Interreg North Sea

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WaterWarmth

WORKPACKAGE 6
Governance of collective energy systems

6.2 Innovation and Governance arrangements of AE systems; A multi-case analysis of WaterWarmth pilots

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ACCELERATING THE TRANSITION TOWARDS SUSTAINABLE HEATING AND COOLING BASED ON COLLECTIVE SURFACE WATER HEAT PUMP SYSTEM

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A GREEN TRANSITION

WATER = WARMTH

Project WaterWarmth
20 partners from 6 countries: Sweden, Denmark, Germany, The Netherlands, Belgium, France
Lead partner Province of Fryslân
Period June 15, 2023 – September 15, 2026
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A GREEN TRANSITION

WATER = WARMTH

Report Summary

The aim of this Work Package 6 (WP6) report is to describe and analyze insights from Interreg North Sea WaterWarmth demonstration pilots. Specifically, WP6 examines the pilots' innovation and governance arrangements that help implementation and scaling of aqua thermal energy (AE) systems in real-world contexts. The work is therefore primarily based on lessons learned through a mixed methods approach with the Interreg North Sea WaterWarmth project pilots. To help address the shortage of knowledge on innovation of AE systems, this report builds on frameworks previously used in WP6 work (see Deliverable 6.1; Hoppe et al., 2024) where a mapping of theoretical frameworks and a typology to analyze governance of AE and other heating systems was performed. Particularly, we are applying three of the approaches and theoretical frameworks from Deliverable 6.1 from various scholarly backgrounds. For example, the multi-level perspective (MLP) and Strategic Niche Management (SNM) have a background in Science-and Technology Systems studies, Transition Studies and Evolutionary Economics, while Governance Arrangements (GA) has its roots in Governance and Policy Studies. As the focus of this report is on bottom-up *niche level* developments, we use concepts from SNM involving voicing and shaping of expectations, network formation, and learning. The pilots are implemented under societal conditions and hence also influenced by the existing heating regimes. Therefore, we address *challenges and tensions*, which we assume indicates incumbent regime influence that often hinders AE innovation development applying the MLP. Finally, we are interested in what role governance**,** and more specifically, regulation plays in pilots. This refers to organization authority and legitimacy, the role of government, and policy instruments like regulations, permit systems, and/ or subsidies.

For this report, nine pilot projects using an exploratory multi-case study approach were studied. The first questions for mapping the AE projects were posed to individual pilot leads in an online survey in April 2024. A workshop with the pilots was then held in Caen, France in May 2024. Following this, semi-structured interviews were performed with nine key pilot study respondents throughout the autumn of 2024. The results are assessed for each pilot within this report, and a synthesis analysis is presented followed by conclusions and policy recommendations. Results show that not all nine pilots have a *vision*. Four of the pilots indicate they do not yet have a vision, while five others indicate they. Four pilots are located in municipalities that operate a municipal heat vision. *Networking* was observed to occur in various forms across the pilots. In several projects networking was seen as a way to attract key stakeholders, with projects having internal guidelines on how to select stakeholders who are considered desireful to join the network. This includes having frequent and also bilateral meetings with local stakeholders, in two cases leading to the formation of a local heat coalition. However, networking was also observed as a way to mobilize intra (organization- and intra-municipal capacity to advocate AE in regional policy making, so as to develop and adapt policy frameworks and planning schemes. *Learning* was practiced in different ways among the pilots. First, learning takes place by involving local stakeholders in projects and benefiting from their experiences and perceptions. In some of the pilots this even entailed citizen participation and co-creation of plans. In five pilots learning from past experiences of other and past, similar pilots occurred. Learning was also observed to occur in a reflective way. For example, by monitoring and reflecting on one's own project planning and implementation process. As well as learning from monitoring progress, ongoing data collection, developing a knowledge base.

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Different aspects of *governance* are considered across the nine pilots. First, as a positive development of national, regional or local Climate Agreements on banning natural gas spurred action towards sustainable initiatives like AE. At the same time there are still plenty of regulatory barriers that need to be overcome, I such as permit systems. In general, there is a need for establishing a national Collective Heat Act to regulate collective district heating systems using AE heat sources.

1 Introduction

1.1 Interreg WaterWarmth project and WP6

Interreg North Sea WaterWarmth is a project funded by the European Union. The project aims to raise awareness about the potential of aqua thermal energy (AE) so that energy cooperatives and other actors can utilize this sustainable energy source. The movement to greater AE system use has the benefits of reducing carbon dioxide (CO_2) emissions, decreasing air pollution, contributing to energy system diversification and localization, as well as the more efficient use of energy and resources. The WaterWarmth project achieves this through collaboration with over twenty project partners in six EU countries: Sweden, Denmark, Germany, The Netherlands, Belgium, and France, and across six work packages with the ultimate aim to provide the knowledge necessary for collective energy initiatives. The work packages include research on how to intelligently utilize the local energy system development, avenues for system scaling, and how to navigate regulation and permitting processes. The Project lasts from June 2023to September 2026 and has a total budget of €8 million.

This report presents work from Work Package 6: Innovation and Governance (WP6). The objective of WP6 is to develop a framework for the analysis of current governance (arrangements), policies and stakeholder involvement in AE development. This is done through conducting a literature study, collecting empirical insights from real-world use cases (pilot studies), data analysis (reflecting on case material using an analytical framework), mapping and assessment of governance arrangements and enabling policies, identification of barriers that can hinder AE system niche development, and via co-designing AE “visions” with regional authorities and related stakeholders. The work presented in this report addresses empirical insights on governance and innovation observed in the nine WaterWarmth pilots (Deliverable 6.2).

1.2 Background on Aqua thermal Energy

AE systems refer to the extraction, storage and distribution of thermal energy from different water sources. They can include drinking water sources (TED), surface water (TEO), and wastewater systems (TEA). AE systems can be used to cool and heat homes and other buildings (NAT, 2023; Goossens et al. 2021; STOWA, 2023). According to the *Netwerk Aquathermie* (NAT; ‘Network on aqua thermal energy’ in English; translation by the authors), *aqua thermia* refers to the sustainable way of using water for thermal heating and cooling needs while simultaneously contributing to climate neutrality goals by lowering emissions and dependence on fossil fuels such as gas, coal, and oil.

AE systems are an under-explored technology in many parts of Europe. They can be viewed as an important part of deploying heat pump technology transitions in the EU, as they are key in amplifying the energy from water sources to high quality energy for warming and cooling purposes in buildings. In countries where there is experimentation with AE systems using different surface and wastewater sources, there is also a consideration for policy and governance systems that will allow further implementation of these systems (NAT, 2023). According to NAT (2023), countries such as Norway, Sweden and Finland have an established practice of using AE systems. However, there are currently very few projects of this kind because of low technology up-take due to an emphasis on other energy sources such as hydropower and biomass as well as perceived high costs associated with the implementation of AE projects. The countries with the most AE system installations include Switzerland and the Netherlands (NAT, 2023).

In the Netherlands, several actors including government, regional water boards, commercial and investment groups signed a 'Green Deal Aquathermie' in 2019, to work together in finding solutions for governance, large-level investment and implementation of AE projects (Green Deals, 2019). NAT lists three large AE projects that have been implemented in the Netherlands including: Thermo Bello (TED); De Veldkamp swimming pool (TEA); Merwerhoofd (TEO).

1.3 Research question

The WaterWarmth Interreg North Sea project has a number of pilots where AE systems are demonstrated in different technical and societal conditions. This report focuses on the analysis of these projects. With a current dearth of knowledge on innovation of AE systems and the role of policy, regulations, stakeholders and governance, the report adopts a governance and innovation perspective. Therefore, it addresses the lessons that can be learned from these pilots when focusing on societal experimentation, the scaling of AE systems, and the governance factors influencing them. The research question that guides the analysis is what insights can be learnt from WaterWarmth demonstration pilots regarding innovation and governance arrangements that facilitate implementation and scaling of AE systems in real-world cases?

1.4. Structure of the report

This report is structured as follows. Section 2 outlines the theoretical framework used in WP6.2 work, focusing on a synthesis of insights from multiple theoretical frameworks in transition and governance studies. Section 3 presents the research approach and methodology, which is a multi-case research design of nine demonstration pilots in the Interreg North Sea WaterWarmth project and one energy cooperative. The results are presented in Section 4 addressing 1) case-by-case analysis, and 2) a multi-case synthesis. Finally, in Section 5 the conclusions are presented. This contains answering the research question, limitations, future work and policy recommendations.

2 Theoretical Framework

This chapter presents the theoretical framework that we have used to assess the governance arrangements of the respective pilot studies. More concretely, it provides an introduction to each of the chosen theoretical frameworks and how they complement each other (Section 2.5). A deeper description of each of the theoretical frameworks can also be found in the WaterWarmth project 6.1 Report: Framework and typology to analyse governance of current AE and other relevant heating systems. The different frameworks have different scholarly bases, which when taken in their entirety, constitute a robust assessment of the governance of AE systems. The multi-level perspective (MLP) and Strategic Niche Management (SNM) have a background in Sustainable Innovation and Transitions (part of Science-and Technology Systems studies), and Governance Arrangements (GA) have a disciplinary background in governance and policy studies, each rooted in political science. Another relevant theoretical framework, the Governance of Change (GoC), has a basis in both fields. Energy communities are also important AE system development actors that influence the social and institutional context in which AE is planned and implemented; however, they are implicit to the study.

The Multi-Level Perspective (MLP) analyses transitions defined around a particular technology and proceeds from a view that transitions are nonlinear processes resulting from the interplay between three key analytical levels: niches, regimes, and the landscape. The socio-technical regimes are the locations of the existing established practices and associated rules, that stabilize the system.

The following six regime dimensions are commonly mentioned within the MLP framework (Geels, 2002): 1) industrial networks, 2) science, 3) markets, 4) culture, 5) technology, and 6) policy. The niches represent the spaces on the margins of the dominant regime and are occupied by the networks of actors of the radical innovations, such as AE systems. The niche level is represented by fewer actors and lower degrees of alignment between the elements compared to the regime level.

