors. Instead, this discourse asserts that the inflexible demeanour of EBO, COWI and KAB is responsible for the halted progress of DH in Avedøre Landsby. The division of the advisors continues to make itself present in discussions about the village, as the advisors have different perspectives on the value that the project should ultimately have for citizens, and why citizens should be motivated to be part of the project when it one day becomes a reality. From the side of Transition/Ekolab/Energy Service, it is clear that the advisor group cannot let the citizens be unaware of the project any longer, and citizen engagement is needed to overcome these issues. Through a narrative about the citizens having ***little to no knowledge*** about DH plans, they assert a perspective in which the project stands at a tipping point. On the side of EBO (and to some extent, COWI) it makes no sense at all talking to the citizens until the advisor group is completely sure of their statements. Here, narratives about EBO being flooded with requests from citizens all over the municipality wanting DH and the promises of energy communities are used to undermine the concerns of the advisors on the other side of the divide. On both sides of these debates, the advisors stand unsympathetic to the perspectives of the other, as the restraints of energy labels and DH as well as the effects of solar panels on both energy labels and housing prices make themselves felt by introducing uncertainties into the conversation.

The last circle on the map called District Heating is an assemblage of technologies and different human and non-human elements that remains to be unfolded. This will be done as an initial part of chapter 3 of this analysis, as it offers a new analytical perspective on the issues raised in chapter 2 while also initiating another layer of analysis coupling chapters 1 and 2.

Chapter 3: Perceived Issues

This chapter is divided into two subchapters. The first subchapter aims to describe the different perspectives of the advisor group in relation to DH. The relational map presented in this subchapter is based on the previous chapters about the advisor workshop. The second subchapter presents a social world/arena map, where collective human actors and non-human actors are mapped out, to show their commitments in relation to an arena of sustainable development.

3.1. The Different Realities of District Heating

By utilising relational maps, SA provides the tools needed for analysing a situation through different relations or perspectives. In exploration of the different perspectives of the advisors and how they relate to the realities of DH, a second relational map was constructed. In the situation surrounding AGC and Avedøre Landsby, it can be argued that DH is perceived in two different ways. This relational map is a visualisation of those perspectives (see **figure 13**). In the situation of concern, DH is an assemblage of multifarious actors, and as such it only exists as a result of the collaboration of both human and non-human actors. However, depending on which actor perceives this assemblage, the importance attributed to different elements, changes the degree and root of perceived stability of DH implementation.

Through the perspective of EBO, DH is first and foremost a collection of technologies that only when finalised and implemented can be seen as one entity, DH. Even then, having to service and develop different elements is a reminder that DH is not much more than a headline describing a network of technologies that together produce and deliver heat to buildings. EBO's relation to DH is one of uncertainty, and this uncertainty makes itself felt in their relation to every element surrounding DH: How are DH prices affected by the choice between flex boosters or a central heat pump, and how will this decision affect our ability to prevent legionella? — What kind of pipe network is most efficient, and what do we do about the shortage in available contractors to put the pipes in the ground? — How many m^2 of photovoltaic panels are needed to ensure a sufficient supply of locally generated electricity to increase profitability of the final solution? These questions are just a few examples of how the materialities of DH enforce themselves in the situation. The one thing EBO are sure about is that the citizens are intelligent customers who are willing to wait for the best product. This construction of the citizens is asserted through the already discussed narratives about EBO being flooded with requests from citizens all over the municipality wanting DH and the promises of energy communities ensuring profitability.

From the other side of the map, DH is the solution to a common problem of rising energy prices, shared between both advisors and homeowners. However, as the citizen is currently in the dark when it comes to future DH plans and anxious to get off gas or oil-based heating, Transition/Ekolab/Energy Service

perceives a scenario, where the citizens get individual heat pumps, as the most urgent threat to the AGC-project.

