# END-USERS PERSPECTIVE TOWARDS SCALING UP HEAT GRID IMPLEMENTATION IN THE NETHERLANDS

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**The urgency for the energy transition is growing due to the tangible impacts of climate change, yet the Netherlands is struggling to meet its emission reduction goals. Heat grids offer a promising alternative to electrification by providing sustainable heating solutions through centralized, renewable sources. However, implementation faces major challenges, including financial barriers, policy uncertainties, and critically, the reluctance of end-users to connect. This research focuses on the demand side of the heat grid implementation process, specifically investigating the role of different end-user groups in influencing project success. By analyzing both building and household characteristics, behavioral aspects, and the decision-making process of end-users, the study identifies key barriers and enablers that affect willingness to connect to heat grids. Through literature review, multiple case studies, and a national survey, this research uncovers critical insights into how end-user engagement varies across different phases of the heat grid process. It proposes a framework of tailored communication and engagement strategies to optimize willingness to connect among diverse user groups. This demand-side perspective provides project initiators, such as municipalities and energy providers, with actionable guidance to effectively include homeowners and tenants in heat grid development, thereby supporting the acceleration of the energy transition in the Netherlands.**

# 1. INTRODUCTION

## 1.1 INTRODUCTION

The urgency of transitioning towards sustainable and renewable energy sources has never been more apparent and the impacts of climate change are being felt worldwide and in the Netherlands. Think about how heavy rainfall in the provinces Noord-Brabant and Limburg, leading to flooding are becoming more and more common, as well as the wood fires in Greece (NOS, 2024; NOS, 2023)
Despite ambitious international and national targets, such as those outlined in the Paris Agreement (United Nations, 2015) and the Dutch Klimaatakkoord (Ministerie van economische zaken en Klimaat, 2019), current efforts remain insufficient to meet reduction goals. The PBL, the Netherlands Environmental Assessment Agency projects that, without accelerated action, the country's greenhouse gas emissions will likely achieve only a 42–50% reduction by 2030 instead of the required 55% to be on track for net-zero in 2050 (PBL, 2022). As energy generation accounts for approximately 40% of $CO_2$ emissions in Europe (Valkhof, 2020), transforming the heating sector is critical for climate mitigation. However, despite the clear goals, phasing out natural gas as the main supply source for households, which is priority according to the Klimaatakkoord (2019), is quite challenging.

Historically, the energy transition strategy in the Netherlands has prioritized electrification through technologies such as solar panels and heat pumps. Nonetheless, currently one of the most concerning challenges in the energy transition in the Netherlands is the net congestion, where electricity demand exceeds grid capacity (Liander, 2023; Rijksoverheid, 2022). This had exposed the limitations of relying solely on electrification (Reda et al., 2021). On top of that, various researchers (Amel et al. 2017; Bolderdijk and Steg 2015; Ölander and Thøgersen 2014) have found out that although the government and municipalities are stimulating homeowners to participate in the energy transition, they have been reluctant, and the pace is too low to reach the goals. The main barrier for them is the cost of energy-saving measures, while the cost saving on energy bills can be considered a main driver (Ebrahimigharehbaghi et al., 2019). Moreover, policymakers and other governmental entities face their own obstacles in achieving policy and agreement goals within budgetary constraints, while ensuring widespread participation in the energy transition. This results in major delays and costs a lot of money and time in (housing) development projects, making it even harder to reach the goals and face other accurate problems like the housing shortage (NOS, 2024b). Given these problems, and time ticking, the rising gas and energy prices are likely to push more and more households into making a choice regarding energy efficiency measures for their house, often leading to a choice between for example an (electric) heat pump or a connection to a heat grid, with the first choice contributing to the problem of net congestion.
So consequently, alternative solutions such as heat grids are gaining renewed interest. Heat grids distribute heat produced from renewable or residual sources, such as industrial waste heat or geothermal energy, through underground pipelines to buildings. Any heat source can be used and adjusted to the (future) demand, as long as it is more

sustainable than gas (Warmtenetten Voor Beginners - Stichting Warmtenetwerk, 2023). And when sustainably powered, heat grids can reduce greenhouse gas emissions by up to 60% compared to conventional gas boilers (Milieu Centraal, n.d.).

Despite their potential, the implementation of heat grids in the Netherlands faces considerable challenges. Financial uncertainties, stakeholder conflicts, and policy changes most notably the upcoming Wet Collectieve Warmtevoorziening (WCW) have delayed many projects (NOS, 2024b; Opheikens, 2024). Furthermore, public trust is at risk, as negative media coverage around project feasibility, price uncertainties, and governance disputes negatively influences confidence and trust in heat grid initiatives. Although the WCW aims to ensure fair pricing and more public oversight, it has also created concerns among municipalities and energy companies about financing, governance capacity, and operational control (NOS, 2024b).

A key factor influencing the success of heat grid projects is the willingness of end-users, being mostly homeowners and tenants, to connect to the new systems. Willingness to connect has emerged as a crucial determinant in feasibility assessments and business case validation, particularly given the cost sensitivity and behavioral dynamics among households (Rubio Agulló, 2024; Bouw, 2015). However, user perspectives have received little research attention compared to the technical, financial, and policy dimensions of heat grid implementation. There is an increasing recognition that different end-user groups, depending on their building types, household characteristics, and behavioral traits, respond differently to transition measures (Ebrahimigharehbaghi et al., 2019).
Given that securing sufficient commitment from end-users is crucial at multiple key decision-making moments during the heat grid development process (Rubio Agulló, 2024), it becomes essential to investigate how their motivations, barriers, and decision-making behaviors can be better understood and addressed. Recent studies emphasize that a "one-size-fits-all" communication and engagement strategy is ineffective; rather, tailored approaches that meet the needs and conditions of diverse user groups are necessary (Hajarini et al., 2022; Palomo-Vélez et al., 2024).

This study addresses this gap by focusing on the demand-side perspective in heat grid projects. It investigates how household and building characteristics, behavioral factors, and external conditions influence willingness to connect, and how tailored communication and engagement strategies can optimize user participation. By combining literature review, case study analysis, and survey research, this study aims to provide actionable insights for project initiators to strategically engage different end-user groups and thereby support the acceleration of the energy transition in the Netherlands.

The main research question guiding this study is:

***"How can different end-user groups be effectively engaged in the heat grid implementation process to optimize their willingness to connect?"***

## 1.2 PROBLEM STATEMENT

While the Netherlands has committed to ambitious climate goals, including a 55% reduction of greenhouse gas emissions by 2030 and net-zero emissions by 2050 (Government of the Netherlands, 2019), the country is currently not on track to meet these targets (PBL, 2022). The heating sector, traditionally reliant on natural gas, must undergo a major transformation to contribute to these ambitions. Heat grids offer a promising alternative, providing sustainable heating solutions based on renewable and residual energy sources (Milieu Centraal, n.d.; Reda et al., 2021). However, despite their technical potential, the practical implementation of heat grids faces significant barriers.

One of the most critical challenges is the willingness of end-users to connect to a heat grid. Recent research highlights that a lack of sufficient user commitment at key decision-making moments can influence the financial feasibility of heat grid projects, causing delays or cancellations (Rubio Agulló, 2024). Recent news articles (NOS, 2024) write that currently, 90% of the heat grid projects are on hold or cancelled.

Simultaneously, broader system challenges such as net congestion (Liander, 2023) and rising energy prices (NOS, 2024) are reshaping the context within which households make heating decisions. People might be pushed towards making alternative choices for their heating system, like heat pumps. As a result, homes that could be suitable for connection to the heat grid may lose interest in a heat grid connection, which will increase the costs per household.

Furthermore the upcoming Wet Collectieve Warmtevoorziening (WCW), which aims to increase public control over heat networks and protect consumers against excessive pricing (Rijksoverheid, 2024). Although the WCW's intentions align with safeguarding user interests, uncertainty about its implementation has raised concerns among municipalities, energy companies, and grid operators (Opheikens, 2024). Negative media attention around project delays and governance disputes has further eroded public trust, a crucial factor influencing user willingness to connect (Palomo-Vélez et al., 2024; Opheikens, 2024).

Moreover, not all end-users are the same. Differences in building characteristics (for example: insulation levels, current heating systems), household compositions, financial situations, and behavioral characteristics mean that willingness to connect is highly heterogeneous (Ebrahimigharehbaghi et al., 2019; Hajarini et al., 2022). A one-size-fits-all approach to communication and engagement is therefore unlikely to succeed. Instead, tailored strategies that recognize the diversity of end-user groups are needed to optimize participation rates.

Despite the increasing importance of end-user participation, most heat grid studies have focused on supply-side challenges (like: technical feasibility, financial models, or policy frameworks), leaving a critical knowledge gap regarding how end-users perceive, engage with, and decide about heat grid connections (Bouw, 2015; Rubio Agulló, 2024).

This research aims to investigate how different end-user groups can be effectively engaged in the heat grid implementation process to optimize their willingness to connect by addressing this gap. It explores how personal circumstances (building, household and behavioral characteristics) influence the decision-making process, identifies barriers and enablers throughout the project phases, and aims to formulate tailored communication strategies for successful end-user participation.

## 1.3 RESEARCH QUESTIONS

To address the knowledge gap regarding the engagement of end-users in heat grid projects, the following main research question will be guiding this study:

**"How can homeowners be effectively engaged as end-user in the heat grid implementation process to optimize their willingness to connect?"**

This main research question is broken down into the following sub-questions:

Sub-question 1:
**Who are the different end-user groups within suitable areas for heat grids, and what are the specific characteristics and needs that influence their willingness to connect?**
*This sub-question explores which end-user groups can be distinguished based on building characteristics, household compositions, socio-economic factors, and behavioral attributes relevant to energy transition decision-making.*

Sub-question 2a:
**What barriers hinder different end-user groups in their willingness to connect to heat grids and their decision-making process?**

Sub-question 2b:
**How do these barriers vary across different user groups and phases of the implementation and decision-making process?**
*This question investigates the obstacles that hinder willingness to connect, such as financial concerns, trust issues, technical readiness, or perceived fairness, and maps them onto the different phases of the decision-making process and a typical heat grid project process.*

Sub question 3:
**How can project initiators use different strategies to effectively engage different end-user groups and optimize their willingness to connect throughout the heat grid implementation process?**
*Building on the insights from SQ1 and SQ2, this question aims to identify communication and engagement strategies tailored to the needs and profiles of diverse user groups, considering timing, messaging, and channels across the project timeline.*

By systematically addressing these sub-questions, this research contributes to a deeper understanding of the demand-side dynamics in heat grid projects and aims to provide actionable recommendations for municipalities, housing associations, and energy companies seeking to increase end-user willingness to connect to a heat grid and support the acceleration of the energy transition in the Netherlands.

## 1.4 SOCIETAL AND SCIENTIFIC RELEVANCE

The energy transition represents one of the most urgent societal challenges of our time, as the impacts of climate change intensify worldwide. Achieving the Netherlands' climate goals, as outlined in the Klimaatakkoord, requires acceleration in the decarbonization of the built environment (Ministerie van Economische Zaken en Klimaat 2019; United Nations, 2015). Heat grids are increasingly recognized as a potential and promising solution of this transition, offering an alternative to electrification that can mitigate the growing issue of net congestion (Liander, 2023; Milieu Centraal, n.d.). Meanwhile there is a societal need for raising more awareness and keeping people well-informed since the challenges are more often being outlined in the news, possibly affecting people’s perception about heat grids.