Thirdly, the landscape level represents the exogenous economic, political and cultural contexts beyond the influence of the niche and regime actors. The stability of the socio-technical regime is maintained by for example standards, lower costs, key actors with few incentives to change, policies, industry networks, user practices, and production structures. Weakening of the regime often occurs over time, and may first appear as unintended side effects, eventually accumulating to a degree where impacts are becoming obvious. Pressures from the landscape level can lead to further pressures to alter practices, which opens a window of opportunity for niche actors to gain force.

Building on the MLP, Strategic Niche Management (SNM) can be seen as an applied approach to support and help ensure niche level innovations develop and mature (Kemp et al. 1998). It promotes aligning social (e.g., institutions, policies) and technical systems (e.g., energy technologies). SNM was developed to understand the emergence and diffusion of innovations. It is useful in examining how innovations can evolve through sets of experiments. Experiments refer to (local) projects in which one can learn about the characteristics and performance of a given niche innovation (Weber et al. 1999). SNM consists of three internal processes to manage niche innovation. They pertain to 1) the voicing and shaping of expectations, 2) actor network formation, and 3) learning processes.

Table 1 presents a detailed overview of the three internal niche processes of SNM. *Voicing and shaping expectation* refers to expressing and moulding expectations. This involves the participation of various actors, including firms, users, policy makers, entrepreneurs, and other relevant stakeholders, who contribute their expectations to the project. It is crucial to articulate these expectations as it helps to garner attention, resources, and new actors to the project. This is particularly vital during the initial stages of technology development, when the innovation's functionality and performance may still be indeterminate. By voicing and moulding expectations, niche projects can establish a shared vision and gain support for innovation (Raven, 2007). The second niche internal process entails *network formation*.

During the early phases of an innovation's life cycle, the social network supporting it is often fragile and needs to be nurtured. Experimentation in niche markets allows different actors to come together and form new social networks. These networks are vital in knowledge exchange, collaboration, and resource mobilization. They facilitate learning, trust-building, and sharing experiences among actors involved in the niche, ultimately enhancing chances of successful innovation (Smith et al. 2005). Third, *learning* is imperative for successful innovation as it allows for the customization of technology and its societal embedding. Learning by doing and experimenting in a local project context is critical in the case of "configurational technologies", such as energy technologies, where multiple components must work together effectively. By following this process, actors within the niche gain valuable insights, acquire technical know-how, and refine the innovation to increase its chances of successful diffusion (Van der Laak et al. 2007).

2.1 Governance Arrangements framework

The question can be raised about how to develop governance arrangements (GA) that contribute to governing change (e.g., in transforming fossil fuel-based heating systems into sustainable heat systems using AE technology). This goes further than adopting a mere focus on hierarchic and monocentric approaches to governing energy transitions and formulating appropriate (traditional) economic and regulatory policy instruments that support them. In fact, such an approach to governing would only suffice when dealing with simple structured problems that can be resolved with straightforward solutions, like when constructing new homes, implementing a permit system to safeguard housing qualities (for example, on safety, structure, pricing, energy and sustainability standards).
In reality, especially when dealing with grand societal issues like energy transitions, more comprehensive, radical governing approaches are required that assume complex, unstructured, messy problems, e.g., societal problems that are characterized by a high degree of uncertainty and contested knowledge, and the presence of multiple stakeholders holding a multitude of often opposing views and (public) values. The latter typically applies to environmental issues like climate change, circular economy, and sustainable energy transitions.
Termeer et al. (2017) developed a framework to further understanding in governance arrangements that are designed to cope with unstructured problems. We propose that experimenting, scaling and future governing of collective AE systems falls within this category. Typically, new governance arrangements addressing sustainability issues and/or transformative change in society face tensions with existing institutions, and interests of incumbents.

Acknowledging the political nature of governance, these governance arrangements should be seen as emergent outcomes of complex political processes, instead of mere rational designs by 'scientific' and assumably 'rational' policy makers and engineers.
Termeer et al. (2017) discern a series of seven basic core elements that belong to said governance arrangements: 1) the framing of the problem, 2) the (territorial) governance levels at which to act, 3) alignment across sectoral boundaries 4) the timing of policies, 5) the selection of policy instruments, 6) the organization of the science policy interface, and 7) appropriate forms of leadership. See for more details on relevant theoretical-conceptual frameworks on governance and governance arrangements Deliverable 6.1 (see link in Section 2).

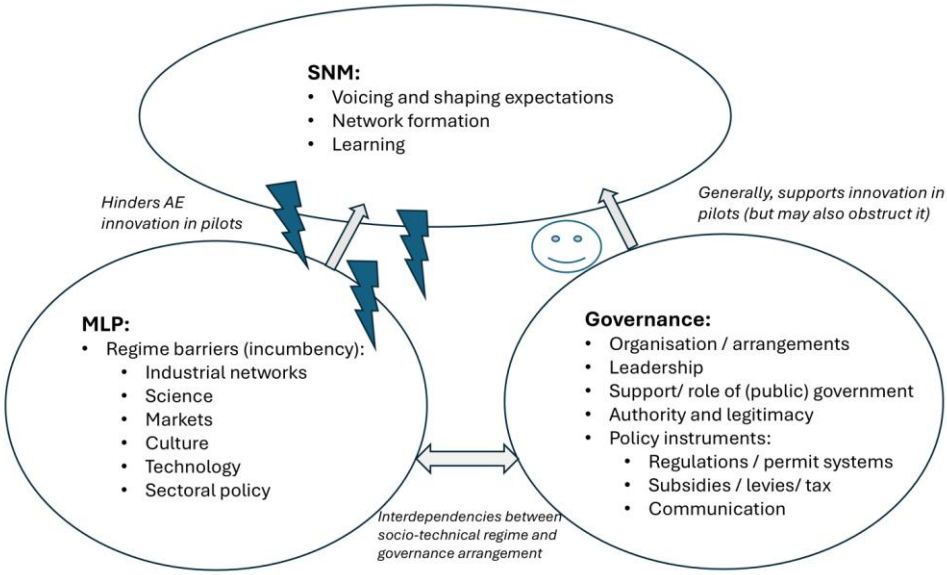
2.2 Synthesis of the frameworks

In this report, pilot projects are addressed where AE technological innovation is applied and tested in societal conditions with the aim of being scaled to become part of the future heat system regime. The focus is therefore on the *niche level*. For this reason we deem it useful to consider using theoretical concepts from SNM. They concern voicing and shaping of expectations, network formation, and learning. Because pilots are implemented under societal conditions – and in the case of WaterWarmth AE pilots are not shielded from market conditions – we assume that these pilots are subject to heating regime influences and agency.

Therefore, we also focus on *challenges and tensions* the pilots undergo, which we assume indicates incumbent regime influence that generally - but not always - hinder AE innovation development in the pilots (i.e., via industrial networks, science, markets, culture, technology, and sectoral policy). This is where MLP becomes important. Finally, we are interested in how governance, regulations and in particular governance arrangements plays out in the WaterWarmth pilots. This would refer to organization, leadership, authority and legitimacy, the role of government, and policy instruments like regulations, permit systems, or subsidies. Governance can be seen as generally in support of niche development and dedicated pilot experimentation; however, some of its elements, such as permitting systems, may also cause obstruction and delay. Please note that governance structures, arrangements, policy and public sector stakeholders are also affected by the sociotechnical regime, and vice versa.

Figure 1 below presents the synthesized theoretical focus of the present study. In Section 3.2 attention is paid to how this integral framework will be used in an analytical way to support the multi-case analysis of the WaterWarmth pilots.

Fig. 1: *Synthesis of theoretical frameworks: SNM, MLP and governance arrangements.*



3 Research design and methodology

3.1 Exploratory multi-case study design

Exploratory case study research design is a qualitative approach to investigate complex phenomena within real-life contexts. It is especially useful when exploring a theme with limited prior understanding, such as AE system development. By employing various data collection methods, researchers can collect rich, detailed insights that drive deeper understanding.

Multiple case studies use information from different studies. In this work multiple cases are selected so that individual case studies either predict similar results or predict contrasting results but for anticipatable reasons. When the purpose of the study is to compare and replicate the findings, the multiple-case study produces more compelling evidence so that the study is considered more robust than the single-case study (Yin, 2017). To analyze a multiple-case study, a summary of individual cases should be reported, and researchers need to draw cross-case conclusions and form a cross-case report (Yin, 2017). With evidence from multiple cases, researchers may have generalizable findings and develop theories (Bryman 2016).

3.2 Data collection

The data was collected from the pilot projects that are partners in the WaterWarmth project. In total, there are nine pilot projects that have been initiated as part of the project to assess the implementation and viability of AE projects. For some of the partner countries, a single pilot is presented (i.e., Denmark, France) while in the Netherlands and Belgium multiple pilots are included. In addition, an interview was conducted with an energy cooperative representative who partnered with one of the pilots to explore possibilities of using AE to generate electricity for this person's own local community.

The data collection process was set up in different steps to progressively gain deeper insights into socio-technical aspects of the pilots. The process started with theoretical frameworks with focus on MLP and SNM were mapped out in the WaterWarmth Deliverable 6.1 (Hoppe et al., 2024). The first broad questions for mapping the AE pilots using these frameworks were asked to the pilots in an online survey in April 2024. Building on these responses a workshop was held during the meeting in Caen, France, in May 2024 where additional dimensions of the pilots were covered. Responses were integrated and in the next step interviews were carried out with a key respondent for all pilots during autumn 2024.

For the interviews a semi-structured approach was adopted that combined a predetermined set of open questions with additional questions posed to explore certain themes and responses further. Key questions were defined to explore issues related to governance and implementation of AE systems. The questions were designed to align with the governance analytical frameworks that the research team is using for the project; all the respondents were asked the same questions. The questions were formulated as per key SNM, MLP and GA theoretical framework elements. Using these frameworks, questions were compiled that explore issues of project visioning, how learning is organized within the pilots, network formation and regulatory frameworks that are important for the pilots.