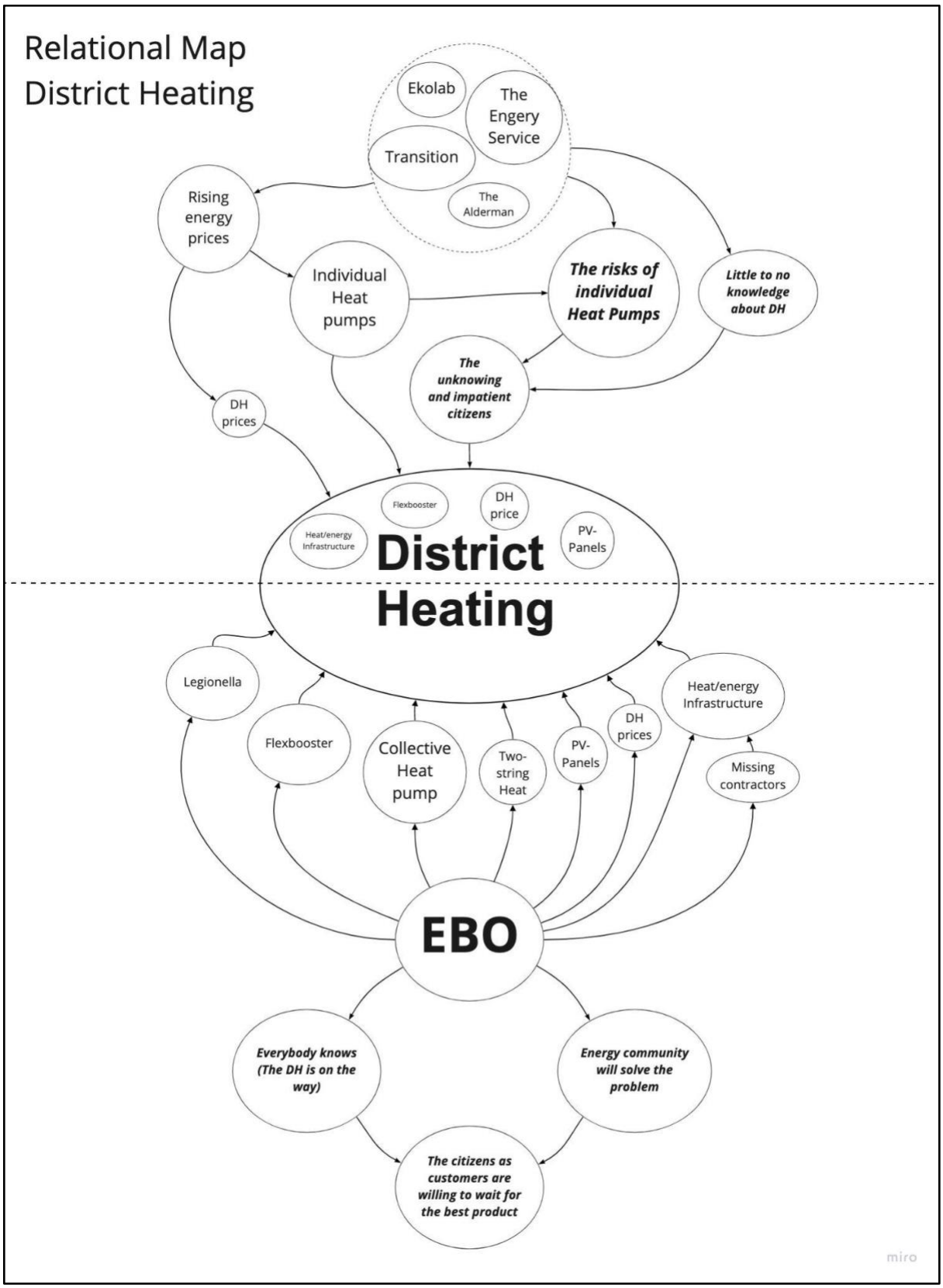


Figure 13 Relational map of district heating.

Borrowing the concepts of black boxes and translation from ANT aids us in understanding how EBO can perceive DH as the disordered and unstable element in the situation of concern, while the different concerns of Transition/Ekolab/Energy Service forces them to accept DH as temporarily stable enough to move forward with citizens engagement.

Because of the perceived threat of individual heat pumps, Transition/Ekolab/Energy Service accepts DH as a black box, closing the lid on its complexity to act in the situation. The possibility that there might not be any citizens left to sign up for DH in a near future, makes uncertainties regarding the specific constitution of DH and its parts become less relevant. This is because everything in the network that makes up DH is equally dependent on that scenario not becoming reality. And so in the perception of Transition/Ekolab/Energy Service, the network becomes translated into a temporary order by shedding its complexity to appear a stable tangible actor. Taking DH for granted allows them to include citizens in the process. Conversely, EBO's construction of the citizens means that negotiations between the elements of DH cannot be finalised before the constellation of technologies is stabilised through a collective rationale of energy efficiency. Only then can the plans for DH be presented to the citizens.

3.2. Avedøre Landsby - The silent Actors

Based on the analysis prior, this subchapter presents a social world/arena map. The social arena for the project has been named *Sustainable Development*. The arena describes the placement of all the major actors and the common goal of the whole project. Even Though it has been difficult to see the clear vision of the AGC project through the analysis, it is still the area of concern. *Sustainable Development* describes the wish and commitment of making a project that can contribute to a sustainable development, within the field of DH. It consists of two major social worlds; these social worlds describe the situation through the unstable relations between the different viewpoints (see **figure 14**).