However, with approximately 90% of heat grid projects currently on hold or cancelled due to feasibility issues, governance uncertainties, and stakeholder conflicts (NOS, 2024; Opheikens, 2024), there is a clear risk that the sector will fail to deliver on its potential. Ensuring end-user willingness to connect has shown to be a critical success factor, influencing the viability of heat grid projects (Rubio Agulló, 2024; Bouw, 2015). The societal relevance of this research lies in addressing this gap: more successful, inclusive, and user-centered heat grid projects can help municipalities, housing associations, and energy companies move forward with sustainable heating solutions, contributing to national and international climate targets.

From a scientific perspective, existing literature on heat grid implementation has been predominantly supply-side focused, analyzing technical, economic, and policy aspects (Reda et al., 2021; Hajarini et al., 2022). The demand side, including the role of homeowners decision-makers, remains underrepresented. In particular, there is limited research into how end-user characteristics, behavioral factors, and contextual conditions influence willingness to connect, and how tailored engagement strategies could optimize willingness to connect.

By addressing these gaps, this research presents scientific understanding of the human dimensions of heat grid projects. It contributes to the interdisciplinary fields of energy transition studies, stakeholder management, and sustainable urban development. Furthermore, by offering a practical framework of tailored communication strategies linked to different phases of heat grid projects, this research provides actionable insights for practitioners aiming to support end-user participation and scaling up heat grid implementation. This contributes to the broader goal of accelerating the energy transition.

# 2.
# THEORETICAL BACKGROUND

In this chapter, existing literature on this research topic will be reviewed and discussed. First the role of heat grids within the energy transition will be explained. Then it is key to understand what makes an area or building suitable for a heat grid connection. The heat grid process alongside the stakeholders' positions and interests in such projects will be analyzed, to then explore the barriers and drivers for end-user willingness to connect to a heat grid.

## 2.1 HEAT GRIDS AND ENERGY TRANSITION (What?)

Heat grids- also known as district heating networks- have gained significant attention as a key element in the energy transition, particularly in densely populated urban areas (Hoppenbrouwer & Louw, 2005). Heat grid systems centralize energy generation and deliver it to multiple end-users through underground pipes. These systems are suited to utilize a wide variety of energy sources, including industrial waste heat, biomass and geothermal energy (Milieu Centraal, n.d.). This flexibility in energy sources makes heat grids an adaptable solution to evolving energy demands, and an attractive option for reducing greenhouse gas emissions and reliance on fossil fuels, which aligns well with international climate goals such as the Paris Agreement and the Dutch *Klimaatakkoord* (Climate Act)(Reda et al., 2021). Heat grids are already being used in many countries, such as the Netherlands and Denmark, as well as in large urban areas in Seoul and Stockholm (News - Smart City Sweden, 2020). Heat grids are increasingly recognized for their capacity to decarbonize heating supply when driven by renewable energy sources, enhancing a role in the broader energy transition.
Like any other technology, heat grids are constantly in in development towards more innovation. While the first generations were vulnerable to heat loss and needed high temperatures.

*Table 1: Production and energy sources for district heating generations over time (Lake et al., 2017)*

| | 1st generation | 2nd generation | 3rd generation | 4th generation |
|---|---|---|---|---|
| **Peak technology period** | 1180-1930 | 1930-1980 | 1980-2020 | 2020-2050 |
| **Heat production** | Steam boilers | CHO and heat-only boilers | Large-scale CHP | Heat recycling |
| **Energy source** | Coal | Coal and oil | Biomass, waste and fossil fuels | Renewable sources |

Over time, newer generations have improved efficiency and reduced heat loss. Table 1 summarizes the evolution of district heating systems from first to fourth (and emerging fifth) generation, including their typical production technologies and energy sources (Lake et al., 2017). From the 3rd generation on the heat losses have been reduced and the systems allow more environmentally friendly solutions with renewable energy sources and lower temperatures. The most advanced fourth (4GDH) and fifth generation (5GDH) combine smart energy management and renewable energy sources like solar

and geothermal energy. The 5GDH systems can even provide both heating and cooling (Buffa et al., 2020).
Currently in the Netherlands, heat grids are still largely dependent on natural gas, so there is an immense potential to shift this towards renewable energy sources and its impact is huge. According to Milieu Centraal (n.d.) a shift to renewably powered heat grids can reduce greenhouse gas emissions by up to 60% compared to traditional natural gas boilers. Dutch government is committed to phasing out gas under the Dutch Climate Act, which emphasizes the increased adoption of electric heat pumps, solar energy and heat grids. Currently there are 18 major and 100 minor heat grids in the Netherlands, with 40% of all Dutch municipalities expressing their interest to implement a heat grid in their area, using renewable energy sources like residual waste heat and geothermal energy (Segers et al., 2019). This is in line with the made agreements. Nonetheless, as of 2022, district heating supplied only about 7% of the Netherlands' total heat demand (CBS, 2023), which suggests significant room for growth in order to meet climate targets.

At the same time, a notable shift is occurring at the end-user level from gas-fired boilers toward electric heating technologies (heat pumps) and solar energy usage for hot water and space heating. This trend is evident in the rapid increase in heat pump installations). However, the electrification of heating is contributing to increasing stress on the electric power grid, contributing to net congestion, since many neighborhoods were not designed for the high electricity demand of widespread heat pump use and electric vehicle charging. Given these grid capacity challenges, the implementation of heat grids as an alternative becomes more relevant than ever. District heating can reduce the strain on the electricity grid by supplying thermal energy through pipelines instead of adding electrical load for heating (Van den Ende, 2024). Timing is a critical factor: as energy prices rose in recent years, many households have opted to invest in individual solutions (like heat pumps) now, which could reduce future demand for a collective heat grid connection if those investments are already made. In other words, if a homeowner has recently installed a costly new heating system, they may be less interested in switching to a heat network later. This underscores the importance of accelerating heat grid projects to attract consumers before they make long-term individual investments.
Another challenge for heat grids is ensuring affordability and avoiding monopolistic practices. Because a heat grid in a given area typically operates as a natural monopoly (with a single network operator and supplier), there is a risk of high pricing or limited consumer choice. To mitigate this risk and protect consumers, the Dutch government is developing new legislation known as the Wet collectieve warmtevoorziening (WCW), or Collective Heat Supply Act. As of 2024, this Act is in the proposal stage; it aims to increase public control over district heating projects and introduce transparent, cost-based price regulation for heat supply In essence, the WCW will replace the existing Heat Act and is designed to prevent unfair pricing by heat companies, strengthen consumer protection, and ensure municipalities have a greater role in planning heat networks. This policy development, along with subsidies and other regulatory support, is intended to make heat grids an affordable and reliable component of the Dutch energy transition.
In summary, heat grids represent a scalable solution for sustainable heating. One that can provide reliable warmth to communities while leveraging diverse and flexible energy

sources. When powered by renewables or waste heat and governed by fair regulations, heat networks can offer significant environmental benefits and contribute substantially to decarbonizing the building sector. The Dutch context illustrates both the potential of heat grids (in policy ambitions and pilot projects) and the hurdles to overcome (technical, economic, and timing-related) to achieve broader adoption.

## 2.2 STAKEHOLDER DYNAMICS IN HEAT GRID IMPLEMENTATION PROJECTS (Who?)

Implementing a heat grid involves a complex network of stakeholders, each with different roles, interests and influences on the project's success. To understand the role of end-users and in particular homeowners in the implementation process of heat grid projects, first all the involved stakeholders and their dynamics must be understood. The energy transition encompasses a wide range of stakeholders whose involvement should be duly considered. In fact, stakeholder identification is an ongoing process throughout the project's life cycle (Maqbool et al., 2022). To get a better understanding of implementation processes of heat grid projects, first the key stakeholders will be identified, to then dive into the process and find the end-users' role.

### 2.2.1 Key stakeholders

Effective stakeholder identification and engagement are essential for the success of these projects, ensuring that the demands, expectations, and needs of all parties are addressed appropriately (Hamdan et al., 2021).

*Table 2: Stakeholder roles in heat grid projects (changed from Bouw, 2015)*

| **Stakeholder** | Housing Associations | Tenants/ homeowners | Local governments | Grid operators |
|---|---|---|---|---|
| **Roles** | Initiator, coordinator, shareholder, owner | Shareholder, heat purchaser, end user | Initiator, coordinator, facilitator, shareholder, (co)financer, owner, heat purchaser | Initiator, network owner, investor, coordinator |

Table 2 shows who the key stakeholders in a typical project would be. Primary stakeholders are those directly and significantly affected by or able to influence the project outcomes. In heat grid projects, the primary stakeholders usually include municipalities, housing associations, energy companies, and end-users (customers). These actors have substantial influence on decision-making, particularly during critical phases such as feasibility studies, business case development, and the contracting of connections. Ensuring alignment among primary stakeholders is often crucial for a project to move forward. Secondary stakeholders include parties that are not directly receiving heat or making project decisions, but whose support or regulatory authority is important for the project's environment. These typically include national and regional governments, regulatory bodies, consultancy firms, and energy cooperatives or community organizations (Bouw, 2015). While secondary stakeholders are not the immediate users or operators of the heat grid, they provide the policy frameworks, technical expertise, funding mechanisms, or community support that enable the project. For example, national government sets the legal regulations, regional authorities may coordinate between parties, consultants may supply feasibility analyses or support participation processes. There is often a leadership hierarchy or initiative structure in heat grid projects. In the Netherlands, municipalities are frequently in the lead to achieve local energy transition goals, especially since they have been mandated to develop heat transition visions and plans for phasing out natural gas. They may initiate heat network projects to fulfill climate targets at the local level. However, depending on the context, a housing association or an energy company might also be the driving force or co-initiator of a project. For instance, a housing association could spearhead a district heating project to upgrade its housing stock's sustainability, or an energy company might propose a network where it sees a viable business case. This leadership aspect will be further explored in Section 2.3 regarding how it influences processes. It is important to note that the relationships between stakeholders can greatly affect project progress. Trust and collaboration (or lack thereof) among key actors can make or break a project. Prior studies have noted that distrust between local authorities (municipalities), residents, housing associations, and energy companies can cause deadlocks in the decision-making process, leading to significant delays or even project cancellation (Hoppe, 2012). Therefore, building mutual trust and aligning interests is a recurring challenge. On the other hand, government actors can facilitate a more favorable environment for business and investment in heat networks by offering subsidies, guarantees, or streamlined permitting processes. So, identifying who the stakeholders are and understanding their interrelations is a critical first step in managing a heat grid project.