We also explored issues about the tensions and challenges faced by the demonstration pilot projects as they were in the process of being implemented (please see WP6, Deliverable 6.3 for this analysis).

This data could lead to a revelation of current governance arrangements in the different countries where the pilot projects are implemented, and hopefully provide insights on how such projects can be scaled and become part of the renewable energy solutions in the sustainable and inclusive energy transition.

The themes covered in the interviews with all pilots and cooperatives were based on four overriding questions as listed in Table 1 below.

Table 1: *Interview questions used and associated embedding in theoretical framework.*

Analytical Framework / Analytical approach	**Interview questions**
Strategic Niche Management & Multi-Level Perspective	1. In what ways are visioning (developing shared visions among stakeholders) and setting expectations addressed in your pilot?
	2. In what ways is learning organized in your pilot?
	3. In what way is network formation (network adaptation) part of your pilot, and how does it enable supporting your pilot?
Governance	4. What are the most important regulatory frameworks, laws and policies influencing your pilot, and what impact do they have?

Each interview was conducted by a minimum of two members of the WP6 team. All the researchers documented notes during the interview, and these were compiled into a single document after the interview. This ensured that all the information was cross-checked by the research team and safeguarded against data omissions that may occur if only one person documented the interview session. Even though we collected qualitative data, all the interview notes were transferred onto a spreadsheet for ease of documenting all the interviews in a single file. The responses were captured and organized according to the key themes as raised in the interviews. This provided the team with an in-depth overview of how each question was answered and the ability to compare all responses from the different pilots to each question. After the text for the pilots was compiled by the authors, it was sent to the respondent for validation and commenting. Any new aspects or changes were considered by the authors and integrated in the document.

3.3 Data analysis

The data on the spreadsheet was analyzed by observing the responses to each question from the different pilots. Based on combining the transcripts from pilot interviews with the first phase of work in WP6 in the online survey of April 2024 and following from the project workshop, an innovation story per pilot was established. These written text documents were then shared with the dedicated pilot leads who read and commented on them, which increased the validity of each of them. In the next step, an overview of main insights per pilot case was established. This was done using the theoretical framework presented in Section 2.3. Finally, a comparative analysis was conducted into the pilot cases to identify key similarities and differences of key criteria in Section 4.2.
Annex 1 and Annex 2 show comparative analysis using key theoretical framework elements. Information on key themes was captured, which would allow for answering the main research question.

4 Results

4.1 Individual cases

In this chapter the results of the analysis are presented using a case-by-case basis information per questionnaire item indicating key elements of the theoretical framework used. As such, the analysis is categorized as per the described elements: visioning, learning, network formation and adaptation, and regulatory frameworks. This analysis intends to provide clarity of several issues that influence the governance and innovation of AE systems in pilot demonstrations in the EU North Sea Region. Prior to presenting the analytical items attention is paid to the general introduction of the pilots.

4.2 Data ethics and Data management

The WP6 research team consisted of academic researchers that conducted qualitative research through interviews, text documents and workshops with the WaterWarmth pilot leads and other relevant stakeholders. The research team followed the ethical guidelines established by the Human Research Ethics Committee (HREC) of Delft University of Technology (home to the WP6 lead). Prior to completing and submitting the research ethics application form, the team worked with the Faculty of Technology, Policy and Management's Data Steward in completing a Data Management Plan (DMP). Through the DMP, the researchers provided information on the type of data they will be collecting, how the data will be processed, the purpose of processing and the organizations that will have access to the data. In the DMP, information is presented on how the research team safely stores collected data, and most importantly, how this data will be shared among the research institutions that are part of the WaterWarmth research project consortium. Once the DMP was completed, it was subjected to ethical research standards' approval (by the faculty human research ethics committee). On the ethics application form risk assessment and mitigation plans concerning data protection were included, with information on the type of data to be collected, collaborating partners, location of research participants and how they would be recruited.

It is important to note that no interviews were conducted prior to the research team's receipt of provision ethics approval from the HREC. Part of ensuring that due ethical procedure is followed includes requesting the research participants to give their consent for the information they are providing to be used for specified research uses. Participants were therefore properly informed about the purpose of the study and how their data would be used during data collection and they had to confirm their consent by signing the forms and handing them to the researcher team. To ensure extra measures in protecting data for the Interreg North Sea WaterWarmth project, it was decided by the Data and Privacy Department for the key data collecting institutions to have a formal 'Joint Controllership Agreement'. This agreement enables the WP6 research institutions to freely share the research data among each other while ensuring data protection measures.

4.2.1 Fryslân region; Terherne, Baard, Heeg (The Netherlands)

The Fryslân region hosts three of the WaterWarmth pilot projects, namely the village of Terherne village in the municipality of De Fryske Marren, the village of Baard in the municipality of Leeuwarden, and the Heeg village. They also have an alliance with the Warm Heeg energy cooperative in the Heeg village under the Súdwest Fryslân municipality. For the Fryslân region, data was collected from two pilot projects and an energy cooperative.

The village of *Terherne* is a popular tourist destination located on an isle and there is an abundance of water around and within the village itself. In the old part of the village, there are 120 homes and several large buildings (e.g., school, hotel, restaurants) that can potentially be heated by a small collective heating network. The other homes in the town which almost all directly face a waterfront can be heated by individual AE systems that can use the water flowing through the town as a network. The goal of the Interreg North Sea WaterWarmth project for the Terherne pilot is to determine whether heating using the AE system is plausible in the 'small' level of 120 homes, as this is not done elsewhere in the Netherlands. The plan is to implement an AE system in around 100 homes by using systems that fit the houses and the layout of the village while keeping in mind that the noise from heat pumps is not appreciated by the locals. The pilot is organized in collaboration between a citizen-led energy cooperation and the municipality De Fryske Marren. Pilot Status: Exploratory, with a focus on exploratory studies, feasibility studies, and business case development.

The village of *Baard* pilot is about a small 'source-district' heating net which connects five to nine privately owned homes and a primary-school in the village. Each building connected to the network will have its own heat pump. The source of the net is a combined 'closed' heat exchange system, like MEFA (heat pump system), sufficient for all the buildings. There is also a plan to have geothermal storage connected to the system, for buffering summer heat for winter use. The pilot entails development of a closed system AE project, by extracting heat out of the Baarder Feart River, bordering on the six homes and a school building. The pilot is organized (governance) via multiple stakeholder ownership, which is expected to turn into an energy community at a later stage. The focus of the project is on setting up a workable organization and attracting upfront investment. Pilot Status: The pilot is under development, with construction of the technical project attributes and setting-up the ownership rules and legal affairs.

The village of *Heeg,* located in the municipality of Súdwest Fryslân, aspires to be energy neutral by 2025. First of all, that means saving as much energy as possible, including through good home insulation. But it also means becoming independent of natural gas. Work is being done to create a collective heat supply for the entire village. The heat will be extracted from the surface water of the Hegermeer (a lake). The intention is that all residents of Heeg will soon be connected to this. It is important that the heat network is accessible and affordable for all residents of Heeg.
In the pilot the energy cooperative Warm Heeg has a central role because it entails a community-driven project. The process leading to the pilot set-off in 2012 and has already surpassed the exploratory and development stages.
Pilot Status: Preparations for project implementation are ongoing. Currently, Warm Heeg is carrying out excavation work for its AE project to install infrastructure, such as heat exchangers and piping that will connect the surface water source to the heating network. This infrastructure is crucial for extracting thermal energy from the water and then distributing it to homes and other buildings in the village (Warmheeg, 2024).

Visioning

In the village of *Terherne*, De Fryske Marren municipality visioning and setting expectations was addressed by formulating several project specific visions. The main vision for the municipality was the 'Warmtevisie' (Heat Vision in English) strategy document which describes the energy transition and provides a description of alternatives to natural gas and how the heat demand and heat supply are best coordinated in the municipality. Since 2021, each municipality in the Netherlands is obliged by the national government to formulate a local heating vision ('lokale warmtevisie'in Dutch) document of its own.
The heating vision document of the municipality of De Fryske Marren stated that all existing buildings must be natural gas-free by 2050 at the latest. The municipality also has a role definition vision that was developed in 2024 to clarify the role of local government in energy projects. This would serve as a guidance to how the municipality implements AE and other (sustainable) heat systems.
The *Baard* village pilot located in the Leeuwarden municipality was also guided by the municipality's heat vision document. In the *Heeg* case, the Warm Heeg energy cooperative used a vision of its own that aims to achieve energy neutrality for the Heeg village, hence the initiation of the Warm Heeg project. While the energy cooperative has a legal-organizational constitution as a cooperative company, it perceives this as a broad vision that allows for flexibility in their operations and makes it easy to engage in different renewable energy activities with different actors at any given time.

Learning

For the Terherne pilot no formal first order learning process took place, which was seen by the pilot leader foremost as lack of self-reflection by the municipality. For the WaterWarmth project, the municipality had to document the pilots' hurdles and successes, helping to steer the learning process to some extent. Second order learning was observed with project monthly meetings and gaining insights from experiences from other projects that are trying to achieve similar goals.

In the Baard pilot, learning was organized through the regional AE network in the province of Fryslân, i.e., 'Wetterwaarmte' (water warmth in English; translation by the authors) in which different stakeholders share their experiences with each other during network events.

There is also a Community of Practice (CoP) in the Fryslân region where stakeholders are used to learning-by-doing. Recently, the Baard project was collaborating with the EU funded AquaCOM project, which aimed to “empower energy communities in North-West Europe to use aqua thermalenergy to sustainably and efficiently heat their community”. Similar to the WaterWarmth project, the AquaCOM project is also funded by the EU-Interreg programme.

In the Heeg pilot, the energy cooperative, Warm Heeg, learning was organized by contacting projects that are in the same phase of implementation as the Heeg pilot itself in order to supplement missing knowledge. For Warm Heeg, as a project that focused on having one ‘big’ (collectively owned) district heating pump (instead of several individual systems), acquiring technical knowledge is considered crucial, hence their partnering with a technical company to assist them with project design and on the other hand have partnered with another that will be responsible for verifying this technical information. The Warm Heeg energy cooperative engaged in the habit of documenting all their project phases in a logbook which was made available online for others to refer to and learn from.