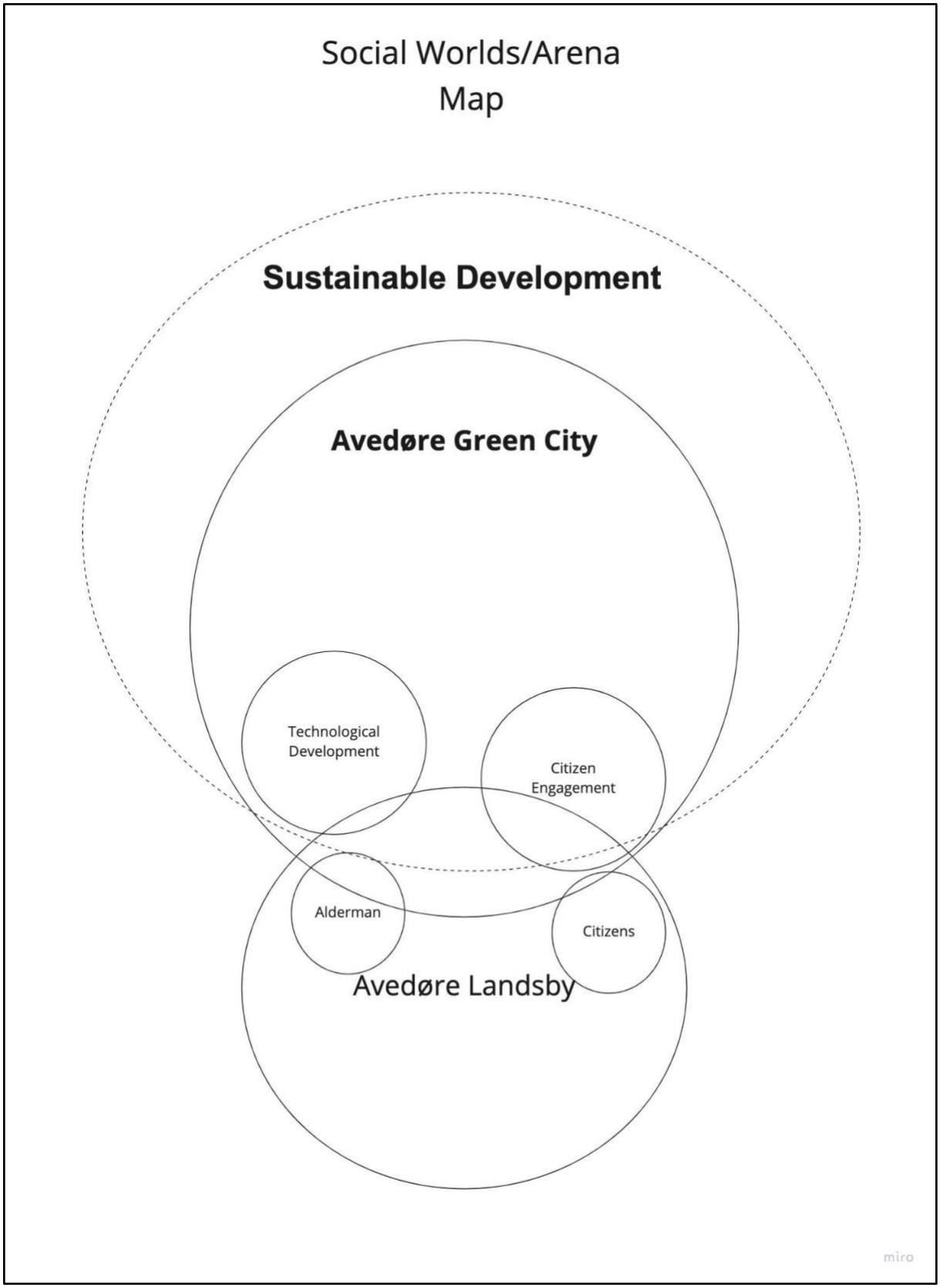


Figure 14 Social worlds/arena map of the collective actors within the project.

The two major social worlds that consist of the social arena are Avedøre *Green City* and *Avedøre Landsby*. The first social world is *Avedøre Green City;* it consists of the advisor group and their

negotiations, shown in the relational map. Under the social world of AGC, are two smaller social worlds, with their commitments. In the first one is *Citizens Engagement* seen, this social world describes the one narrative of the advisor group, they see the citizens as someone who needs their help to succeed in the conversion of their heat source to DH. The second sub social world is *Technological Development*, this consists of the advisor group's narrative about the technological solution. The citizens are seen as the consumers which are willing to wait for the best technological solution and by that they do not need help to make a decision of what is best for their individual situation.