### 2.2.2 Stakeholder roles and responsibilities

Each stakeholder in a heat grid project plays a distinct role. The following summarizes the typical roles and responsibilities of the main stakeholders (based on literature and common practice):

- **Municipality:**
  Local governments often act as initiators, coordinators, or overall program managers for heat grid projects. They are responsible for aligning the project with local energy transition goals and national climate targets. A municipality may facilitate stakeholder collaboration, integrate the heat network into urban development plans, and ensure that the project serves the public interest (affordability, sustainability, inclusivity). Their responsibilities also include creating enabling policies or supportive regulations at the local level, securing funding or subsidies (often from national programs or EU funds), issuing necessary permits, and possibly providing rights-of-way for infrastructure (Hoppe, 2012). Moreover, municipalities play a crucial role in building public trust through community engagement and communication, as citizens often look to local authorities for guidance and assurance on such projects. In many Dutch heat projects, the municipality is the driving force that convenes other partners and keeps the project aligned with policy objectives.
- **Energy Company:**
  The energy company (or heat supplier) involved is typically responsible for the

technical and commercial operation of the heat grid. This includes designing the network, constructing and maintaining the infrastructure (pipelines, heat transfer stations, pumps), and managing the production or source of the heat. Energy companies make sure the heat supply is reliable, efficient, and increasingly sustainable. They often co-own or fully own the heat grid infrastructure and thus take on significant investment risk. Energy companies are also usually the entity that bills end-users for heat, meaning they handle customer contracts and service. In project development, an energy company often takes the lead in drafting the business case, evaluating economic feasibility, and securing financing. They negotiate agreements with municipalities (for concessions or partnerships), with housing associations (for connecting social housing blocks), and with individual end-users or building owners for connection contracts. Given their technical expertise, energy companies also evaluate which heat sources can be used. In some cases, an energy company itself initiates a heat grid project, especially if it identifies a market opportunity – though public trust can be a challenge if the community perceives the company as purely profit-driven. Effective risk mitigation and transparent pricing strategies by the energy company are important to gain acceptance.

- **Housing Association:**
  Housing associations represent a significant group of end-users, particularly in urban areas with many rental apartments. They often own large portfolios of residential buildings. In heat grid projects, housing associations can be pivotal because connecting a block of social housing can provide the "critical mass" of customers needed for a viable network. They frequently act as co-initiators in collaboration with municipalities – for example, if a housing association plans to renovate a neighborhood, it might coordinate with the municipality to include a district heating connection as part of the upgrade. The role of housing associations includes advocating for the interests of their tenants by ensuring the heat supply will be reliable and affordable. They also handle internal decision-making about modifying building installations (like removing gas boilers, installing heat exchangers) and may invest in making their buildings heat-ready (insulation, radiator upgrades). Their commitment is often critical: by agreeing to connect their dwellings, they help reach the scale required for the project's economic feasibility. Housing associations often coordinate communication to their tenants about the changes and can organize collective decision processes, especially if tenant approval or consultation is required by regulation. They must balance the sustainability goals, like reducing $CO_2$ emissions of their housing stock, with the financial constraints like for example, rent regulations and limited budgets for retrofits. In summary, housing associations serve as intermediaries between the project and a large segment of end-users, and their early involvement can significantly drive a project forward.
- **End-Users:**
  End-users include the homeowners, tenants, and local businesses who will ultimately heat their premises via the heat grid. In many ways, they are the customers of the heat network, purchasing heat for space heating and hot water. End-users have a crucial, sometimes understated, influence on project feasibility through their willingness (or reluctance) to connect. Their decisions, whether to

sign up for the heat network or stick with individual systems, directly affect whether the heat grid will have sufficient demand. End-user acceptance is shaped by factors such as perceived cost and benefits of switching to district heat, understanding of environmental impacts, trust in the parties leading the project, and comfort with the technology. If too little end-users are willing to join, the project may not gather enough subscribers to justify the investment (Rubio-Agullo et al., 2024). Therefore, achieving a high connection rate is often a key project goal. End-users also have certain responsibilities or steps: homeowners might need to modify internal heating systems, for instance install a heat exchanger unit or extra insulation, and they may experience some inconvenience during construction; streets dug up for pipes, a short heating downtime during switch. Their support and patience are important during implementation (Mundaca, 2016).

In addition to these, there are other stakeholders such as contractors, financiers/banks (if external capital is needed), technology providers, and regulators. However, the roles outlined above cover the core group relevant to this study, with a focus on how end-users interact with the other stakeholders involved. Understanding each stakeholder's position provides context for how the process unfolds and where potential frictions or synergies may arise.

## 2.3 HEAT GRID IMPLEMENTATION PROCESS (How?)

The heat grid Implementation process is a multi-phase process that typically follows a sequence from initial idea to operation. This section describes the general process flow of a heat grid project highlighting key phases (Figure 1) and decision points, especially those that involve end-users, the description is based on the research by Rubio Agullo et al. (2024).


*Figure 1: Typical project phases (Rubio Agullo et al., 2024)*

The process usually starts with an **initiation phase**. Rubio Agullo et al. (2024) describe the early stages of heat network development from the supply side's perspective. In the initiation phase, a project idea is formed, and preliminary explorations take place. Often, as noted, municipalities or housing associations take the lead at this stage. The initiator will conduct initial studies to assess the potential for a heat grid in a target area. This includes identifying possible heat sources (for instance, whether there is an industrial facility or data center nearby that emits usable waste heat, or the availability of geothermal potential), and reviewing neighborhood characteristics such as housing density, total heat demand, and the presence of interested partners. These exploratory studies yield insight into whether the concept is worth pursuing further. If the initial outlook is positive, a decision is made to proceed to a more detailed feasibility analysis. Next is the **feasibility phase**, where rigorous technical and economic analyses are performed. During this phase, the project team assesses detailed heat demand calculations, models different scenarios for network routing and design, and estimates the required infrastructure investments. A draft business case is developed, including cost projections (capital and operational expenditures) and potential revenue from heat sales. Technical feasibility (can the area actually be served by a network and can a sufficient heat supply be secured?) and financial feasibility (can the project be profitable or at least cost-covering under reasonable assumptions?) are also done in this phase. At this point, alignment between key stakeholders is crucial. For example, the municipality and the energy company must agree on roles, financing, and risk-sharing. Often, subsidy applications or grant proposals will be prepared during this phase to improve the business case. By the end of the feasibility phase, the stakeholders decide whether to move forward with the project. A critical part of that decision is an initial estimation of end-user interest: the business case will factor in what percentage of households or buildings are expected to connect. If not enough potential demand is foreseen, the project may not proceed. If the project seems feasible, it enters the **contracting phase**. This phase is crucial for formalizing commitments. Contracts and agreements are drawn up between the various parties: for instance, a concession agreement or public-private partnership agreement between the municipality and the energy company (defining responsibilities, concessing duration, price agreements, etc.), agreements with housing associations (for connecting their buildings and perhaps guaranteeing a number of connections), and connection agreements or offers to end-users (homeowners and other building owners). It is often during this phase that potential end-users are approached to sign connection contracts or letters of intent. The contracting phase can be challenging because it requires building a high level of trust and transparency. End-users often want clarity on what they are signing up for: the costs of connection, expected heat tariffs, service levels, and any compensation for changes needed inside their homes. Given that a heat grid often represents a long-term commitment (with infrastructure lifetimes of 30+ years and limited possibility to switch from supplier) homeowners may be cautious. Thus, this phase typically involves extensive communication and negotiation. It may also overlap with securing permits and finalizing financing of the project. In many documented projects, reaching a satisfactory number of signed end-user contracts is a requirement for financiers or authorities to give a final green light. Therefore, the contracting phase is a crucial point where the project either gains enough momentum (if end-user uptake is high) or stalls (if people are reluctant to commit). Once agreements and financing are in place, the project moves into the **realization phase**. During realization, the heat distribution network is built, trenches are dug and pipes laid throughout the neighborhood, energy centers or source installations are constructed or connected, and individual building connections are installed (heat exchangers for example). The energy company oversees the technical deployment and quality control. Safety checks and system tests are conducted as sections of the grid are completed. After construction, the system can be used and finally, the **operational phase** begins when the heat grid starts delivering heat to end-users. In the operational phase, the focus shifts to the day-to-day management of the network: supplying heat reliably, maintaining the infrastructure, and handling customer service. End-users experience the new heating system and can provide feedback on performance. The success of the operational phase is measured by factors like system uptime, customer satisfaction, actual versus expected cost savings for users, and the reduction in carbon emissions achieved. Operational data can also inform plans for future expansion, for example connecting additional users or extending the network.

It is worth noting that the process is not strictly linear; there are feedback loops and possible iteration. For example, if during contracting not enough end-users commit, the project might loop back to do additional feasibility tweaking or increased incentives, or it might be put on hold. Two critical decision milestones typically occur before the project reaches the “financial close”: one at the end of the feasibility phase and one at the end of the contracting phase. Rubio Agullo et al. (2024) emphasize that there are (at least) *two go/no-go decision moments* in the early process, and both rely significantly on the expected or confirmed willingness of end-users to connect. During the feasibility phase, a provisional assessment of end-user interest (perhaps via surveys or letters of intent) can influence the decision to proceed. Later, during contracting, if insufficient households sign up, the project may not achieve financial close. This makes especially the feasibility and contracting phases critical from an end-user perspective and will be interesting to investigate. Moreover, this is also the reason that this study focusses on the end-user’s willingness to connect.

It is also important to recognize that the implementation process can vary depending on which stakeholder is leading or initiating the project. As mentioned, a project led by a municipality might place more emphasis on public value, whereas a project led by an energy company might prioritize economic viability and operational efficiency. Research by Rubio Agullo et al. (2024) suggests that the nature of the process can vary depending on the leading party. For instance, when a municipality is in charge, there may be more extensive community consultation before and during feasibility, potentially slowing things down but increasing local support. A housing association-led project might integrate the heat grid with planned renovations and thus strongly focus on tenant communication and managing retrofit costs. An energy company-led project might initially move faster in technical planning but could face more skepticism from residents or need greater support from the municipality to ensure public acceptance. These variations in leadership can influence the types of barriers and enablers encountered throughout the project. For example, public-led projects might struggle with technical expertise or funding, whereas private-led ones might struggle with public trust or regulatory hurdles.

*Table 3: Influence of different project initiators on project focus and end-user involvement (based on author's assumptions)*

| Leading party | Focus & approach | End-user involvement |
|---|---|---|
| **Municipality** | Align project with public policy goals; emphasize social benefits, affordability, and local sustainability objectives. May prioritize inclusivity and long-term community value, but could lack in-house technical expertise. | Tends to facilitate a community-driven process. Likely more public meetings and participatory planning, which can build trust and increase willingness to connect if managed well. However, technical or financial challenges might arise if the municipality’s capacity is limited, potentially causing delays. |
| **Housing association** | Focus on tenant needs and integrating heat grid connection with broader housing portfolio improvements (energy retrofits). Must balance investment with regulated rents and budgets. Often motivated by sustainability targets for | Likely to engage tenants directly, potentially creating a sense of obligation for residents to join. Needs effective communication and involvement of tenants in decision-making to ensure acceptance. If done well, can secure a bulk of |

| | | |
|---|---|---|
| | their housing stock, but constrained by financial resources. | connections, but if tenants feel forced, it could lead to resistance. |
| **Energy company** | Prioritize economic feasibility and efficiency; focus on profitability, scale, and technical optimization. Brings technical expertise and project management experience. However, may place less emphasis on social considerations unless required. | End-user engagement might be more top-down. There is a risk the process feels corporate and impersonal, which can create mistrust if residents feel their concerns are not heard. Clear, transparent communication and perhaps partnering with local authorities or community groups is critical to gain user trust. Early adopters may be consulted, but broader participation might be limited unless proactively managed. |

Table 3 provides an overview of how the leading party (municipality, housing association, or energy company) might influence the focus of the project and the approach to end-user involvement, based on typical strengths and weaknesses of each and assumptions from literature and practice.
In practice, many projects are co-led by multiple parties; the above tables are simplified for illustration due to limited prior research distinguishing processes by initiator.
These comparisons underscore that regardless of who leads, end-user involvement is crucial and must be carefully managed throughout the project. Different leadership approaches simply mean different strategies are needed to involve and convince the end-users. This research will later explore how and if, these variations influence the barriers and enablers for end-users' willingness to connect.