For Warm Heeg, learning was not only considered essential for the energy cooperative, but also for energy consumers and community members who need information about renewable and sustainable energy sources. As such, Warm Heeg was also involved in organizing education campaigns to build trust and inform the local community about their work and how the community can benefit from it.

Network formation and adaptation

For the municipality of De Fryske Marren, in the Terherne pilot, network formation meant the inclusion of energy cooperatives from the beginning of the energy projects that the municipality is planning to implement. The municipality officials realized that when building (social) networks, it is important to have a well-developed business case as some of the stakeholders do not want to get involved when it is not clear what their role and the objectives of the project are. On the other hand, the municipal officials are wary that a big network may mean more administrative responsibilities for them as a municipality.

In the Baard pilot, the key network formation is considered to be with residents and local energy cooperatives. As previously mentioned, for this pilot, the network is key in sharing experiences and learning from each other. It is also a form of support, particularly for technical difficulties that they come across as they attempt to implement their project. In the Heeg pilot, the energy cooperative Warm Heeg considers network formation as being part of networks that support energy communities such as the national federation for energy communities ‘Energie Samen’ in the Netherlands does. Warm Heeg also considers participation in the Interreg North Sea WaterWarmth project as vital for their network formation as an energy cooperative as this supports them with knowledge sharing and support that they need to develop their own organization and activities.

Similar to *Baard*, the Heeg pilot team considers having a connection with other projects that have similar goals of providing their communities with renewable and sustainable energy important in learning and adapting best practices. Similar to their learning experiences, the Heeg pilot team considers community education campaigns to build trust and disseminate information as important strategies in network formation. This also encourages building a reliable customer base.

Governance and regulatory frameworks

In the *Terherne* case, the municipality of De Fryske Marren, considers regulatory frameworks to be important at different levels of government. At the national level of government, collective heating laws and bills such as the Collective Heat Act ('Wet Collectieve Warmte' in Dutch) and heating instruments laws are seen as important as they aim to facilitate the development of new heat networks across the country. This law is not only important for customers, but also for the heat companies and investors that want to have clarity of the rules and regulations that would govern their investments in the energy transition. Another important regulatory framework is the EU legislation that backs subsidies towards energy communities and the rules on compensating energy cooperatives. Clarity of such rules will make it easy for municipalities such as De Fryske Marren to determine the type of funding that can be allocated as compensation for energy communities that take part in AE projects. The local regulations are also important but are considered difficult to apply because of bureaucratic administrative systems. The regulation that is making it difficult to implement district heating projects as a municipality is that district heating is not considered a public service as per EU regulations, and therefore can only be implemented by private sector companies. The continuous change and debate in national legislation on private versus public ownership in the last few years has been a challenge.

Similar to De Fryske Marren, the Collective Heat Act is also important for the *Baard* pilot project. For the Baard pilot team, this legislation guides how they plan their activities and the type of energy sources they can make investments in. The National Climate Agreement (a national metagovernance arrangement) is also important as it guides local heat visions like the one in Treherne towards their 2050 goal of not using natural gas anymore. The municipality of Leeuwarden's energy and climate agenda is also considered as an important framework that is informed by the national Climate Agreement. The regional energy strategy (RES Friesland; energy region strategy document) aims for 49% of carbon reduction by 2030. The regional Water Board regulations on permits have an influence on the implementation of AE projects as they have to ensure that the water quality is well maintained. The problem with the Water Boards across the Netherlands is that they have different rules and therefore lack of consistency.

In the *Heeg* pilot, for Warm Heeg as an energy cooperative, the company and foundation regulatory frameworks are considered as leading in the way they operate. Even though Warm Heeg is not a formal cooperative yet and only registered as a foundation, they are in the process of transitioning to this state.
So far, they have identified some regulatory obstacles that hinder their operations but are working closely with some relevant government stakeholders to address these issues. The AE technology regulation that is important for their work is the one concerning ground storage limits.
Currently, the allowance of this heat storage is 20 degrees Centigrade, but for the system to work optimally, they require 40 degrees Centigrade or higher. Finally, it should be mentioned that Heeg is a pilot project in the national natural gas-free districts programme ('Programma Aardgasvrije Wijken' in Dutch) and has received a subsidy of €4 million from the national government for this purpose, with a project work time span from 2022 until 2030 (assuming that the pilot is realized by 2030).

4.2.2 TU/Delft; Firma van Buiten (The Netherlands)

The aim of the Firma van Buiten pilot is to augment the current Air-Source Heat Pump (ASHP) based heating system with an aqua thermal one (while the ASHP remains as backup and peak 'boiler') and using this as a test bed for shallow water AE systems.
Pilot Status: Exploratory.

Visioning

The Firma van Buiten pilot does not have a formal vision document but has a vision statement included in the proposal that was sent to the Delft University of Technology's campus innovations department. This proposal outlined the project goals and costs and was approved by the university campus innovation committee. This vision was also shared by the university campus innovation team, as they were interested in testing AE for possible future applications on the university campus. The overall aim of the vision statement was to prove feasibility with 25kW in heat exchangers (initially aimed for 60kW of extraction but had to compromise due to [MF1] constraints by the permit issuing party). Initially, the Water Board had permitted 10kW extraction, but the project aspired for 60kW, which led to a compromise to 25kW. Heat delivered by the AE system would be 37.5kW at maximum. The remaining heat demand would continue to be supplied by the ASHP system on the coldest days. There is currently no formal business plan according to the pilot lead as Firma van Buiten is an experimental and temporary site.

Learning

Learning in the pilot is based on previous experiences such as observing and changing the AE system behavior and deriving lessons from these changes. Pilot researchers also use progress reporting to the campus innovation committee every three months. The lessons from this pilot will be mainly used for academic and scientific publications to broaden knowledge and information about the implementation of AE systems. Currently, the pilot is not incorporating lessons from other projects and no comparison is made to other projects.

The main questions addressed in this pilot are does AE technology work in shallow waters (aquatic effects), and how balanced is the supply/demand during the heating season under realistic conditions? The knowledge is therefore aimed at broader system learning, not specifically for expanding AE throughout the campus (although positive results of this research project may result in that). The on-site building of the pilot is equipped with a PV array, which will partially supply the AE system. Furthermore, there is also a potential future opportunity to integrate the AE technology with a Low Temperature (LT) network that includes storage.

Network formation and adaptation

For this pilot, the most important network formation was having good contact from the beginning of the pilot with the Hoogheemraadschap Delfland (HHD) Water Board who are in charge of the permits. The pilot provided extensive baseline temperature measurements to the Water Board and in turn implemented the feedback and suggestions to improve the pilot conditions, which led to compliance.

The Hoogheemraadschap Delfland Water Board were also interested in the pilot's results and this might result in a smoother AE permitting process in the future, based on the lessons learned.

The project network is mainly on the university campus where the five key actors are TU Delft faculty of Architecture and the Built Environment (ABE - research project lead), Firma van Buiten foundation (building owner and user), TU Delft Campus Innovation Committee (CIC) (funding agency), TU Delft Campus Real Estate department (CRE) (grounds owner), and Hoogheemraadschap Delfland – (waterway owner and permit issuing agency). The stakeholders are supported by the contract manager, procurement officer and project controller at TU Delft faculty of Architecture and the Built Environment, a technical designer and an external company in charge of project management.[MF3] These stakeholders are important for the functioning of the project as they are well informed about the university procedures and implementation of such projects on campus but are less concerned with the actual outcome of the project. The university also takes care of insurance responsibilities for the project. As with each stakeholder there are different motivations for being part of the project, for the Campus Innovation Committee, it is the potential replication of testing the innovation on other university sites, which would be made possible by the abundant water resources on campus.

Governance and regulatory frameworks

For Firma van Buiten, the 'Omgevingswet' (the Dutch integral environmental law on a broad array of environmental, spatial and other aspects addressing impact of infrastructure on the natural environment), which replaced many laws as of January 2024, is important as it provides a single permit with multi-party consultation. This law provides citizens and businesses regulations on the permits that they need to apply and get approval for if they want to make changes to the environment. The government makes a decision to involve other relevant stakeholders that have an interest in that environment, if that is needed in order to provide approval for the application made.

The Kaderrichtlijn Water ('Water Framework Directive' in English; translation by the authors) is also an important regulation as stated in the Environmental Act and the Environmental Quality Decree. It focuses on water quality, water temperature regulation and permissions from Water Boards. It also provides an important incentive for integrated water management and river basin approach in the Netherlands. The Green Deal on aqua thermal energy (2019) is also important as an overriding document for this pilot and the university has an obligation to comply with it as it includes energy transition goals which are a national priority in having innovative ideas focusing on producing renewable energy. The Water Board's regulations on surface water quality[MF2] are also important for Firma van Buiten. Their concerns are on the effects of scaling up AE technology on water quality on the aquatic environment. Hoogheemraadschap Delfland has indicated that they are very interested in both the results as well as the recorded data, as they can use the lessons learned in future permit approval processes.

4.2.3 Kortrijk; Buda Island, Kortrijk; Weide, Kortrijk; Havenkaai (Belgium)

The city of Kortrijk sees opportunities for the successful application of AE and has three experimental AE projects: Buda Island, Kortrijk Weide, and Kortrijk Havenkaau (i.e. Howest University of Applied Sciences). The three pilots are geographically close, all on the Leie river. These three locations represent the large-scale implementation of the WaterWarmth project - i.e. AE technology demonstration pilots - in Kortrijk. Research was conducted into how much energy can be extracted from water courses with the aim to contribute to making the city of Kortrijk energy-neutral. The ultimate goal is to complete all necessary research, calculations, and designs within the project which will be followed by implementation. The investment for

Buda Island is 50% by the energy cooperation and 50% by the city of Kortrijk. Additional funding opportunities will be explored by the project team together with the Interreg North Sea WaterWarmth consortium project partners.
Pilot Status: Development stage.