The second major actor in the social arena map, is the social world of *Avedøre Landsby*. It is created through the narratives of what the city is, and the expectations of what the city should do in relation to implementing DH heating. In the social world of *Avedøre Landsby*, two underlying elements exist, the first of these is *The Alderman*. He represents both a narrative of the village and what it stands for, but he is also the narrative of success from the advisor group, as the one with the direct contact to all the citizens in the village. Therefore, *The Alderman* both become a part in the social world of *Avedøre Landsby*, and an individual actor as shown in previous maps.

The second element in the social world of *Avedøre Landsby* is the *citizens*. Throughout the whole project, the citizens have been mentioned as some of the most important actors, but as the project has progressed, there has been little to no space for describing the actual citizens, the ones that will be implicated by the project and the ones to make the decisions they really want. Their narrative has not been presented through the meetings or the descriptions of the project. They have been the silent actors, who may have had the most to say.

Over the course of this master thesis, the AGC-project has been evolving. The narratives of the actual citizens were never presented, and therefore never taken into account, because of the above-mentioned social worlds and relations. Even Though the narratives of the village and its citizens have been invisible from the advisor group, there exists a narrative about the village and its inhabitants. Through a guided tour around the village, a story was presented by the alderman to the authors of Avedøre Landsby being the oldest village in all of Denmark about 5000 years old, and a story about the villagers, upon being ignored by a past king, taking action themselves, building a school when the king didn't want them too. The narrative that came out of these stories was of vigorous citizens that only made projects as a community, with no to little need for outside help. In this way, the project stands or falls on the perceptions of the advisor group, but with the narrative of a self-sufficient village, how is it possible to make change when they do not know the project? With the risks of the citizens getting their individual heat pump, are they even aware that someone is planning a green transition on their behalf?

Chapter 4: Vision versus Reality

The final chapter of the analysis is centred around a positional map, constructed to lay out the major positions taken by collective groups of actors. Through the analysis, different kinds of mapping have been shown, presenting the relations and social arenas/worlds of the situation. The positions are established through discursive relations, so instead of focusing directly on the actors, the positional map provides the methods to visualise the positions taken through discourses (Clarke et al., 2016).

In the positional map shown below (see **figure 15**), positions taken within the situation are placed in relation to two axes, each representing a spectrum of a rational found relevant to the situation. The horizontal axis represents a difference in emphasis placed on the choices of the citizens. The vertical axis represents a difference in emphasis placed on the technological solution in Avedøre Landsby.