## 2.4 SUITABLE AREAS FOR HEAT GRIDS (Where?)

Having discussed what heat grids are and how they are implemented, the next question is where they make the most sense. To understand who the potential end-users of heat grids are, first an understanding of what makes an area suitable for heat grid implementation is needed. The suitability of an area for heat grid implementation is influenced by several factors. In the Dutch residential context, on which this study is focused, it is important to note that most of these areas are not solely residential. The Netherlands is characterized by its mixed-use urban structure, which is a result of the compact city as a concept for Dutch urban policy in the past decades. The goal of this concept is enhancing the simultaneous growth of housing stock and employment opportunities and mixing this (Hoppenbrouwer & Louw, 2005). As of today, this focus remains popular and new neighborhoods are often designed to be walkable, bikeable, mixed-use and consisting of diverse housing typologies.

*Another word that is being mentioned in literature is mixed development (Boschman et al., 2013). This refers to the focus on integrating different socio-economic groups in developments under the Dutch housing policy from the 1990s on. The aim was to stimulate social cohesion and mitigate the issues that rose from isolated low-income groups (Bektaş & Taşan-Kok, 2020). Within the scope of this research mixed use refers to* *different type of building use (residential, retail, offices etc.) rather than the mixed income definition. However, it must be noted that this type of areas might be worth mentioning and researching separately since they can give a relevant representation of the different types of end users in an area for a heat grid.*

So social factors influence suitability. Neighborhoods with strong community structures, like apartment buildings with VvE's can facilitate collective decisions about connecting to a heat grid. However, the willingness to invest in such systems varies across income levels. Higher-income neighborhoods may be more open to initial investments, while lower-income areas may require financial incentives or guarantees for affordability (O'Neil, 2002). For this reason, mixed use neighborhoods are very suitable because the diversity can be an opportunity since varied stakeholders, from businesses to homeowners, can help balance the heat demand throughout the day. Heat demand is a critical factor in determining the suitability of areas for a heat grid. For a heat grid to be economically viable, there needs to be a consistent and high demand for heating. Looking into the Dutch context this doesn't only mean balanced heat demand, but also a high demand. Areas with a great share of older buildings, especially those constructed before energy efficiency regulations were introduced, often require more heating and thus they can sustain the higher demand needed for a heat grid to operate efficiency. More specifically this includes for example pre-war neighborhoods and post-war apartment blocks, which can be found in and around most city centers in the Netherlands. This will be further elaborated in Section 2.4.1.

In addition, access to (renewable) energy sources and existing infrastructure plays a crucial role in determining suitable locations. Areas near industrial zones or data centers with a lot of waste heat are great locations for example, as well as cities with older district heating systems. For example, in Rotterdam Pendrecht and the Hague. Additionally, regions where Municipalities have implemented policies supporting sustainable energy with local subsidies or initiatives for heat grids are more likely to see successful projects.

So according to literature, in the Dutch context, suitable areas for heat grids often involve a combination of dense urbanization, access to residual or renewable energy sources, existing infrastructure, supporting policy frameworks and the building characteristics. Next to this, household characteristics, such as income and interest in sustainability, play a significant role. This focus on specific characteristics helps to ensure the economic and environmental sustainability of heat grids, contributing to broader energy transition goals (Lake et al., 2017).


*Figure 2: Suitability pillars for areas (author)*

### 2.4.1 Building characteristics

Zooming into building level, mixed-use areas come along with diverse building characteristics in an area. This means that the starting point for getting a building ready for a heat grid connection can differ, since a certain level of insulation and building quality is needed for a heat grid connection to be efficient. Research by van den Brom et al., (2018) shows that having a grip on these building characteristics can help choose the right target groups for energy saving policies and campaigns. Several factors influence the suitability of a building for a heat grid connection and affect how ready that area is for a connection.

First of all, the energy consumption that is depending on the heat gains and losses of a dwelling. This is determined by its technical and architectural characteristics on the one hand and by the characteristics and behavior of the residents on the other. The latter will be discussed in chapter 2.5.2.

Several factors influence the technical suitability of a residential building for a heat grid connection. These factors are often influenced by the urban morphology, building year and size, household type, previous (energy efficiency) renovations (EER) and the current heating system. The energy label, when combined with these characteristics, provides an indication of the yearly energy demand.

For example, consider an old apartment building, built in the 1960s. Based on its construction period, it is likely that it lacks modern insulation standards, leading to higher heat loss. Connecting such a building to a heat grid requires a certain level of improved insulation and installation of double-glazed windows. In contrast, a recently constructed residential block from 2015 might already meet energy-efficiency standards with triple glazed windows and insulated facades, making it more directly compatible with heat grid integration without significant modifications. So older buildings, particularly those without any EERs, tend to have a higher energy demand than newly constructed dwellings (van den Brom et al., 2018).

Based on these characteristics, some buildings may need some improvements to be suitable for a grid connection. Furthermore, households that recently did EERs might not be interested because they just installed a heat pump for example.

This shows the importance of building characteristics, because living in an unsuitable building or house may have a negative impact on one's willingness to connect. All these factors need to be taken into consideration by potential end-users during the decision-making process for a heat grid connection (Santin et al., 2009). So, it is important to have some background information about these matters to be able to place the research outcome from the survey responses in context.

Therefore, the following list of potential influencing dwelling features is used in the survey:

*Table 4: Building characteristics and potential influence (author, adopted from: Brounen et al., 2012; Vaseur & Marique 2019; Mashhoodi et al., 2020; Wahi et al., 2023)*

| Building characteristic | Potential influence |
|---|---|
| **Building year** | Older buildings often have higher heating demands but may require additional retrofits |
| **Building typology** | Single-family homes versus apartments differ in heating needs and retrofit costs |
| **Square meters** | Larger homes have higher energy demands, which can reduce efficiency |
| **Heat demand** | Affected by insulation, design and building material it is a suitability measure |
| **Energy Label** | poor energy labels indicate inefficiency, requiring upgrades for optimal heat grid performance |
| **Previous energy efficiency measures/retrofits** | Recent investments in energy efficiency can reduce end-users' interest in additional heat grid investments |
| **Current heating system** | Compatibility with heat grid varies |

### 2.4.2 End-user characteristics

As briefly mentioned in the previous section the end-user characteristics are playing an important role when determining their willingness to connect to a heat grid. To understand the different perspectives of different end-user groups, it first must be determined who the potential end-users of heat grids are and what characteristics have potential influence on their willingness to connect.
Since the suitable areas for heat grids are especially mixed-use neighborhoods, all types of households (Figure 3) are taken into consideration.

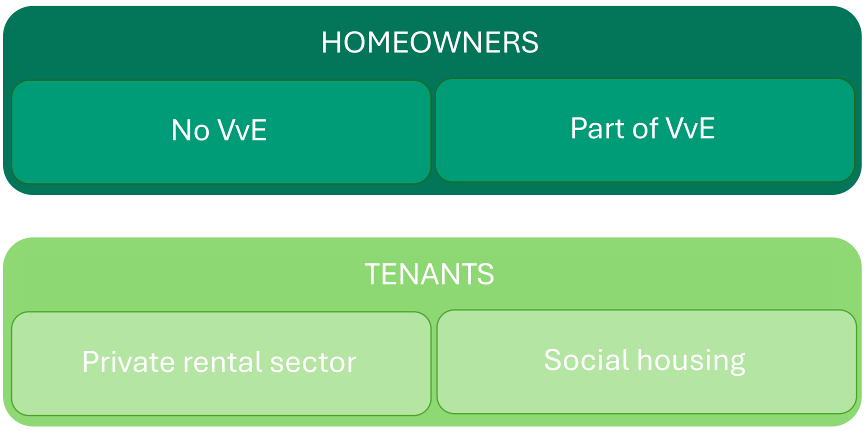



*Figure 3: Types of households (author)*

When making a power interest matrix of this distinction between different types of ownership, this aspect comes to light as key factor, as the decision-making power can vary depending on whether an individual owns or rents their home. Being part of a VvE or renting from a housing association also influences this power.  It is all about their

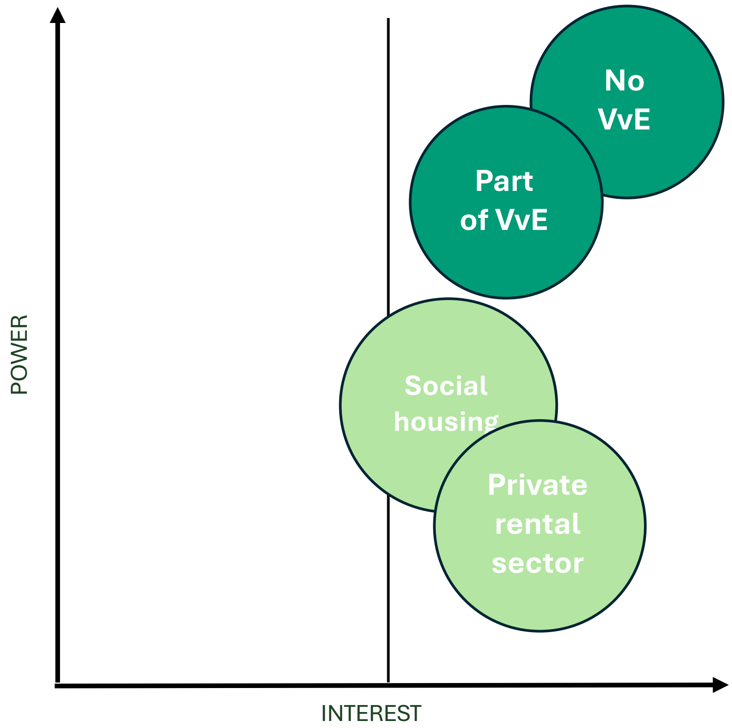



*Figure 4: Power-interest matrix regarding decision making-power for heating system (author)*

decision-making power regarding a heat grid connection (Rubio Agullo et al., 2024). Homeowners generally have more autonomy in decision-making regarding their heating system. They are directly responsible for investment decisions and can weigh the long-term benefits of connecting to a heat grid, such as cost savings and sustainability. In contrast, tenants may have less influence on decision, as these are often managed by landlords or housing associations. Recent study suggests that tenants tend to prioritize immediate cost savings and stability in their energy bills (Ebrahimigharebaghi, 2022). Importantly, having less decision-making power, doesn't necessarily mean less interest. Homeowners who are part of a VvE for example can still have high interest in connecting to a heat grid, even if they have less power compared to homeowners without VvE obligations. Similarly, being a tenant does not imply disinterest; tenants may still be highly interested to being engaged in sustainable energy solution decisions or want to be informed (Khor et al.,2023). See figure 4.
Understanding these different perspectives is key to designing effective engagement strategies that address the specific concerns of each group. However, this research will, based on their increased decision-making power and the lack of previous research focused on them, focus on homeowners. Various characteristics like age, education level, income, moving plans among others, influence the willingness to connect to a heat grid (Santin et al., 2009). The heterogeneousness within this sub-group still needs to be unraveled to better understand the factors influencing their willingness to connect to a heat grid. Therefore, the following list of potential influencing socio-demographic

factors as household characteristics has been developed based on previous research to help group different end-users.