Visioning
A heat zoning plan was developed in collaboration with the Belgian national grid operator Fluvius, examining possible techniques/energy sources for each zone. This plan identifies four potential heat networks based on sustainable heat sources in and around Kortrijk, including the Buda Island and Kortrijk Weide. The pilots are therefore part of the cases that are within this heat zoning plan.

The Buda Island pilot is suitable for collective heat systems due to heat density, and it fits within spatial energy planning of the municipality. The AE system implementation seemed promising to explore at the city level. Kortrijk Weide, Howest together with the Province West Flanders and Ghent University have formed an energy cooperative and they are trying to create a shared vision together. The vision aims for energy neutrality, starting from optimizing the current infrastructure. However, it is still unclear who will take the role of managing the heating network. This is also included to value different stakeholders' assets. The energy cooperation to manage the energy still has to be set-up. The legal structure for this in Buda Island is still not clear.

Learning
The municipality of Kortrijk has been learning from the Mechelen pilot (also in the Interreg North Sea WaterWarmth project), particularly about the city's role in alternative energy provision. The civil servants in the Coordination Commission for Integrated Water Policy working group (CIW) helped to develop a framework for granting permits for the AE pilots. It is a working group across cities and provinces focused on the implementation of AE. The aim of this group is to provide policy recommendations and share insights, experiences and practices. There is also information available from the activities that the pilot team has been engaged in as part of the pilot implementation, but it is not fully documented due to time constraints.

Network formation and adaptation

The Kortrijk municipality pilot team reported that it has limited stakeholders involved for the Buda Island project. At Kortrijk Weide there is academic and research support from Howest University of Applied Sciences as well as support from the energy cooperation that was recently formed. There is currently a plan for a cooperative focusing on heat-nets and solar that will join the Buda Island pilot. This cooperative has helped to develop the project proposal and has good collaboration with the municipality. While developing an investment project for Buda Island, the city has been in touch with energy cooperatives and has noticed that they are interested in getting involved in this project. Attracting and building cooperatives and citizens is a major concern for the city due to its lack of urgency in the Flanders region to adopt new (renewable) energy technologies. National government does not signal changes in energy prices, and there is limited communication with other stakeholders. High taxes on electricity and absence of taxation on gas provides no financial incentive to adopt alternative energy sources such as AE.

Even though subsidies on gas prevent energy poverty to some extent, the pilot team argues that this gives Belgium a bad reputation in Europe as this energy pricing does not promote decarbonization. The Cityis currently developing a knowledge base and convincing stakeholders to eliminate gas use due to climate change and high gas prices.

Governance and regulatory frameworks

The existing regulations do not have specific information on regulating AE systems. Permits for implementing AE projects, particularly for water extraction, are important but it is difficult to get them from the 'Vlaamse waterweg' (Flemish waterways authority).

Currently, the City is working with the Flemish (regional) policymakers to develop regulations based on pilot experiences. Both the Kortrijk and Mechelen cities are part of a committee advising the Flemish government.

A regulatory development from the Flemish government that is considered positive by the Kortrijk pilot team is the Spatial Department appointing someone to prepare policy advice with the aim of collaborating with municipalities and renewable energy stakeholders. In preparation for the new City council that will govern for the next six years, there is a need for careful preparation to adopt a thermal heat grid programinto the municipal plans. If this opportunity is missed, there is a risk that this plan will be delayed by six years, until the next council elections.

4.2.4 Kortrijk; Howest University of Applied Sciences (Belgium)

The pilot site with which Howest participates in WP2 of Interreg North Sea WaterWarmth, is part of a larger investment project. The complete investment project features student accommodation buildings, university buildings, apartment units and office spaces with a total area of 18,000 m^2. For the duration of the Interreg North Sea WaterWarmth project the student accommodation (127 rooms) and possibly a few of the residential apartment units nearby will be operational, as the whole site is currently being built. Therefore it can be considered that Howest's pilot site will be the student accommodation building. On the pilot site AE will be used in combination with geothermal energy. Since the demand is expected to be high, there are high fees for extraction and discharge of water for heating on the Leie river. As the project site will be expanded, it was decided that the techno-economic optimum was to use the AE system for regenerating the geothermal borehole field. Simply put, the heat extracted from the river will be stored in the soil around the boreholes in order to extend the lifetime of the field.

Pilot Status: The Howest student building is expected to be completed and operational by fall 2025. The first tests and commissioning of the AE and geothermal systems should begin in June 2025 and be put in operation for the beginning of the heating season 2025-2026.

Visioning

For this pilot, there is no formal vision or plan. There are only technical schemes that outline the system (AE and geothermal) layout. The technical schemes include hydraulic schemes of the complete heating installation of the site, and a river water capturing structure scheme.

Learning

Thus far, the learning has been an informal process whereby documentation of processes that the pilot is engaging in is not formalized but only done through notes that are taken during events and when trying to find solutions for project challenges. There is a desire to learn and capture the lessons from the implementation process, but this is limited due to a cooperation agreement. It should be possible to compare it with the other partners under the condition that the investors approve of the information to be disclosed. Some partners with financial interests on the project believe that it may not be favorable if some information about the project is made public. As part of the learning process, the pilot is developing a roadmap for future reference based on project lessons and experiences, while ensuring that all of the involved parties with the 'Havenkaai' site are onboard with the information shared with the wider public.

Partners use a shared electronic filing system for organized project information. Finally, learning is also achieved through ongoing data collection and tests on the implementation site.

Network formation and adaptation

For the Howest pilot, the stakeholders include six investors, implementers, and an energy cooperation (i.e. an energy service company; Esco). Stakeholders include Howest researchers and Howest University of Applied Sciences as the site customer through student accommodation and the school building, the investor company building the site, study bureaus for technical data inputs, and an Esco (a combination of two companies gathering information). Receiving positive media attention was considered beneficial for the project as the site is a former parking lot which residents were not keen on having in their vicinity. The involvement of the City of Kortrijk was considered helpful in issuing permits. Howest University has bi-weekly meetings with investors to ensure progress of the project and that all stakeholders are updated about the project.

Governance and regulatory frameworks

The City of Kortrijk's Green Deal (Green Deal-Kortrijk) aims for climate-neutral public buildings by 2040 and this motivates the municipality to engage in the project in order to meet this goal. The Howest pilot considers the important permits that are to be granted by the Flemish water authorities. These permits are expensive and took the longest to obtain which delayed the implementation process. A maximum 3°C temperature difference is allowed between offtake and discharge of the river water. The Heat Pump Association of Flanders is calling for tax removal on heat extraction and this proposal is currently under review. Other permits that were required for the project include those concerned: environmental aspects of the project, permits from the city concerning the underground network, building permits that also have to consider spatial planning and geothermal installations. There is irritation with government regulation of not providing funds for new technologies in Belgium which leads to high reliance on private partners. Moreover, the regulation that prioritizes ship traffic on the Leie river hampers the project planning and progress.

4.2.5 Gent; Energent (Belgium)

The Energent pilot focuses on new residential buildings (mainly new apartments) with 1 MW peak power (thermal energy). Energent, a citizen-led energy cooperative, will develop a concept plan to use AE as a heat source for heating homes and apartments in the Muide city district within the city of Ghent (Flanders region, Belgium). The Muide is situated next to a large canal, which has sufficient potential to heat a large number of homes using heat pump technology. Energent wants to investigate the role of energy cooperatives in the roll-out of local heating networks, where aquathermy (i.e. AE) is present as a sustainable and fossil-free energy source. At the end of the Interreg North Sea WaterWarmth project, the aim is to have knowledge of which technical development is required, what the profitability is and which legal framework applies to heating networks using AE.
Pilot Status: Studies and activities are conducted to develop a project concept, project plan and business case.

Visioning
The Ghent pilot currently does not have formal visioning guidelines and there was no clear vision from the municipality for this project. The energy cooperative Energent was contacted to share expertise on AE during the planning process, hence their involvement in the pilot. Over time, the project concept has evolved which has led to an eighteen-monthdelay on the part of the project linked to the Interreg North Sea WaterWamth project. The pilot has internal guidelines on capabilities and when to involve other partners, such as those that are financially capable to participate.

Learning
Energent learns from other partners within the EU Interreg North Sea WaterWarmth project and considers this a positive experience with no financial pressure during the planning phase of their AE systems pilot, as WaterWarmth partly covers costs. It also learns through involving more stakeholders (i.e. the municipality, the regional water body, city management, architects), in their projects. Energent previously worked only with private partners and is now adapting to also work with public governmental organizations. In the process of implementing the AE system pilot, Energent has learned to develop heat grids on public domain and with governmental organizations, which is an important skill in the RE sector. Learning experiences are also influenced by the work scope that is changing frequently as stakeholders realize AE projects' potential, which has led to doubling of the housing plan size. The project now includes existing buildings due to recognized potential, compared to when it first started and only considered new buildings. Learning experiences are well documented by Energent and the implementation process is recorded in a logbook which contains conversations and decisions.

Network formation and adaptation

The pilot has internal guidelines on capabilities and when to involve other partners, such as those that are financially capable to participate. The work of Energent is guided by listening to stakeholders and customers (e.g., the City of Gent) and responding to them based on their capacity.

Energent considers network formation as crucial particularly concerning working on public infrastructure and grounds, which requires collaboration with many people. For Energent, it is helpful to have many parties involved. However, it realizes that these stakeholders must share and commit to the same goal. Energent is currently expecting more people and government departments to join its network, as they see the benefits of collaborating with Energent. Finally, Energent participates in networking events to meet potential clients.

Governance and regulatory frameworks

There are several regulatory frameworks Energent has to abide by. There are water use restrictions that are imposed by the Water Board due to ecological concerns which affect the project size.

Then there are drilling restrictions for borehole and thermal energy purposes that are also part of the regulations that are important for Energent to consider. For example, one is only allowed to drill on privately owned property which limits project expansion. The City of Ghent's heat plan is important as it creates urgency and supports the pilot, aiming for climate neutrality. Finally, the costs for water extraction using an open-loop system are high and have a negative financial impact on the project.