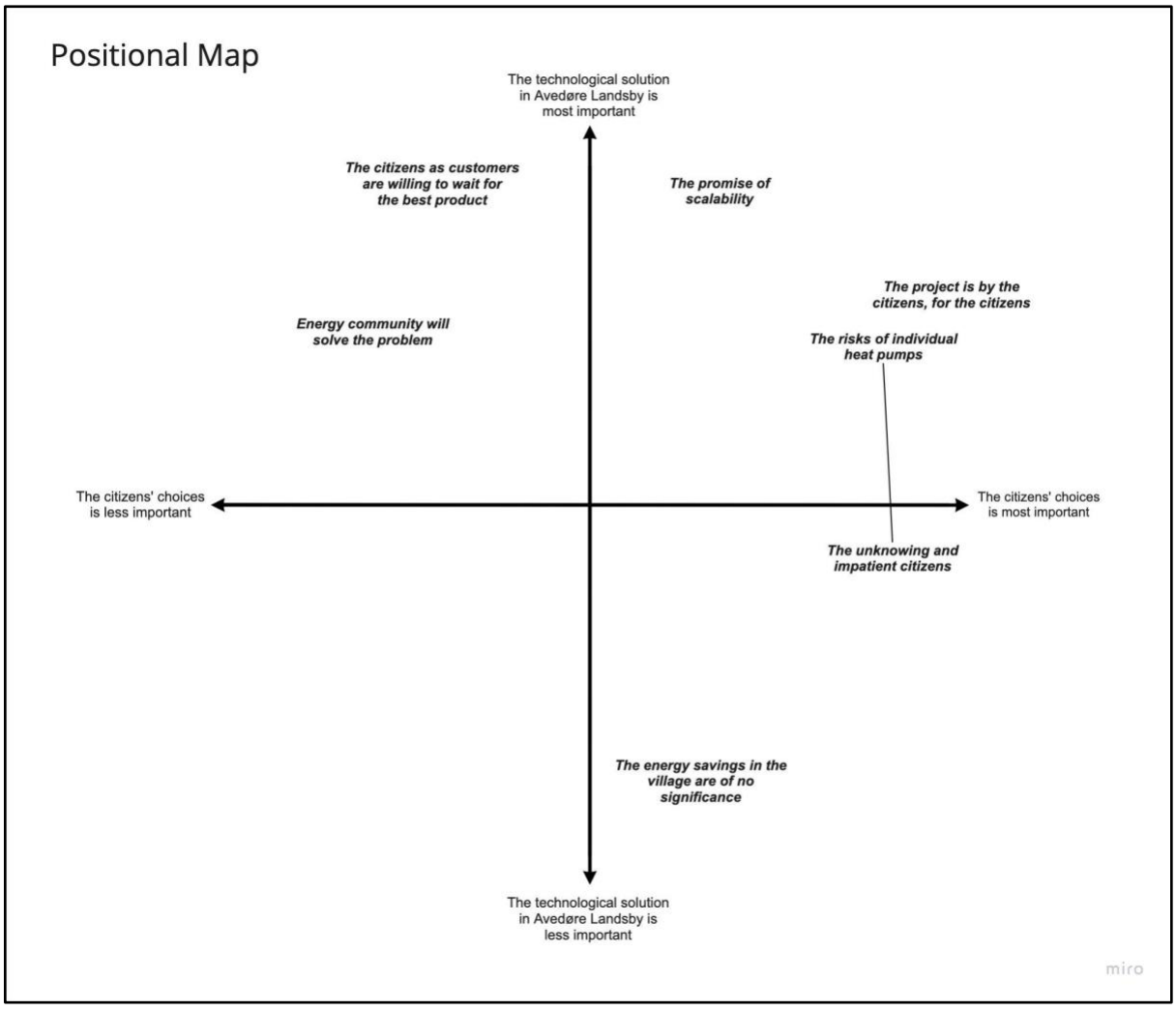


Figure 15 Positional map, of the discursive positions taken though the project period.

As argued in Chapter 1, ***The promise of scalability*** is one part of the initial vision for the AGC-project. This discourse takes the position that the successful implementation of low temperature DH in Avedøre

Landsby holds immense value, as the technological composition of DH can be applied in similar cases. Within this position exists an appreciation for the fact that citizens' adoption of the technologies is a requirement for success. ***The project is by the citizens, for the citizens*** is the second part of the initial vision for the AGC-project. This discursive position states that importance is first and foremost placed on the choices of citizens, but as the aim is creating a more green and sustainable city, implementing the "right" technological solutions are a central piece of this position.

Chapters 2 and 3 have presented ***The unknowing and impatient citizens***, a discursive construction of the citizens in the village as lacking knowledge of the DH plans, while being impatient in relation to waiting on someone else to make the necessary decision of what they should do with their current heating source. This represents a position where the specific constellation of DH in Avedøre Landsby becomes less important, and citizens' choices become an urgent matter of concern. A related position is that of ***The risks of individual heat pumps***. Here**,** the risk of the individual citizen making their own choices and acquiring their own heat pump, is present in the positions as a potential danger for the whole AGC project. The position implies that sufficient technologies exist to meet the concerns of the citizens trying to move away from fossil-based heating.

The position, ***The citizens as customers are willing to wait for the best product***, states that as the citizens are customers wanting the best technology or product to solve their problems, their choices matter less than the efficiency of the final solution. The position of shifting the citizens to being a customer, changes their position in relation to the project and the way that involvement is seen. The discourse, ***Energy community will solve the problem***, represents a position that undermines the effects of specific technologies "within" DH to the citizens and the choices. It argues for a collective system of citizens and technologies, who all contribute to the village's energy needs and become producers of electricity to make the project more profitable.

The energy savings in the village are of no significance is a position that has been left out of the analysis until now. It comes from the workshop, and it was taken in a conclusion in the minutes of the workshop to the advisors' discussions regarding energy savings in Avedøre Landsby. At the workshop, the implementation of the new heating system and energy infrastructure in Avedøre Landsby was described as of lesser importance to the AGC advisor group. On one occasion, the EGC representatives explained how, *"the village is the marguerite route"*, and as such its success or failure would not affect the larger AGC-project by much. In the minutes of the workshop, this position had been enforced through the advisors' presentation of long payback times on investments, and so the minutes stated: *"The energy savings in the Village are of no significance for the ELENA project's energy saving goals. Due to long payback times on energy-saving measures, the energy savings will generally only take place via conversion of heat supply."*. Everything around the implementation of DH in Avedøre Landsby and the needed assessment for that to succeed, was treated with disregards and indifference. From the

statement, we started to question the narrative and the motive behind the project in Avedøre Landsby. Was the project led by the motivation of helping citizens to get affordable and sustainable heat supply, or was the work in Avedøre Landsby only motivated by the project's goal of reaching 30% energy savings?