*Table 5: Household characteristics and their potential influence (author, adopted from: van den Brom et al., 2018; Santin et al.,2009; Khor et al.,2023; Ebrahimigharebaghi, 2022)*

| Household characteristic | Potential Influence |
|---|---|
| **Ownership form** | Homeowners have decision-making power; tenants depend on housing associations or landlords |
| **Age** | Older users may prioritize long-term stability; younger users may value sustainability |
| **Education level** | Higher education levels may correlate with greater environmental awareness and openness to change |
| **Employment status** | Stable employment may influence financial readiness for upfront cost |
| **Income** | Higher-income households may afford upfront costs; lower-income groups may require subsidies |
| **Disposable income** | Availability of higher disposable income may increase flexibility to make the investment |
| **Savings** | Higher savings can reduce financial barriers and give indication of theoretically being able to pay for the upfront cost |
| **Willing to spend on energy transition measures** | Commitment to sustainability initiatives can drive the willingness to connect |
| **Household size** | Influences heat demand and larger households may prioritize cost efficiency in heating |
| **Household composition** | Families with children may prioritize safety and long-term cost benefits |
| **Occupancy time** | Longterm residents may be more willing to invest |
| **Moving plans** | Households that plan to move shortly may be less interested |
| **Previous EER** | Positive past experiences can increase interest to new systems, however recent change of heating system can have opposite effect |

## 2.5 END-USERS IN HEAT GRID PROJECTS (for whom?)

The involvement of end users is key to the success of heat grid projects, as their willingness to connect directly impacts the viability of the business case, like previously mentioned. From earlier research (Rogers et al., 2008; Kalkbrenner & Roosen, 2016) and the typical process in place, it becomes clear that for a heat grid project to succeed, there must be sufficient commitment from end users to ensure that the network will have enough demand to sustain its operation. Without this commitment, the initial investment in infrastructure becomes too risky, making it difficult for municipalities and energy companies to justify moving forward. This, once again, demonstrates the importance of end-users and why they are a central focus of this research.

Furthermore, the process graph by Rubio Agullo et al. (2024) indicates that there are several decision-making moments where end-user participation is crucial, as described in Section 2.3.2. For example, during the feasibility phase, end users must express their interest in connecting to the proposed network, allowing project initiators to assess whether there is sufficient demand to justify further investment. Similarly, in the contracting phase, formal agreements with end users are necessary to secure the project's long-term financial stability. At these critical stages, the willingness of end users to participate becomes a determining factor for the project's continuation or potential delays. This is not dependent on the type of process, given different initiating parties, in every process there is a key decision moment where the project is likely to be cancelled or postponed if there are not enough potential end-users willing to connect.

### 2.5.1 End-user decision-making process

Similarly to project process phases, end-users go through a decision-making journey themselves. The decision-making process of end-users is a complex, multistage journey, influenced by numerous factors. The building aspects and household characteristics have already been discussed in the previous chapter. However, it is key to understand all the steps and factors in the decision-making process in the context of the heat transition to optimize their engagement through proposed strategies.

Research has established distinct stages in this decision-making journey, focusing on EER. These typically involve considering, gathering information, pre-evaluating options, deciding, planning and implementation (Baginski et al., 2017; Ebrahimigharehbaghi et al., 2019). Their decision-making process is shaped by external parties' influences, including municipalities, energy providers, housing associations and peers, as well as internal considerations such as financial capacity, trust, and perceived benefits. Projecting these outcomes on heat grid implementation, the process follows a structured sequence that begins with awareness and moves through various stages to get to the final decision to connect. However, the process does not end with implementation, as the evaluation of the experience influences future adoption trends and trust in the system and therefore should not be forgotten. Ebrahimigharehbaghi et al. (2019) argue that making this distinction is needed to understand the change in the way decisions are made during the process. According to their research, which is based on an extensive literature review, the steps are as follows: (1) considering, (2) planning, (3) decision, (4) executing, and (5) experiencing.

In the considering phase, the socioeconomic factors such as education and income appear to be most important, in the planning phase, the awareness of the benefits becomes relevant, in the decision and executing phase access to information and professionals appears to be required to decide to renovate, and during the evaluation phase, good and bad experiences will have influence on the following renovation project (Ebrahimigharehbaghi et al., 2019).

Another way to classify these steps is (A) Pre-renovation, (B) During-renovation and (C) Post-renovation (Nia et al., 2024). This research highlights the importance of building characteristics and occupant profiles as influencing factors in the decision-making process and reveals that awareness and transaction costs, such as the effort required to gather information, pose significant challenges. On top of that, current engagement strategies focus on broad targets rather than individual end-users needs and concerns. Understanding the decision-making landscape of energy retrofitting provides valuable lessons for enhancing end-user engagement in the heat transition. Figure 4 shows an adapted journey in which the influencing factors in each phase come to light, so they can be used to determine what different end-user groups would need to move on to the next step and be able to decide.

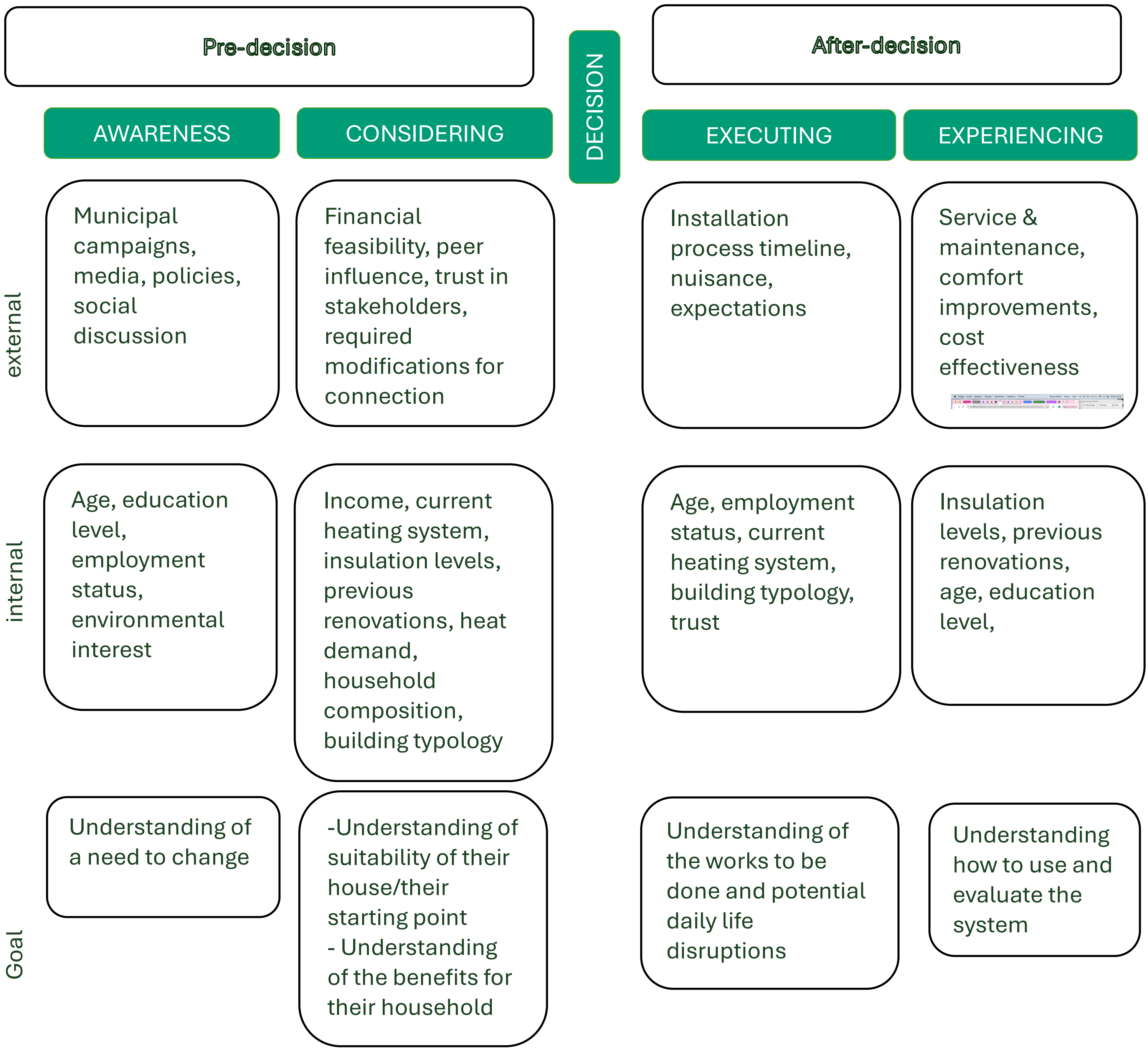



*Figure 5: End-user decision-making journey (adapted from Nia et al., 2024).*

In the figure, awareness is added as a step and the planning phase is left out to make it more applicable to heat grid implementation processes. This is because heat grids remain to be relatively unknown among end-users and the planning is done by the executing party and the end-users don't have to do it themselves. Furthermore, the phases evolve around the decision, because of this research's focus.

For example:  age potentially influences interest in sustainability in awareness phase, but also willingness to tolerate temporary inconvenience in executing phase. Typology influences starting point in considering phase.

In their decision-making process, they need to take certain steps and gather knowledge to move on to the next phase. However, this information might not be available or not have been communicated effectively in this specific phase and individuals might lose interest or can't make informed decisions.

### 2.5.2 Behavioral characteristics

The decision-making process of end-users is shaped by a variety of behavioral characteristics. Their decisions are not only based on financial and technical factors; psychological, emotional, and social elements also play a crucial role. Recognizing these behavioral influences is essential for designing policies and interventions that enhance user engagement and willingness to connect to a heat grid.

Trust in leading parties, institutions, service providers, and policymakers is a critical determinant of end-user willingness to connect. Concerns about monopolistic practices, unclear pricing structures, and potential lack of consumer protection can create skepticism. Homeowners are more likely to connect if they perceive the process as fair and transparent. The behavior and choices of neighbors, community members, and early adopters significantly impact an individual's decision to connect to a heat grid. Positive word-of-mouth, visible benefits in the community and peer-recommendations can have a positive effect. Conversely, widespread skepticism or negative experiences among initial adopters or in the media can deter potential users. Many homeowners resist transitioning to heat networks due to the perceived risks associated with costs, reliability, and service continuity. Risk aversion often leads to hesitation. Additionally, loss aversion, the psychological tendency to weigh potential losses more heavily than gains, causes users to focus on the possible drawbacks rather than the long-term benefits of heat networks. Therefore, people tend to prefer maintaining the status quo, even when a new alternative may offer advantages. Homeowners already using gas heating systems may be hesitant to switch due to habit, uncertainty, or the inconvenience of transitioning. Behavioral nudges such as connecting new buildings to district heating, or making the opt-in process easier, can help counteract inertia. Excessive technical and financial details can overwhelm homeowners, leading to decision fatigue and information overload. Complex legal agreements, financial estimations, and uncertain cost structures can also have a discouraging effect. However, on the other hand, too little information can slow down the decision-making process.
While financial considerations play a key role, emotional attachments to current heating systems and concerns about affordability often weigh heavily in decision-making. Even if heat networks are projected to be cheaper in the long run, the upfront costs and potential short-term disruptions in the daily life of potential end-users create psychological barriers.

To conclude, the decision-making process for connecting to a heat grid is influenced by building and household characteristics that can't be changed, these determine the first starting point of an individual. External factors on the other hand potentially significantly influence willingness to connect and can be changed or used to influence the decision-making process and willingness to connect.