4.2.6 Mechelen; Ragheno (Belgium)

Mechelen City is located in the region Rivierenland in Flanders with a population of 87.000 inhabitants. The city as a frontrunner in local sustainable heating has mapped the potential of renewable heat sources including geothermal and AE systems and is planning a local policy framework to support the development of heat projects with AE energy. The present project involves using AE energy (in combination with geothermal borehole thermal energy storage (BTES) systems) from canal Leuven-Dijle for fossil-free heating of a new development on the Ragheno-site next to the canal. **Pilot Status:** The feasibility study is drafted, and the next step is for the study results to be presented to a project developer.

Visioning

The city of Mechelen started working on its municipal heat plan in 2019 and adopted it in 20241. The heat plan includes a 'transition vision' and a 'heat strategy' to shift from fossil-fueled to fossil-free heating. Following the heat plan, Mechelen has established an ambitious urban renewal project in Ragheno which is within the city. Ragheno is a former brownfield will be redeveloped in an innovative, lively district with more than 2.500 dwelling units and more than 100.000 m² office spaces2.

A masterplan was made for this brownfield redevelopment and one of the key challenges was to integrate these high ambitions with regards to sustainability in the masterplan and other spatial planning instruments. Sustainability certification schemes such as BREEAM communities were not very effective in practice due to high costs and unclear benefits. Nevertheless, the City was aware of the strategic importance of Ragheno in the municipal heat plan and with the support of SHIFFT3, an energy masterplan was conducted in 2020 by Ingenium.

[1] https://klimaatneutraal.mechelen.be/fossielvrij-verwarmen
[2] https://www.mechelen.be/stadsvernieuwing/ragheno
[3] https://shifftproject.eu/

A promising concept put forward in this study was an innovative, very low temperature heat network, which would be able to exploit the local renewable and waste heat sources available on-site and in immediate surroundings. This included AE from the adjacent canal Leuven-Dijle, and geothermal BTES-systems. The WaterWarmth project the next steps of the project with a focus of development of large-scale heat infrastructure with aqua thermal energy as heat-source in Ragheno.

Learning

The city is still looking for ways to embed reflexive learning in its policy processes and the Waterwarmth project is seen as an opportunity to improve this dimension. Formalization of learning still needs to be developed, and the city is embarking on this through several activities. An example of such activities is that the City organized 'transition arena' participatory workshops with 20 local stakeholders that led to the municipal heat plan and heat coalition. The city's heat coalition which includes policymakers, businesses, energy service companies, and energy communities aims to establish a transition team for planning critical learning points during the implementation phase of the project. On project level, the City has mapped key learnings of the Ragheno pilot as part of WaterWarmth. On of the key lessons from this project is that project developers need to be convinced to implement a collective energy concept for their project development, and the game changer could be the ban to connect to gas grid for new developments.

There is a synergy between geothermal energy and AE whereby the concept for the energy system relies on geothermal energy storage for (passive) cooling. AE could then be used to replenish the borehole thermal energy storage fields in the summer. This could be used to convince the Waterbody authority which is not in favor of using the AE system for cooling purposes.

Network formation and adaptation

The Mechelen pilot has directly or indirectly led to multiple networks with various stakeholders. As part of its heat strategy, a local heat coalition has been established which includes key actors such as DSO Fluvius, energy cooperatives Klimaan and Ecopower, engineering firms such as Extraqt and Ingenium, and umbrella organization such as VVSG (Flemish Association of Cities and Municipalities). Contacts between the City of Mechelen and the Flemish Waterboard resulted in the involvement of City of Mechelen in a Flemish policy working group on AE 4. In this policy working group, tools and processes will be developed to support the uptake of AE in building permitting and spatial planning. In fact, a sub-working group has been established to focus on the integration of these tools in spatial policy and energy policy instruments and processes, led by City of Mechelen and with involvement of two other WaterWarmth partners i.e. City of Kortrijk and Extraqt5 (the latter a technical business company).

The insight has come that heat networks need cross-sector collaboration and city credibility. In this case, the municipality acts as the energy broker. The city hired a broker/intermediary to facilitate discussions with project developers, public authorities (eg. Flemish Waterboard) and heat network developers (eg. DSO Fluvius).

[4] https://www.integraalwaterbeleid.be/nl/over-ciw/organisatievorm/organisatievorm/ciw-projectgroepen/thema-andere/projectgroep-aquathermie
[5] More information will be put online soon at vrp.be/thema/aquathermie

The City's energy broker works very closely with the city's project coordinator of Ragheno, who is the single point of contact within the city administration and other stakeholders involved in the urban renewal project. The City's energy broker is a member of the learning community 'Platform Energiemakelaar', which connects public authorities and entrepreneurs in Flanders with similar projects and experience6. This community exchanges practices and experience related to implementing collective heat and energy projects.

Lastly but equally important, periodic peer-to-peer exchanges between the City of Mechelen, the City of Bruges and the City of Antwerp to exchange practices and experiences with regards to heat policy, heat planning and heat networks initiated during the duration of the Interreg 2Seas SHIFFT projects (2019-2023) was continued in the Interreg North Sea WaterWarmth project, attracting other cities such as City of Leuven and City of Kortrijk. A remarkable fact is that the Flemish Energy and Climate Agency is not part of any of these networks, due to the lack of capacity or setting other priorities. It is clear that there is a need for a strong supporting framework for the roll-out of large-scale heat infrastructure to valorize the potential of aqua thermal energy. In this sense, the involvement in multiple networks indicate strategies from local authorities to cope with this.

Governance and regulatory frameworks

For Mechelen, the 2021 gas ban for new, large buildings was a game changer despite regulatory challenges. This meant banning gas as a heating source would promote the use of renewable energy. The Flemish government offers up to 40% investment subsidy for heat networks (Groene Warmte), but only for connecting existing buildings. Before 2023, this was also possible to connect new buildings, but this has been made obsolete by the gas ban. So in that sense the gas ban was not really favorable for collective heat networks (as the financial support was removed) in contrast to individual air-sourced heat pumps. This has led to a lower market uptake of heat networks in Flanders.

EU funding (for the SHIFFT and WaterWarmth projects) is considered as crucial for the heat policy plan.The brownfield governance strategy supports redevelopment of polluted industrial sites with subsidies from the Belgian government. In this case, the government buys or leases former industrial areas for new activities. Energy regulation in Flanders has minimal policy on heat networks and lacks integration with spatial, water, and environmental policies. For Mechelen, this hinders energy projects and development that integrates several elements such as the implementation of AE systems that rely on water and spatial regulations. The report on the 'inventory of spatial and energy regulation relevant for AE in Flanders' has been prepared by the policy working group. The Flemish Climate Pact of 2022, which is part of the Green Deal, obligates the development of a heat plan by the municipalities, but local governments lack tools to implement it. Another regulation that influences the implementation of the project is that energy use reports go directly to Flemish administration and bypass local government. This makes it difficult for the municipalities to follow-up their municipal heat plan, if they have it in place. The energy agency in Flanders can learn from the water agency that is regarded as an example of integrated governance, using co-creation processes with local governments and businesses to create coherent policies (Commissie Integraal Waterbeleid or CIW7).

[6] https://www.platformenergiemakelaar.be/
[7] https://www.integraalwaterbeleid.be/nl/over-ciw

4.2.7 Ouistreham; Le CANO (France)

The pilot is located at 'Le CANO', which is the Water Sports Center of the city of Ouistreham, Normandy, France. Located at the outlet of the River Orne, the Caen Canal, the maritime entrance to the urban community of Caen-la-Mer and the setting of the Bay of Sallenelles, the Center brings together associations and the public in a sporting, educational and cultural center focused on the sea and water sports. In the framework of the Interreg North Sea WaterWarmth project, a heat pump will be installed to supply Le CANO facilities, particularly the bathrooms and shower. The key actors are the users of Le CANO facilities (such as the sailing club, Société Nationale de Sauvetage en Mer) and the company that is central to the pilot and installing the AE system. The pilot envisages using sea water because the Normandy region has a lot of coastlines which could be used to provide heating and cooling. It is an important resource of the region, with around 600 km of coastline.

The key stakeholders and local authorities of the pilot consist of the City of Ouistreham, Ports de Normandie (Normandy Ports), DDTM14 (Calvados Departmental Directorate for Territories and the Sea), the Harbour master's office (Capitainerie), Normandy Region, and Caen-la-Mer. The pilot is owned by the city and the works are under the supervision of Ports de Normandie (Normandy Ports) which is the local authority approving the modification of the area.

Pilot Status: Implementation phase. The pilot site is currently under construction.

Visioning

The pilot project was initiated by BUILDERS, an engineering school, and offered to the city of Ouistreham which is a municipality in the Calvados department in Normandy region and is supported by the mayor of the city. The pilot tests an experimental system in the coastal area in Normandy with the aim to target Caen-la-Mer and surrounding municipalities in Normandy with its potential freshwater systems. The company Elairgie, familiar with the building and part of the stakeholders, installed the heating system in 2020. Since before a combination of electricity, gas, and an air/water heat pump was used for running the facility. In a previous sea water project in the city of Cherbourg, a nearby municipality in Normandy, an AE system experiment failed due to corrosion and high maintenance costs. Therefore, the Ouistreham pilot project uses a closed loop system instead of an open loop system. Proof of concept is an important goal for Elairgie to demonstrate high performance for both environmental and energy solutions, especially with increasing populations in coastal areas worldwide. The city of Ouistreham will manage the pilot after the project ends, with a contract for the system's take-over currently being prepared.

Learning

The stakeholders involved in the pilot have learned from past experiences of other pilots in the region - i.e., Cherbourg - from a technical perspective, such as avoiding sea water inside the exchanger as it creates corrosion. Currently the pilot team is learning about closed loop systems and central for these learning experiences is the company, which communicates and shares information well.

Authorization changes required strategizing with the company to relocate and reconfigure the heat exchanger. These changes to the project did not have an impact on the overall budget as items could be shifted around.

Frequent meetings ensured all actors were on board and understood the requirements of the project. Regarding a more formalized learning system the main way is to document experiences from the project through keeping meeting minutes.