As the headline of this chapter claims, there is a distinction between the visions of the AGC and the reality of what actually happens. Through the positional map, the different positions taken by different groups of actors has shown that something went missing between the visions presented in chapter 1, to what has been shown through chapter 2 and 3. The position and discourse presented in chapter 1 as ***The project is by the citizens, for the citizens***, was never truly implemented in reality. From the beginning of the AGC project, our perception of what the project was meant to be and what it became changed drastically. With the promises of a groundbreaking development project, where green transition and sustainable living were the goal, somehow got lost. As the project progressed, the scenario feared by Transition and Ekolab became an emerging reality. Through a tour of Avedøre Landsby after the workshop, the Alderman pointed to a van passing by, explaining that the driver, a very influential figure in the village, had just ordered his own heat pump. And with more citizens ordering their own heat pump, the scenario for DH started to vanish.
The other vision of the implementation of a sustainable option to deliver collective heating to the citizens of Avedøre Landsby became more and more invisible. With regard to powering the large heat pump, areas for PV panels were needed to be found. EBO Consult mentioned that they had the perfect area to place PV panels to deliver energy to the new Heat pump. The local riding school had great areas to place the PV panels, and was willing to cooperate with the Advisor group. The only thing they wanted in return to make the decision of placing the PV panels at their ground was an asphalt road between the riding school and an allotment area, instead of a gravel road. So, the vision that presented a citizen-driven process did not involve the citizens, but a situation that turned into classic bargaining to move on.

At the beginning of the analysis, it was shown how the vision of the AGC-project was strung up on ideas about citizen centred and technologically scalable sustainable development of a local community. However, before the fieldwork had really begun, the vision started giving way to the complications of reality. Through the advisor workshop, it became apparent that the collaboration between the group of advisors was strained by the process. They did not display any confidence in knowing how to structure a citizen centred project or uphold the collaboration between themselves. Words like citizen meeting, energy community and citizen involvement were used and portrayed as solutions but never defined. Examples from their conversations and internal relations reveal that they do not know how to structure their own cooperation. The planning process is stalled by the advisors' disagreements on whose knowledge counts when it comes to citizens' attitude towards the future DH plans, and the advisors do not engage each other in dialogue to align their perceptions. Meanwhile, none of the advisors take it

upon themselves to ask the citizens where they stand.

These issues become distinct when the positions are laid out in the map above, as different conceptions and logics create a situation where the positions taken point in conflicting directions. Perceiving the AGC advisor group as a network of human and non-human actors like advisors, technologies and ideas, the concepts black box and translation from ANT once again provide additional analytical insight. The absent negotiations of the actors and ideas in the network become the reason AGC as a network cannot stabilise. AGC cannot take action as one entity as long as it is simultaneously too early and too late to engage the citizens. The lacking knowledge about structuring collaborative and citizen centred parts of the project affect the conditions for the successful implementation of DH in Avedøre Landsby. Throwing the right words around is obviously not enough to solve the issues facing AGC, and to insist that human complications be isolated from technical ones and vice versa, presents the initial obstacle to the process of this transition.

Discussion

As presented in the problem analysis, doing “business as usual” represents a significant barrier to developing and implementing LTDH, as doing so requires higher degrees of collaboration between stakeholders (Averfalk et al., 2021). This insight reveals the “business” of planning and implementing DH to be a social process first and foremost. With the sociotechnical/socio-political perspective from Johansen and Werner (2022) it was made clear that DH has always been heavily influenced by social and political factors, and in light of present time geopolitical pressures to decarbonize the European heat supply, this point is underscored. And so, an argument can be made that DH can only be seen as a sociotechnical entity continuously intertwined in current and future local, national and global issues. Throughout the analysis, it has been revealed that it is precisely the social processes of planning and implementing DH that distorts the project in Avedøre Landsby. In this discussion, we argue that for projects like AGC to succeed, the social nature of technology implementation must be designed for and included into the internal fabric of every project.

One major insight from the analysis is that the lacking knowledge about structuring collaborative and citizen centred parts of the project affect the conditions for the successful implementation of DH in Avedøre Landsby. Here it becomes obvious that the social processes are as important as the technological solutions, as it is the social that will carry the technology after its implementation. One must understand that infrastructure is not just limited to heat and road networks, it is also something that exists as structures of knowledge sharing and communication in the relations we are a part of. As sustainability holds a central position in the AGC-project, it becomes critical to realise that what risks becoming unsustainable is not the technological constellation of DH in Avedøre, but instead the collaboration between actors engaged in the project. The project itself must be able to support itself and sustain itself. Insisting that human complications be isolated from technical ones and vice versa, presents the initial obstacle to the process of this transition.