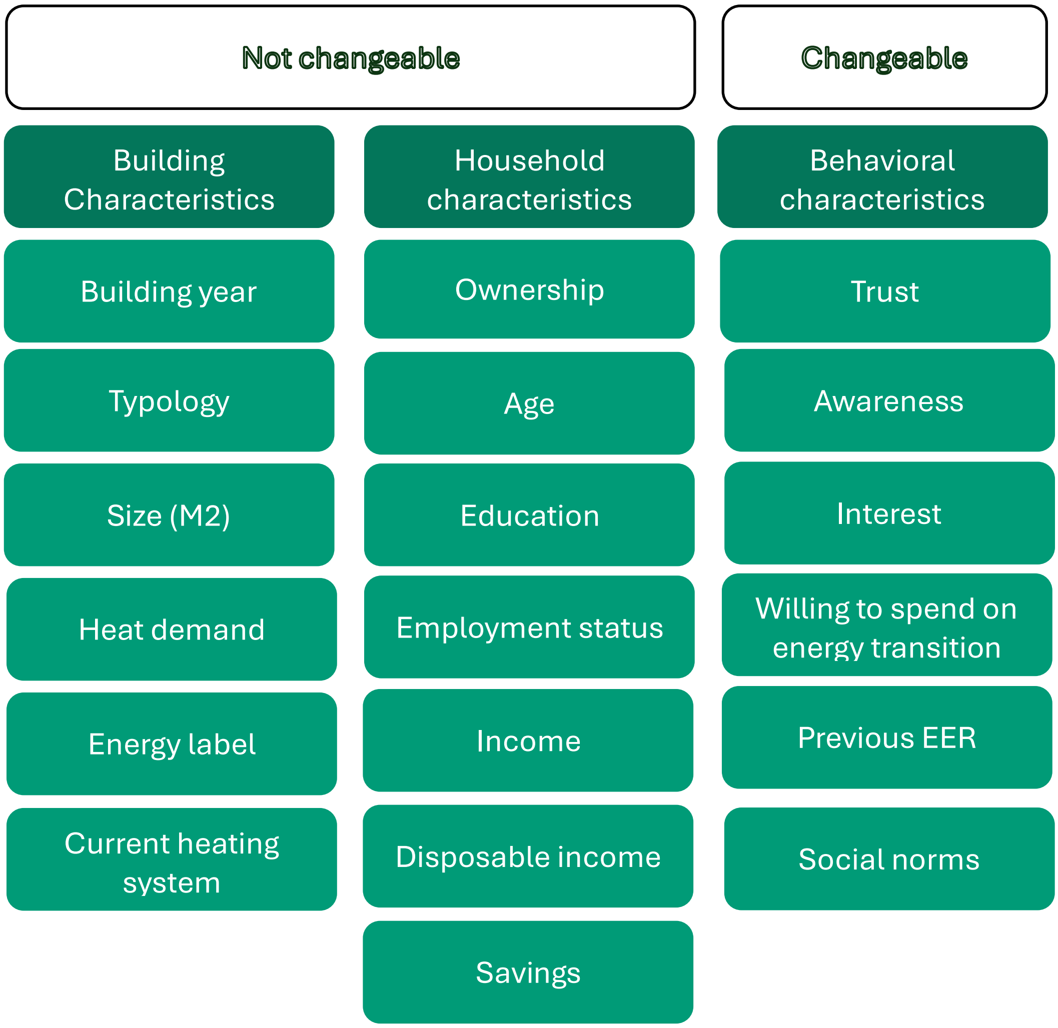



*Figure 6: Overview of potentially influencing characteristics (author)*

### 2.5.3 Barriers & drivers for willingness to connect

The goal of this research is to find out which of these barriers apply to which end-user group and in which phase they occur, to then use the enablers to come up with tailored strategies to mitigate them within their decision-making process and maximize the willingness to connect. The same goes for the drivers.
In this chapter, the most important barriers will be linked to a decision-making phase and the characteristics aspects influencing it

#### 2.5.3.1 Barriers

The uncovered supply side barriers in heat grid projects by Rubio Agullo et all., (2024) have been analysed in relation to end users.

The list showed that one of the discovered behavioral barriers from recent research (Rubio Agullo et al., 2024) is indeed the willingness to connect. The added willingness to connect barrier refers to the willingness that residents do or do not have to connect to the heat grid. This behavioral barrier is interconnected with, and caused by other reoccurring barriers as well (see Table 6)
However, these are the barriers from the supply-side, so it has to be discovered whether and how they apply to the demand side and expand the list where needed, which is one of the sub-goals of this study.
From further literature research, a combined catalog (Table 6) has been made with the assumed barriers from an end-user perspective. It should be noted that a lot of aspects in this list are based on studies on energy efficiency retrofits, and not yet necessarily directly linked to heat grids yet.

*Table 6: List of barriers (adapted and expanded from Rubio Agullo et al.,2024 ; Ebrahimigharebaghi, 2023 ; Nouwelant and Pawson, 2017;  Arthurson, 2013; Khor et al., 2023;; Chersoni et al., 2021; Osman, 2017;; Amel et al. 2017; Baginski & Weber, 2017)*

| Category | Barrier | phase |
|---|---|---|
| Informational & Organizational | Lack of information | *Initiation:* lack of information about collaborating stakeholders and project details (to share with potential end-users)<br>*Feasibility:* lack of information about potential costs and potential number of connections for feasibility studies<br>*Operation:* use the system correctly |
| | | *Awareness:* No/ limited information to share and raise awareness for the topic<br>*Consideration:* lack of information on costs and project details or the need for energy transition<br>*Decision:* information on contractual details and costs e<br>*Experiencing:* information about the technical working of the system |
| | Accessibility of information | Initiation: technical and financial information not available yet<br>Realization: difficulties in finding information on the project progress |
| | | Awareness: information is not effectively shared with potential end-users<br>Consideration: hard to access the information needed for decision-making<br>Experiencing: access to post-installation guidance and support |
| | Information overload | Initiation: conflicting information from various stakeholders<br>Feasibility: a lot of details making it hard to asses options |

| | | |
|---|---|---|
| | | Awareness: excessive (technical) details can overwhelm potential end-users<br>Consideration: a lot of alternatives and complex information makes decision-making difficult |
| | Lack of awareness | Initiation: Lack of promotional and educational efforts<br>Feasibility: limited understanding of the advantages of collective heating |
| | | Awareness: low familiarity with heat networks and their benefits<br>Consideration: potential end-users don't recognize the urgency of switching<br>Experiencing: not aware of the benefits after connection, such as improved comfort |
| | Nuisance | Initiation: unclarity about potential project disruptions<br>Feasibility: perceived inconvenience discourages willingness to connect<br>Realization: Construction-related noise, dust, and disturbances |
| | | Consideration: concerns about disruptions in daily life<br>Decision: Fear of nuisance hinders commitment<br>Execution: nuisance during this phase can decrease willingness to connect |
| Behavioral & Social | Lack of trust in leading party | Initiation: Lack of credibility in the project initiators affects early engagement |
| | | Awareness: Users question the intentions and reliability of project leaders when being approached<br>Consideration: Doubts about whether project leaders act in public interest |
| | Preferring individual heating solutions over collective systems | Feasibility: Homeowners hesitate due to a perceived loss of independence and find it hard to commit, risks in feasibility studies |
| | | Consideration: Users value autonomy and personal control over heating solutions.<br>Decision: Preference for maintaining current heating systems |
| | Skepticism about system performance | Contracting: Users hesitate to sign agreements due to concerns over system failures |
| | | Consideration: Doubts about efficiency and reliability hinder engagement.<br>Decision: Users are reluctant to sign up |
| | Resistance to change from existing heating system | Initiation: Hesitation to participate in transition efforts<br>Feasibility: negative influence on willingness to connect and uncertainty about number of connections for feasibility studies |
| | | Awareness: Users prefer sticking with familiar heating systems.<br>Consideration: Transitioning is seen as an unnecessary hassle. |
| | Influence of negative experiences from peers | Initiation: hard to get people on board who have heard negative news<br>Contracting: Delays in sign-ups due to past negative project examples |
| | | Consideration: Word-of-mouth prevents potential users from joining the network.<br>Decision: Users refuse to connect due to negative perceptions |
| | No renewable energy source | Contracting: end-users prioritize sustainable source when making a decision<br>Realization: The system does not meet initial sustainability expectations |

| | | |
|---|---|---|
| | | Considering: potential end-users take into consideration to switch to a more sustainable option<br>Decision: no renewable source can decrease willingness to connect<br>Execution: Users expect a fully renewable system and feel misled if this is not the case |
| | Too much effort preparing for the connection | Realization: the efforts that end-users need to make |
| | | Consideration: what preparations does my house need for a connection<br>Decision: Users perceive administrative and practical burdens as excessive.<br>Execution: Frustration due to unexpected preparatory work |
| Economic & Financial | High initial cost | Feasibility: Economic viability is questioned due to high investment requirements |
| | | Consideration: Users hesitate due to expensive upfront costs<br>Decision: Financial concerns outweigh long-term benefits |
| | Uncertainty about long-term cost savings compared to current heating system | Contracting: Lack of cost-saving guarantees discourages users from connecting |
| | | Consideration: Users question whether the transition is worth the investment<br>Decision: Doubts about financial returns delay commitment |
| | Perceived risk of monopolistic pricing | Feasibility: Concerns over fair pricing and affordability |
| | | Consideration: Users worry about dependency on a single provider<br>Decision: Lack of market competition discourages trust<br>Experiencing: stuck with 1 provider on the long-term |
| | Future cost | Contracting: Lack of future pricing transparency. |
| | | Consideration: Users worry about potential price changes or unexpected costs<br>Decision: Unclear pricing structures delay decisions |
| | Costs of alternatives | Feasibility: Economic studies compare heat networks with alternative heating options |
| | | Consideration: Users weigh district heating against other solutions |
| Legal & Technical | Changing policies | Operation: Long-term heat network management affected by policy changes |
| | | Consideration: Uncertainty over government policies affects commitment.<br>Execution: Users fear regulatory shifts post-installation. |
| | Unclear contractual terms, leading to a lack of understanding rights and obligations when connecting to a heat grid | Contracting: Legal uncertainties cause delays in user commitment |
| | | Decision: Users are hesitant due to vague contracts.<br>Execution: Misinterpretation of rights leads to disputes |
| | Legal uncertainties around ownership and responsibilities related to the heat network infrastructure and services | Realization: Project stakeholders are unclear about accountability |
| | | Consideration: Users lack clarity on infrastructure ownership<br>Execution: Responsibility disputes arise post-installation |

The feasibility and contracting phases are the most critical moments in the heat network implementation process, as they heavily influence the willingness of end-users to connect. During the feasibility phase, key financial, technical, and social considerations are evaluated, determining whether a heat network is viable in a given area. At this stage, municipalities, energy providers, and housing associations must ensure that potential users have access to clear and reliable information about costs, expected benefits, and the long-term reliability of the system. A lack of transparency in feasibility studies, particularly regarding projected connection costs and long-term savings, often leads to skepticism. Homeowners and tenants need concrete, scenario-based financial projections that compare the costs of connecting to the network with maintaining or upgrading individual heating systems. If this information remains vague or overly technical, many potential users will hesitate or disengage entirely. Additionally, social acceptance is shaped in this phase, as early communication strategies can set the tone for how end-users perceive the project. Ensuring that communities are engaged early, through targeted outreach and participatory discussions, is crucial to fostering trust and willingness.