Network formation and adaptation

Collaboration with partners is considered crucial by the pilot team. The city owns the site and building, and port workers maintain it. All the participating actors are considered equally important and must work together. Stakeholders include the city, diving school, the harbor, the harbor masters, electricity and gas providers, boats, and safety personnel. The city was the first stakeholder to be contacted, and provided a list of others to follow. The city also advised on less obvious stakeholders such as adding the gas company and building end users and an offshore wind farm working in this area. Besides the more formal meetings with all key actors, bilateral meetings are common in the process, and were perceived as useful. The parties have generally agreed to participate. Some additional stakeholders had to be contacted during the excavation activities for the pipes from the waterbody to the building (20-50 meters from the building).

Governance and regulatory frameworks

Energy rules and regulations are key for this project, and AE system development aligns generally with France's energy transition legislation. In April 2024, an action plan was unveiled in France to promote the use of heat pumps and trigger the production of one million heat pumps by 2027.

Important authorities that the pilot has interacted with in order to adhere to the rules and regulations are the marine environment (DDTM) for sea water, water, and biodiversity regulations. For the latter approval has been granted as the project was found not to impact biodiversity (due to choosing the use of a closed loop system instead of an open loop system). Currently the pilot team is learning about regulations for closed loop systems.

4.2.8 Middelfart (Denmark)

The municipality of Middelfart is located on the west coast of the island of Funen in southern Denmark. The municipality with about 40.000 inhabitants is committed to replace fossil fuels heating and cooling systems with sustainable alternatives. The key actors are the citizens, local business enterprises, the municipality and basically everyone with an address in the municipality. The main competences in the municipality are planning, permissions and implementing renewable energy for space heating.

The initiative was developed by several neighbors in the villages Fjelsted and Harndrup who were interested in more inexpensive and cleaner heating solutions. This grew over time to 300 neighbors in the community. From a citizens' perspective the main point is that the energy source should be renewable,and it was therefore not of key importance if it was AE, geothermal, air-air or another technology. Due to local geographical characteristics, AE was considered a good fit as a solution. The pilot started as an inclusive community driven project, based on the legal entity of a cooperative. Nobody was turned away, and over time, the size of the project became overwhelming. It was a community initiative, to be driven by a legal entity, the cooperative, that was established. However, the project grew out of its 'comfort zone' partly related to the fact that a loan of 40 million DKK became necessary for the project causing the project to collapse.

The main reason why this initial project failed can be attributed to national level policies. A change in the Danish Heat Supply Act was ongoing and national policymakers were discussing if Thermonet, a technology that includes AE, should be included in the Heating Act. If Thermonet was not to be included in the Danish Heat Supply Act, access to loans via municipality guarantees would be more difficult to access. These national disputes caused discomfort in the energy cooperative. Even if the legal dispute that was discussed in the national parliament was not settled, the citizen energy cooperative gave up because of the uncertainty. As the dispute was a national matter, many villages found themselves in a similar situation and the debate and the case featured in many news headlines.

Several political and legal forces, including experts, supported Thermonet. After the cooperative "gave up" the discriminating change in the Heating Act was adopted by Parliament. **Pilot Status**: measurements have started and sensors are installed.

Visioning

The project vision has changed over time due to several challenges experienced by the project team. The current vision has been developed as a plan that would continue with AE implementation, but at a smaller scale than previously planned. This was made possible by the Interreg North Sea WaterWarmth project, which the municipality of Middelfart is part of. It would be based upon the purchase of approx. 14 hectares of land and lakes and establish a Thermonet with AE that could support a smaller heating project for approx. 40% of the local villagers. The purchase of land, and thereby plan B, was not carried out mainly due to poor management at the municipality. Instead, a smaller project was initiated as an alternative plan B within the Interreg North Sea WaterWarmth project. The new AE project would be located at a pond, initially used as a reservoir for firefighting, and protected by a 1992 law. The project has low projected energy demand <0.25 MW, which means that it does not fall under the Danish Heating Act. However, there are still rules and regulations that pose a challenge to the project (e.g., environmental laws).

Learning

For this project, the learning process has been achieved through involving people (e.g., actors with similar interests), knowledge co-creation, exercising patience with governance processes and resilience. The motivation to share knowledge is also a considered moral obligation by the pilot team so that others can learn from their experiences. Sharing knowledge is crucial and also assists the project to achieve larger public support. When the participants and the public understand all the benefits the pilot team expects this will lead to acceptance.

Network formation and adaptation

The Municipality of Middelfart experiences large interest from citizens to support them in the transition to sustainable heating systems. The municipality planned to support the cooperative AE pilot system in Fjelsted-Harndrup and also support Føns and Brenderup with local developments and exploring AE potentials. As discussed, these plans did not succeed due to project size and complexity in combination with a change in national energy policies.

Since before the increasing awareness and investment in climate protection led to setting up a national association for energy communities in Denmark. This organization has shown an interest in AE.

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The association and its local energy communities have been an important part of network formation and creating value and ownership for renewable energy initiatives. Furthermore, the association is working to influence policies in favor of green energy, including AE.

Governance and regulatory frameworks

District heating in Denmark was initiated in the 1970s oil crisis. By 2024, 65% of the Danish households used district heating. There is a law on heating that makes loans and guarantees possible for district heating. A feasibility study provides documentation that it is a healthy project for consumer, company and society. Another important legislation for AE is the Environment Act of 1992 that determines how water bodies are used as part of environmental protection. This is important because the project depends on the pond where the system will be installed.

4.3 Results of the multi-case analysis

Visioning

Results show that not all pilots have a vision. Four of the pilots indicated they do not yet have a vision. However, there are five other pilots that indicate that they do have a vision and the Ouistreham pilot team argues that they have a clear vision. Moreover, four pilot teams indicate that the municipality in which their pilot is located operates under a municipal heat vision (i.e. Mechelen, Terherne, Baard, Heeg). In the Netherlands municipal heat visions are mandatory. Since 2021, all municipalities have had to have a local heat vision prepared. Here, a heat vision refers to a plan that indicates the timeline within which a city district in a given municipality will be disconnected from the natural gas grid. Another way visioning was addressed was by formation of a (public-private) cooperation in the City of Kortrijk, in which a partnership of public and private partners engage in a pathway to achieve a shared future AE heating goal.

Networking

Networking was observed to occur in various forms across the pilots. In several of them it was seen as a way to attract key actors, with projects having internal guidelines on how to select them and who are considered important to join the network. This includes having frequent bi- and multilateral meetings with local actors, as was showcased in the Ouistreham pilot. In two pilot cases like Mechelen, this was followed by formation of a local heat coalition, attracting local actors like citizens and business enterprises. Here, the municipality also acted as a broker in between different actors in negotiations. In addition, the City of Mechelen established a policy working group among civil servants paying special attention to AE. Moreover, the City also initiated an inter-municipal heat advocacy network. Network activities are also considered important in relation to significant activities and obligations in the project, such as permitting. In this area, the Firma van Buiten pilot maintained early and good contacts with the water authority.

Four of the pilots are led by grassroots energy cooperatives (Heeg, Baard, Terherne, Energent), which was showcased by the pilot teams benefitting from network activities from citizen-led energy cooperatives network platforms who advocate local heat solutions. For example, the Heeg, Baard and Terherne pilots benefitted from participation in the regional network initiative ‘Missie Wetterwaarmte’, funded by the Province of Fryslân, as from the ‘Buurtwarmte’ platform organised by the Dutch federation of energy cooperatives, Energie Samen.

Moreover, networking with other projects to share knowledge and best practices was also practiced, such as in the Terherne pilot. Finally, networking with knowledge institutes, such as universities was considered beneficial to AE pilots, as was witnessed in the Firma van Buiten, Ouistreham and Kortrijk pilot cases.

Learning

Learning was practiced in different ways among the pilots. First, learning takes place by involving local stakeholders in projects and benefitting from their experiences and perceptions. In some of the pilots this even entailed citizen participation and co-creation of plans, like in the Middelfart pilot. In five out of nine pilots (i.e., Firma van Buiten, Ouistreham, Terherne, Baard, Heeg), learning from past experiences of other and similar pilots occurred. This was encouraged via activities organized by regional schemes like 'Missie Wetterwaarmte' in the Fryslân region, operating Communities of Practice. In a similar vein, this occurred via project events and meetings organized by the Interreg North Sea WaterWarmth project, as indicated and appreciated by the Mechelen and Energent pilot teams. Learning also occurs in a reflective way, for example, by monitoring and reflecting on one's own project planning and implementation process, like in Kortrijk, and learning from monitoring progress, ongoing data collection, developing a knowledge base, as observed in the Kortrijk, Energent and Heeg pilots. The pilot team in Mechelen is even looking for active ways to enable reflexive learning. In other pilots, like Terherne, a lack of self-reflection is observed, on the other hand. Because AE is perceived as a regulation novelty some of the municipalities such as Kortrijk, have engaged in teaching civil servants on how to cope with the novelty and complexity of permitting AE projects.

Learning is also conducted in collaboration with academic knowledge institutes like the Firma van Buiten pilot involving researchers from different branches of Delft University of Technology. In this way, scientific knowledge enables learning and may serve as input to education. In the Heeg pilot, project workers engage in educational campaigns to promote learning on AE innovation and implementation.

Governance

Different aspects of governance are considered across the nine AE pilots. First, as a positive development, national, regional or local Climate Agreement on banning natural gas use were mentioned in pilots, including Mechelen and Baard. However, although this raises momentum and positive attention to sustainable heat alternatives such as AE system development, there are still plenty of regulatory barriers that need to be overcome. For example, pilot teams complaining about lack of integration of thermal heat plans in municipal zoning (Kortrijk), lack of public funds for AE projects (idem.), are pointing to the need of the national government establishing publicly organized loans and financial guarantees (Middelfart). This is in line with pilot teams indicating a need for establishing a national collective heat Act to regulate collective DH systems and offer more transparency and cope with uncertainties to parties who consider investing in such heat infrastructures (Mechelen, Baard, Terherne). Moreover, in the case when subsidies are available bureaucracy and strict stipulations and administrative costs for heat projects are considered problematic (Kortrijk). Despite these shortfalls, hopeful developments are a potential tax removal being under review, and an energy agency adapting framework from water agencies. Second, regulation and permit systems are observed as offering several restrictions like temperature norms of water effluent, water use, and drilling. This was witnessed in six out of nine pilots (i.e., Kortrijk, Energent, Middelfart, Baard, Heeg, Firma van Buiten). What is also considered problematic pertains to DH not being considered a public service according to EU law.