Citizen Engagement

Concerning the missing citizen involvement, the undermining of its importance needs to be addressed as something essential for a development project to succeed, with the wish for citizens' commitment. In the same way as the decision of what kind of heat pump Avedøre Landsby should have, the same needs to be negotiated about the citizens' involvement. As presented in the analysis, throwing the right words around is obviously not enough to solve the issues facing AGC. The planning process is stalled by the advisors' disagreements in whose knowledge counts when it comes to citizens’ attitude towards the future DH plans, and the advisors do not engage each other in dialogue to align their perceptions. Meanwhile, none of the advisors take it upon themselves to ask the citizens where they stand.

Through the authors' own experience in the field, it is important to notice that there is no quick fix when it comes to citizen engagement and involvement. With the identification of the AGC-project's problematic approach to citizens' engagement, there is a need to discuss how this could have been different because it is easy for us as students to point at the problems, but somehow harder to find the solution. Based on our knowledge in the field of citizen engagement, we will define what could have been done.

When presented with the vision of the AGC-project as "by the citizens, for the citizens", it was unclear how this was going to be realised. Turning to the literature of citizen participation, a clear definition of what you want to achieve by engaging citizens is essential for the structuring of a project (Arnstein, 1969). Arnstein presents her *Ladder of Participation*, which illustrates eight levels of citizen participation, from non-participation, to full citizen control (Arnstein, 1969). She argues that not all types of citizen participation are created equally, and so depending on the project and purpose for engaging citizens, how you do it matters. Arnstein further argues that for a project to succeed with active citizen involvement, the citizens cannot be viewed as secondary in the situation. It is difficult to see the solutions, if we do not acknowledge all involved actors. When you choose to make projects for the citizens, they are co-actors like everyone else in the project group. Therefore, they need to have power over certain decisions. Otherwise, the citizens become something that is there, but not recognised (Arnstein, 1969). As shown in the analysis, the citizens have little to no knowledge of the AGC-project's existence because the advisor group refuses to communicate general information about the project to the citizens. But how then are citizens supposed to enforce the little decision-making power they do possess? And how then is AGC a project for the citizens, by the citizens?

By not defining the goal or methods for citizen engagement, the advisor group risks missing important opportunities to truly include citizens in the project. Of course, citizen involvement does not have a step-by-step guide, and is a process that must be redesigned for every single project. But fundamentally, a citizen-involving process requires strong and early communication between the project makers and affected citizens. To this point, the scientific literature on engaging citizens in infrastructure projects offers several central insights. In two papers researching wind energy and public preferences for community consultation in Ireland, Brennan and Van Rensburg (2016; 2017) argue that there is a general need for more citizen engagement within the field of energy infrastructures and early involvement is key to engaging citizens. In an article on public engagement in emergency care systems, Foley et al. (2017) presents that ongoing and inclusive involvement help communities understand the need for change. Coherent with perspectives from Arnstein, they argue for the importance of "real" inclusion to ensure that the process of citizen engagement does not become tokenistic or manipulative. Richards, Belcher, and Noble (2013) suggest that absent information is often to blame for the ineffective policy-public communication leading to bad outcomes in this regard.

Inspiration for a way to incorporate these insights into the AGC-project, or any other "citizen centred" project for that matter, could come from action research. Action research as described by Reason and Bradbury (2008) is an orientation to inquiry that strives to create spaces for participation and co-research. Here, engaged actors' curiosities are encouraged, and question posing is used to promote reflection on practices. Action research is typically performed through cycles of phases of continuous action and joined reflection. Incorporating this approach into energy planning projects like AGC, the perspective of participation and co-research could be used as a way of ensuring that citizens are viewed as more than mere subjects of planning as the focus shifts to changing with others instead of changing others. The aim is that insight created with citizens will feed into the actions of the advisor group as they continue to develop the project. This could ensure early, ongoing and inclusive involvement, meanwhile tackling any issues regarding absent information.

Internal Collaboration

Actors' relations and ways of interacting yet again becomes a key element of success, but also the determining factor for failure in relation to the advisor group. As we have portrayed in the analysis, the advisor group and their different viewpoints and discourses are spread over all winds, and the missing communication is the element that can make or break a project. What we have shown is that the internal communication of the advisor group never reached a common understanding of what the project was and what the goals were.