As the project progresses into the contracting phase, legal and financial uncertainties become the primary barriers. This phase marks the point at which interested users must formally commit to the heat network, yet it is also where doubts and concerns tend to escalate. Unclear contractual terms, legal uncertainties regarding ownership and service responsibilities, and concerns about monopolistic pricing often deter users from signing agreements. A frequent issue is the complexity of contractual obligations, which can make end-users feel locked into inflexible and long-term commitments without clear exit strategies. To mitigate these concerns, contracts should be as transparent and user-friendly as possible, outlining pricing structures, service guarantees, and mechanisms for dispute resolution. Furthermore, municipalities and energy companies should address concerns about price regulation, particularly the fear of unchecked price increases once users are dependent on the heat network. Introducing legally binding price caps or clear indexing mechanisms can enhance trust and reduce perceived financial risks.

In both the feasibility and contracting phases, communication strategies play a decisive role. Misinformation, lack of accessibility, or an overload of technical details can create confusion and fuel resistance. Therefore, communication should be targeted, phased, and adaptive, starting with general awareness-building efforts in the feasibility phase and evolving into detailed, contract-specific guidance as users move toward the decision stage. Building trusted key figures, such as local community leaders, energy advisors, or housing associations, can also help bridge the gap between project initiators and end-users. Securing a high willingness to connect requires a combination of financial clarity, legal transparency, and socially inclusive engagement efforts, particularly at these two crucial stages.

However, it is important to recognize that not all end-users are the same. Households vary significantly in terms of their financial situation, trust in collective heating and institutions, technical knowledge, and willingness to switch. Factors such as housing characteristics (insulation level, type of dwelling, current heating system etc.) and household characteristics (income, ownership status, household size, energy awareness etc. ) influence decision-making. A low-income household in a poorly insulated home will face different concerns than a high-income homeowner with an existing sustainable heating system. Additionally, behavioral aspects such as trust in local authorities, influence from peers, and environmental motivations play a key role in shaping attitudes toward heat networks.

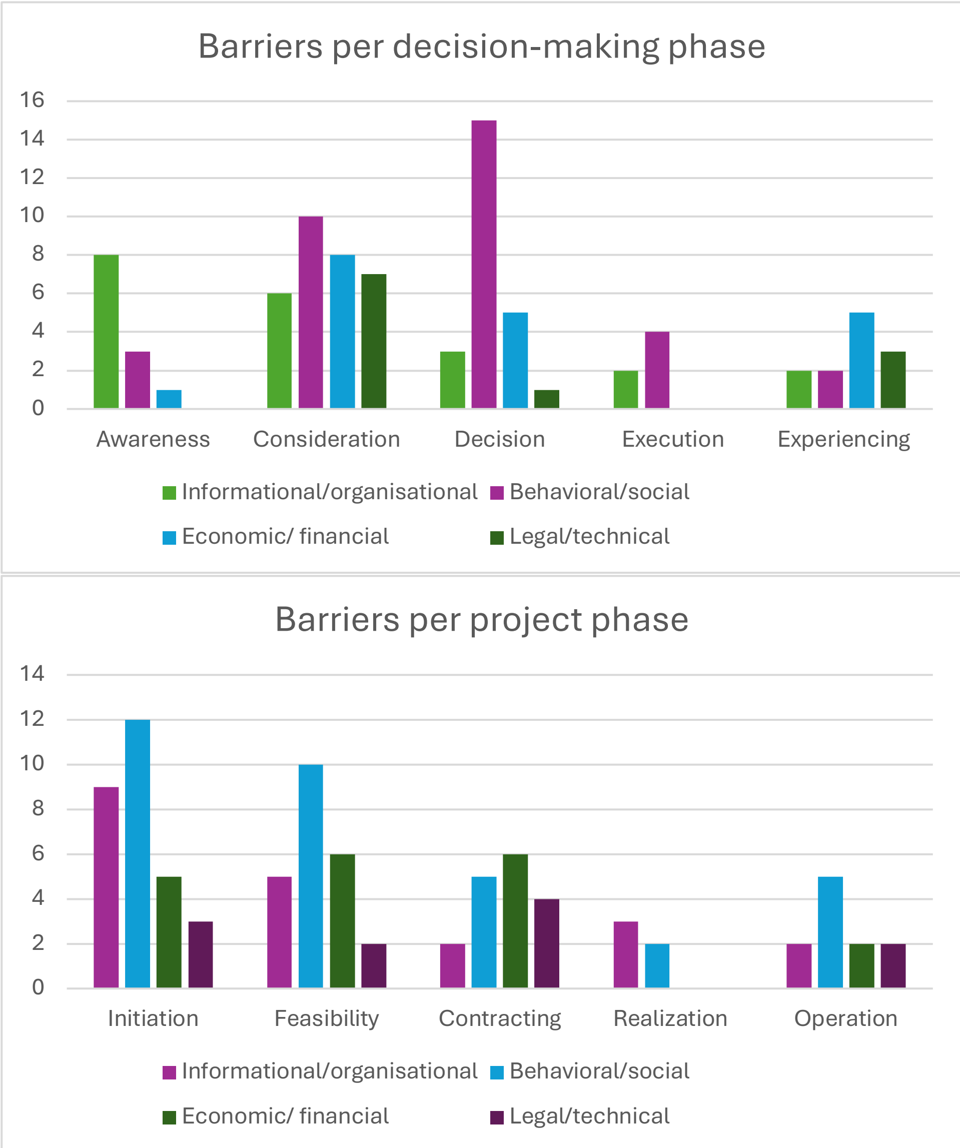



*Figure 7 a & b: Assumed barriers per phase (author)*

### 2.5.3.2 Drivers

In the same categorization as the barriers, the following list of assumed drivers has been made.

*Table 7: List of drivers (author, adapted from: Rubio Agullo et al., 2024; Biresselioglu et al., 2020, Brounen et al., 2013)*

| Category | Drivers |
|---|---|
| Informational & Organizational | Clear overview of the benefits for their household |
| | Accessible and understandable information about the system |
| | Transparency about project timeline and connection process |
| | Guidance and clarity about their role throughout the process |
| | Availability of user-friendly support before, during and aftere connection |
| | Minimal nuisance during installation process |
| Behavioral & Social | Social norm campaigns, people don't want to be left behind from their peers |
| | Positive word-of-mouth recommendations from friends/family/neighbors |
| | Trust in leading party |
| | Having a sense of contributing to a community effort for sustainability |
| Economic & Financial | Lower energy bills |
| | Increased property value |
| | Subsidies |
| Legal & Technical | Energy independence (less reliance on fossil fuels) |
| | Compatibility of heat network with existing (heating) systems |
| | Flexibility to combine heat network connection with other measures (energy efficiency measures like insulation or window replacement / aesthetic measures like new kitchen or bathroom) |

Lot of barriers occur during the execution and operation phase, however they must be addressed and solved beforehand so potential end user can move forward to the next phase. The list of drivers can be used as input to find out what would actually drive end-users' willingness to connect and see in which phase it should be addressed when making tailored strategies.

## 2.6 Approach


*Figure 8: Approach (author)*

An effective approach is crucial in engaging end users in the heat network transition. Clear, transparent, and timely communication ensures that end-users feel informed, supported, and confident in their decision-making process. Several key aspects shape the effectiveness of communication: information quality, source credibility or medium, and timing of delivery (Addimando, 2024).
To encourage the decision to connect, information must be accessible, relevant, and easy to understand (Jia et al., 2021). Technical jargon and complex policy details should be simplified to ensure that homeowners can grasp the benefits and implications of connecting to a heat grid. Providing comparisons with traditional heating systems,

outlining cost implications, and demonstrating long-term benefits help users make informed decisions. Additionally, information should address common concerns, such as service reliability, price stability, and environmental impact.

The credibility of the source and the choice of medium significantly impact how information is received and acted upon. Information from trusted, neutral sources, such as governmental agencies or community organizations, often carries more weight than advertisements from profit-driven companies for example. Examples and experiences from early adopters and neighborhood influencers or community members can enhance credibility and social proof, increasing trust (Gitzels, 2025).
Furthermore the medium plays a role in a sense that different target groups prefer different approaches. Younger people might be more influenced by social media campaigns, while elderly might prefer home visits.

Lastly, timing plays a crucial role in communication effectiveness. Providing step-by-step guidance through the decision-making process with the right frequency ensures that users receive the right information at the right time (NPLW, 2022). This helps preventing information overloads and lack of information.

To conclude, it is assumed that different end-user groups need different approaches to overcome barriers and make an informed decision for connecting to a heat grid. Finding and validating this differentiation is one of the research goals.

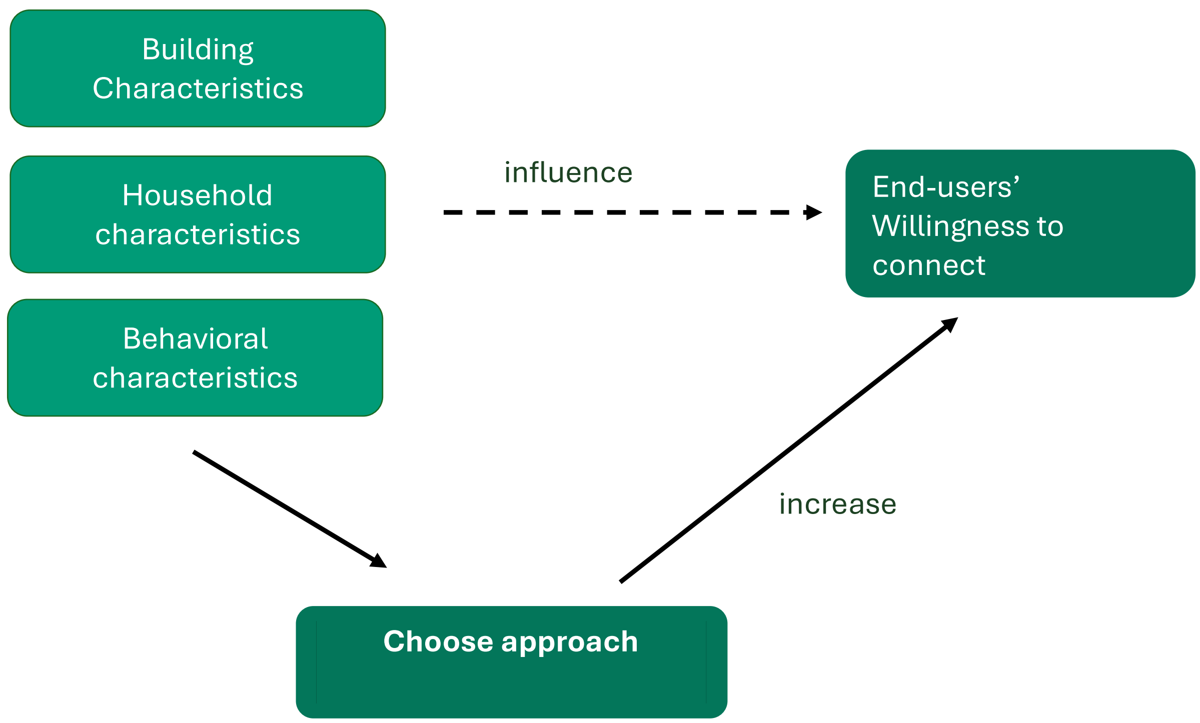



*Figure 9: influencing end user willingness to connect (author)*

# 3. RESEARCH METHOD

## 3.1 RESEARCH DESIGN

This research aims to explore how different end-user groups can be effectively engaged in the heat grid implementation process to optimize their willingness to connect. The research strategy follows a mixed-methods approach, combining qualitative and quantitative techniques to triangulate findings. It will touch upon the complex dynamics of heat grid implementation from a user perspective in the Netherlands to gather insights. Next to this, quantitative research in the form of a survey will be conducted to validate the findings from literature and add to this. This approach is suitable given the relatively limited existence of prior research on the topic. The research follows a convergent parallel design, where all the data is collected simultaneously, analyzed separately and then integrated for a holistic interpretation. By using methods such as semi-structured interviews alongside case studies and the quantitative research, the research can delve deeply into individual and collective experiences, capturing detailed data and information. This design allows the study to uncover both broad patterns in user willingness to connect and insight into the motivations and barriers of different end-user groups in different implementation phases of heat grids. The focus on the demand side of heat grids, specifically the engagement of end-user groups, aims to bridge an existing gap in understanding between the supply-driven approach and the actual needs of participants. The research framework is shown in Figure 10.