5 Conclusion

5.1 Answering the research question

This report started with the research question: What insights can be learnt from Interreg North Sea WaterWarmth demonstration pilots regarding innovation and governance arrangements that facilitate implementation and scaling of AE systems in real-world cases? Adopting an innovation and governance multi-case research approach, nine of the Interreg North Sea WaterWarmth pilots were observed and analyzed. Data were collected and analyzed on four thematic tenets including visioning, networking, learning, and governance.

Results show that not all nine pilots have a *vision*. Four of the pilots indicate they do not yet have a vision, while for five, a vision exists. Four pilots are located in municipalities that have a municipal heat vision of their own. This is important in guiding municipal support to local AE pilots.

Networking was observed to occur in various forms across the pilots. In several projects networking was seen as a way to attract key stakeholders, with projects having internal guidelines on how to select stakeholders who are considered desireful to join the network. This includes having frequent and also bilateral meetings with local stakeholders, in two cases leading to the formation of a local heat coalition. However, networking was also observed as a way to mobilize intra (organizational)- and intra-municipal capacity to advocate AE in regional policy making, so as to develop and adapt policy frameworks and planning schemes.

Other networking activity was seen in pilots participating in grassroots energy cooperatives' network activities or in regional network initiatives like 'Wetterwaarmte', in the Province of Fryslân. Moreover, networking with other projects to share knowledge and best practices was also practiced, in part organized via Interreg NSR WaterWarmth project.

Learning was practiced in different ways among the pilots. First, learning takes place by involving local stakeholders in projects and benefitting from their experiences and perceptions. In some of the pilots this even entailed citizen participation and co-creation of plans. In five pilots learning from past experiences of other similar pilots occurred. This was encouraged via activities organized by regional schemes like 'Missie Wetterwaarmte' in the Fryslân region. Learning was also observed to occur in a reflective way, for example, by monitoring and reflecting on one's own project planning and implementation process and learning from monitoring progress, ongoing data collection, developing a knowledge base. Finally, learning was observed with pilots actively collaborating with academic researchers, or with pilot workers engaged in educational campaigns.

Different aspects of *governance* are considered across the nine pilots. First as a positive development national, regional or local Climate Agreements on banning natural gas spurred action towards sustainable initiatives like AE. At the same time there are still plenty of regulatory barriers that need to be overcome like lack of integration of thermal heat plans in municipal zoning. This also holds for permit systems on issues like temperature norms of water effluent, water use, and drilling.

Pilot teams also request to have more public funds to stimulate AE projects and the national government establishing publicly organized loans and financial guarantees. More in general, there is a need for establishing a national Collective Heat Act to regulate and support collective district heating using AE heat sources.

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Appendices

App. 1-7. Short 1 page case narratives/key characteristics of individual WaterWarmth pilots

Annex 1: Visioning, Network Formation and Governance

Pilot / Country	Visioning	Network formation	Governance / Regulations
BE- Mechelen (Ragheno)	- Municipal heat plan – transition vision and heat strategy - Large scale heat infrastructure using AE as heat source.	- Multiple networks with various stakeholders. - Established local heat coalition. - Part of the policy working group to encourage uptake of AE. - City has an energy broker to facilitate energy projects and discussions. - Heat policy peer-to-peer exchanges between the cities of Mechelen, Bruges and Antwerp.	- Gas ban of 2021 for new large buildings promotes RE. - 40% investment subsidy by Flemish government for heat networks in existing buildings. - Brownfield governance strategy supports redevelopment of polluted industrial sites with RE. - Minimal policy regulation on heat networks in Flanders. - The Flemish Climate Pact of 2022, (part of the Green Deal), obligates the development of a heat plan by the municipalities, but local governments lack tools to implement it. - Energy use reports not submitted to local government but to regional government. - Flanders energy agency should adapt lessons from the water agency on regulations.
BE - Kortrijk (Howest)	- No formal vision or plan for the pilot. - Only technical schemes outlining the AE and Geothermal systems and hydraulic schemes.	- Multi-stakeholder network working on the pilot.	- Permits from the Flemish water authorities take long to obtain. - Strict rules about temperature differences by the water authorities.

			- Permits on environmental aspects and accessing underground networks. - No funds from government for new technologies. - Green Deal-Kortrijk aims for climate-neutral public buildings by 2040 and motivates municipality to engage in the project to meet this goal. - Tax removal on heat extraction is under review. - Ship traffic priority regulation hampers pilot progress.
BE - Kortrijk (Buda Island)	- Based on the heat zoning plan identifies four potential heat networks based on sustainable heat sources in and around Kortrijk. - Formation of an energy cooperative with other stakeholders to create a shared vision together.	- Limited stakeholders involved in the Buda Island pilot. - Academic, research and cooperative support at Kortrijk Weide. - Attracting and building cooperatives and citizens is a major concern for the City due to its lack of urgency in the Flanders region to adopt new RET's.	- No specific government regulations on AE. - Difficulty in obtaining permits from the water authorities. - Currently working with regional government to develop policies based on pilot experiences. - Spatial department now has someone for collaborative policy advice. - Need for integrating the thermal heat grid programme municipal plans.
BE – Gent (Energent)	- No formal visioning guidelines. - The project concept has evolved over time due to other decisions.	- Considers networks that share the same goals as crucial. - Project has internal guidelines on how to involve partners.	- Water use restrictions by the water authorities based on ecological concerns affect project size. - Drilling restrictions for borehole and thermal energy purposes.

		-Work is guided by stakeholder and customer needs. - Actively networks to attract key stakeholders.	- High costs for water extraction using an open-loop system.
DNK - Middlefart	- Initial plan did not succeed, had to settle for a smaller project vision. - Big visions remain but not yet possible.	- Association with local energy communities which influences local interest and policy towards AE.	- Current law on heating that makes loans and guarantees possible for district heating. - 1992 Environment Act which determines how water bodies are used.
FR - Ouistreham	- The project has a clear vision and plan from inception to end. - Pre-determined stakeholders for each phase of the project.	- Frequent meetings and bilateral engagements with local project stakeholders. - All stakeholders considered equal in decision making.	- 2024 French action plan on promoting heat pumps. - Marine environment and biodiversity regulations are important for project development.
NL - Terhene	- Have formulated several project specific visions. - Guided by the main municipality vision: 'Warmtevisie' on being natural gas free by 2050.	- Inclusion of energy cooperatives from the beginning.	- Collective Heat Act is important for development of new heat networks across the country. - regulations about subsidies for local communities. - District heating is not considered a public service as per EU regulations.
NL - Baard	- Guided by the main municipality vision: 'Warmtevisie' on being natural gas free by 2050.	- Key network formation with residents and local energy cooperatives. - Also seek technical support from their networks.	- Collective Heat Act is important for development of new heat networks across the country. - National Climate Change agreement which facilitates natural gas free by 2050. - Regional Water Board regulations on permits have an influence on the implementation of AE projects.

NL - Heeg	- Vision guided by aspirations to achieve energy neutrality for the Heeg village. - Broad vision that allows for flexibility.	- Networking with other projects to share knowledge. - Networking as part of education for the project and its consumers.	- AE technology regulation on ground storage limits hinders their operations.
NL -Delft (Firma van Buiten)	- No formal vision document but has a vision statement included for pilot proposal approval and to prove feasibility.	- Having good contact with the Waterboard to understand the permitting process. - Waterboard is also interested in the project results. - Network mainly with university stakeholders where the project results are most relevant are most informed about university procedures.	- The environmental law is most important for regulations and permits for this project. - The Water Framework directive is also important for water quality, temperature regulation and permissions from Waterboards.

Annex 2: Learning

Pilot / Country	**Learning**
BE- Mechelen (Ragheno)	- Looking for ways to embed reflexive learning. - Working on formalizing learning activities with other stakeholders. - Waterwarmth project has enables active mapping of key learnings of the Ragheno pilot. - project developers need to implement a collective energy concept for their project developments. - There is synergy between geothermal energy and aqua thermal energy for cooling.
BE - Kortrijk (Howest)	- Informal documentation of the learning process. - Desire to capture lessons from the implementation process. - Developing a roadmap for future reference based on experiences and lessons.

	- Learning based on ongoing data collections and on site tests.
BE - Kortrijk (Buda Island)	- The role about alternative energy provision was learned from the Mechelen pilot. - Part of the civil servants' working group sharing insights on permit granting. - Pilot's activities not well documented due to time constraints. - Developing a knowledge base on gas use elimination.
BE – Ghent (Energent)	- Learning from Waterwarmth project partners is valuable. - Learning by involving a wide range of stakeholders. - Learning influenced by constantly changing work scope. - Learning is well documented in a logbook.
DNK - Middlefart	- Through involving people and co-creating. - Promoting learning by sharing knowledge which may lead to project acceptance.
FR - Ouistreham	- Learning from past experiences of other pilots in the region. - Promoting learning by sharing knowledge with local project stakeholders through constant interactions.
NL - Terherne	- No formal first order learning, therefore, lack of self-reflection. - Have documented hurdles and successes as part of the WW project. - Learning from other projects through sharing experiences.
NL - Baard	- Learning was organized through the regional AE network with different stakeholders with similar interests: missie 'Wetterwaarmte'. - Though Community of Practice in Friesland. - Collaboration with other projects with similar scope.
NL - Heeg	- Learning from other projects through sharing experiences. - Documenting all their project phases in a logbook. - Organizing education campaigns for consumers to promote energy learning.
NL -Delft (Firma van Buiten)	- Learning based on previous experiences such as observing and changing the AE system behavior and deriving lessons. - The pilot generates scientific knowledge for wider dissemination.