When internal actors cannot access the same language, or meaning to a project, it is doomed before it even has started. We turn to Henriksen's viewpoints of language and dialogue. He presents the term *Language Games*. This term describes how different notions in the way we speak can both be a mediator for change and for misunderstandings (Henriksen, 2019). He argues that for a group of actors to work together, they need to understand each other's languages. This is especially critical in an interdisciplinary project like AGC. To develop and work together, a common language must be developed, so the different actors understand each other. The same applies for the goals of the project and why you are gathered as a group to make projects. When looking at the advisor group, we can split it into two entities, the ones for citizen engagement and the ones for technological development. These two groups of actors never tried to understand each other as presented in the analysis. Their miscommunication could be one of the reasons why this project did not meet its own requirements because their viewpoints never reach a common understanding of each other. If the advisor group should have succeeded with the AGC-project, clear defined lines were needed to keep every actor in line of what the project was and what it stood for, instead of becoming a project stranded between different viewpoints. If the advisor group had focused on other subjects than the concrete solutions, there could have been a time and a place to create the relations needed for good collaboration. A good relationship

can come through good communication and with that, all actors can be heard. It is important to do more than hear, but actually take different perspectives into account. What value has the perspectives of different disciplines within the advisor group and more importantly the citizens opinions, if it is not used actively? By rethinking the process and using different opinions actively to design new work practises there could have been a possibility of success. The AGC-project could have been the success story of involvement, if the advisor group had listened to the different actors within the group and not taken the citizens' needs for granted. When one does not listen, we alienate ourselves from the situation and when the advisor group does not listen to each other and does not use the citizens actively in a project with and about them, they become *The Other* (Henriksen, 2019). Henriksen presents the importance for dialogue between actors, to make change (Henriksen, 2019). If the advisor group and the citizens engaged in dialogue, it could have been possible to understand them, instead of making assumptions of what the citizens want.

Conclusion

In light of present time geopolitical pressures to decarbonize the European heat supply, this report has sought to elucidate, *how major human and non-human actors affect the conditions for the successful implementation of low temperature district heating (DH) in Avedøre Landsby*. Studying this case of green energy transitions as sociotechnical phenomena, an ethnographic fieldwork has been conducted, centred around participant observation and open and informal conversations with informants. In the problem analysis it was presented how the historical development of DH, reveals the technology to be a sociotechnical entity continuously intertwined in current and future local, national and global issues.

What becomes visible in the analysis is that the advisors have no methods or models for integrating citizens into the project or ensuring prosperous internal collaboration. Lacking knowledge about structuring collaborative and citizen centred parts of the project affect the conditions for the successful implementation of DH in Avedøre Landsby, and the planning process is stalled by the project advisors' disagreements on whose knowledge counts. On both sides of these debates, the advisors stand unsympathetic to the perspectives of the other, and so within the advisor group it becomes simultaneously too early and too late to engage the citizens, and both non-problematic and obviously problematic to implement an energy community. Through the discussion, we have argued that a perspective of participation and co-research could be used as a way of ensuring that citizens are viewed as more than mere subjects of planning, to ensure early, ongoing and inclusive involvement, meanwhile tackling issues regarding absent information. Throughout the present report, it has then been revealed that it is precisely the social processes of planning and implementing DH that distorts the project in Avedøre Landsby. And so, we argue that for projects like AGC to succeed, the social nature of technology implementation must be designed for and included into the internal fabric of every project.

To aid in doing so, a list of recommendations has been made on the basis of constructive insights from the present report. The list can be seen on the following page:

Recommendations

The Green Transition is Sociotechnical

Green energy transition projects need to recognise that technological planning and implementation are sociotechnical processes. This is true, not only in how these processes relate to public policy and geopolitical pressures, but also in the practical performing of collaboration and negotiation between stakeholders and affected actors.

Citizen Engagement

- Concrete knowledge and methods for engaging citizens in green energy transition projects must be designed into the project visions and reevaluated throughout the process.
- Using a perspective of participation and co-research from Action Research can help create spaces for participation and co-creation, where engaged actors' curiosities are encouraged in continuous action and joined reflection.
- Help communities understand the need for change by ensuring early, ongoing and inclusive involvement, renegotiating the involvement process throughout the project.
- Citizens are not secondary actors, and need to be treated as equals.

Sustainable Stakeholder Relations

- Concrete knowledge and methods for creating and maintaining sustainable stakeholder relations must be designed into the project visions and reevaluated throughout the process.
- Create spaces for renegotiating project goals, strategies, and common language.
- Reaching a common understanding or a recognition of different perspectives on project goals and milestones is crucial in interdisciplinary collaboration.

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