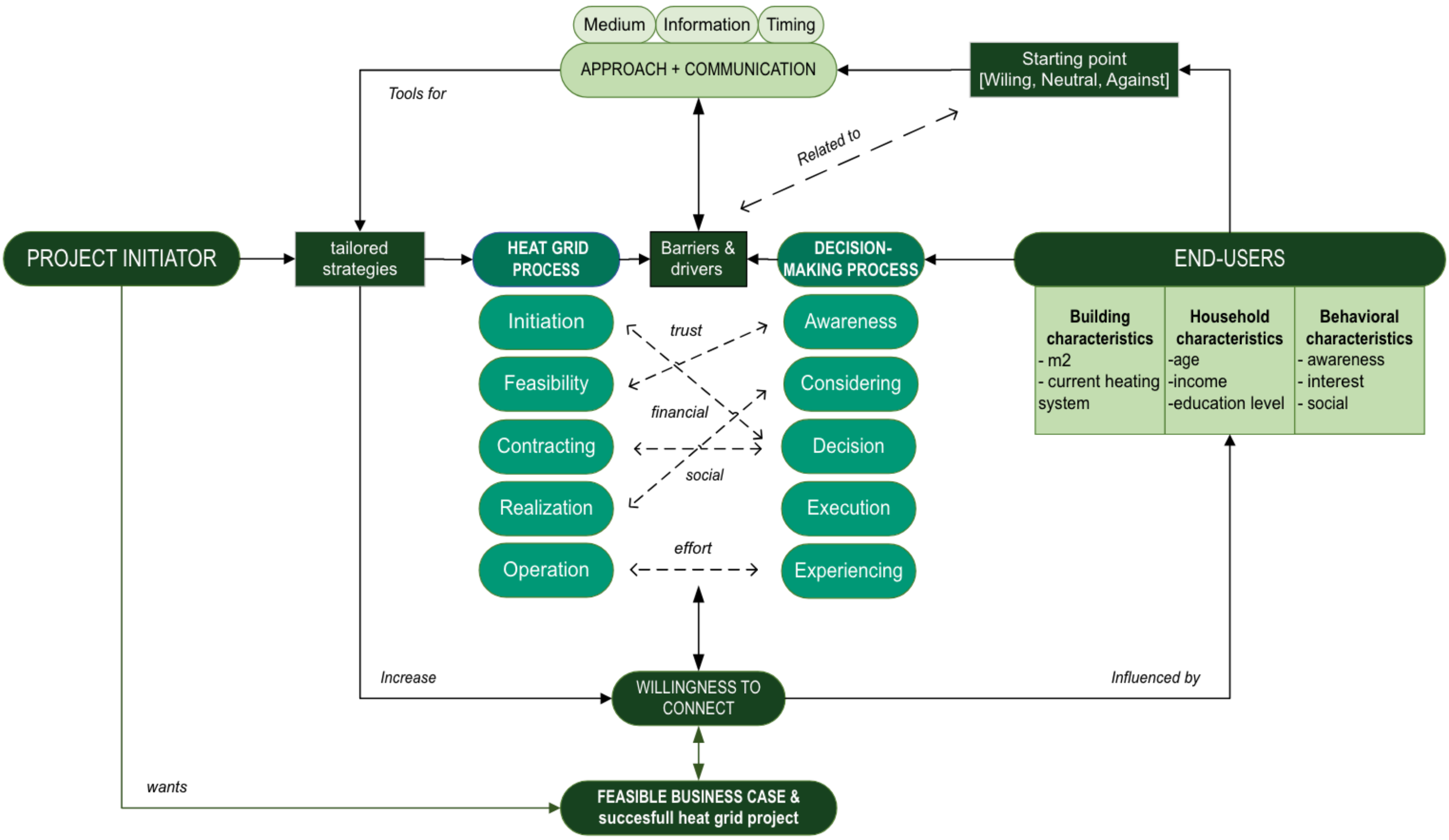



*Figure 10: Theorethical framework (author)*

Furthermore, qualitative research offers flexibility along the way. The open-ended approach gives the opportunity to adapt questions and focus areas along the way, as new insights might emerge during the study. On top of that, it gives the chance to provide a contextual understanding of the research topic, since the topic is influenced by a various social, economic, and governance factors as well as the stakeholders in place (Soafer, 1999). So, this approach ensures that the research findings are grounded in the real-world contexts in which they emerge.
In summary, exploratory qualitative research is the most appropriate approach for this study because it allows for a deep, nuanced exploration of a complex, emerging topic, providing valuable insights that can guide both policy development and practical implementation strategies in the context of end-users' needs towards willing to connect to heat grid development projects in the Netherlands. However, having quantitative data as an addition to validate these findings through statistical evidence will assure this research is relevant and adding to the existing literature. By combining both approaches, this thesis aims to benefit from the strengths of triangulation. The qualitative data will shape the survey design by helping identify relevant themes, vocabulary, and context-specific concerns. The survey, in turn, will provide a broader empirical base to validate and quantify the themes emerging from the interviews.

The main research method in the first phase is desk research. During this phase literature review will be conducted. This will help answer SQ1 and SQ2 by making assumptions.
Then the outcome of the literature review will be used for creating selection criteria for case studies and as input for the survey questions. The case studies will, alongside interviews validate the findings. The interviews will mainly be with project initiators end user representatives. The interviews will, alongside the survey and case study, help map the barriers and enablers per project phase and link them to the end-users' willingness to connect in order to answer SQ2.
The 3rd research question will be answered by combining and translating all the information and knowledge from the previous research questions and the outcome of the survey into creating tailored strategies for different end user groups and project phases. This strategy can be discussed and adjusted in an optional second interview with the same interviewees. And thereby finally the main research question will be answered.

## 3.2 DATA COLLECTION

Given the mixed method, qualitative and quantitative, nature of this research. The outcomes need to be validated. This can be done through the research validation triangle. In this study, the triangle will consist of literature review, case studies and a survey, as shown in Figure 11. The outcome of each of these research methods will be compared to validate its reliability and additional insights.

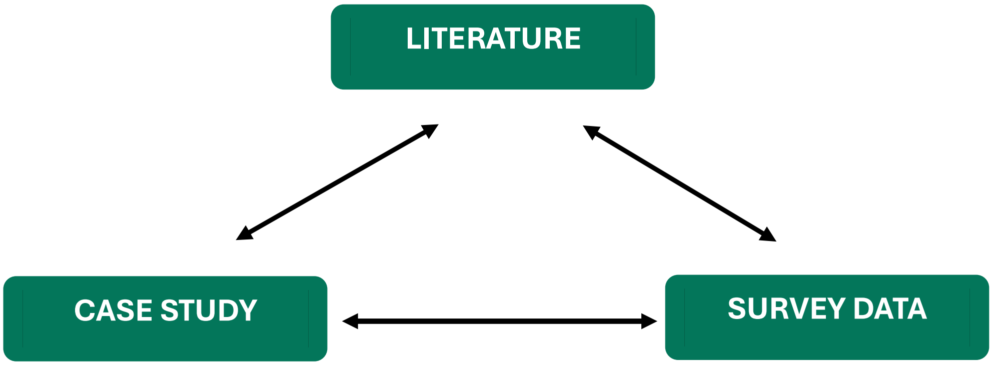



*Figure 11: Triangulation (author)*

So the study design consists of three main parts and the interviews have a supporting role in each part.

The timeline shown in the research plan (Chapter 5) also illustrates the method(s), data collection techniques and output goals for each research question.
To keep the analysis clear and structured. The key themes that will be analyzed in order to answer the research questions in a structured way are:
- Process (heat grid implementation process & end-user decision-making journey)
- Barriers, drivers & support
- Characteristics (building, household, behavioral)
- Approach

the goal is to find the relationships within these themes.

### 3.2.1 Literature review

The data collection process starts with an extensive literature review to establish an understatement of heat grid projects and energy transition. Sources include academic and scientific journal papers, as well as grey literature sources like policy documents and other reputable online sources (Paez, 2017). These documents are searched for through Google Scholar the TU Delft repository, the website of the Dutch Government and the general Google search engine. The literature review will focus on several keywords and areas: energy transition, stakeholder dynamics, barriers, challenges and user perspective factors in heat grid projects. Backward and forward snowballing was used to identify additional relevant references.
This review will help write the problem statement and identify the research gap. Additionally, it inspires in the design of interview questions and case study selection criteria, survey input and analysis.

### 3.2.2 Case study

To complement the literature review and validate the implementation process from end-user perspective, detailed case studies of selected heat grid projects are conducted. The case studies will include both ongoing and planned projects to provide a comprehensive view of the implementation process. Data will be collected through project documentation analysis and, where feasible, interviews with project managers and end user representatives. The interviews will be guided by a set of predefined questions, but in a way that allows for flexibility to explore emerging topics and insights during the conversation. Each interview will be recorded and transcribed for detailed analysis. Next to this, it would be insightful for this research to also use a finished project to validate the process and understand the success factors in such project. Furthermore, a case that has been cancelled due to problems related to end-users will help to better understand the role of their willingness to connect within the process. Therefore, this is one of the main selection criteria for all the case studies: some relation with end-users' willingness to connect. Another criterion is to find a case for each type of initiation, since it was found that the process may vary depending on which party is the leading party. This method will provide contextualized insights into specific challenges and successful strategies for end-user willingness to connect in real-world settings

In the end, two Dutch case studies were selected to study the heat grid implementation process from the demand side:

1. Multatulibuurt, Delft (existing plans)
2. Bospolder-Tussendijken, Rotterdam (under development)

Case studies were selected based on project phase, presence of different types of end-users (homeowners), relevance to heat grid projects (case study selection criteria p. 48). Data was gathered through document analysis, project plans, interviews with municipal project managers, and secondary sources. Special attention was paid to moments where end-user willingness influenced project progression.

### 3.2.3 Survey

There will be a survey conducted among a group of approximately 2000 people with a wide variety of socio-demographic characteristics, who either have been approached to connect to a heat grid before, or hypothetically will be asked about their interest. These people are all homeowners, since this is important for their decision-making power. During this survey, they will be asked to fill in questions about their household, from their age to their income and household composition and their awareness and experience with energy efficiency measures and heat grids. A quantitative survey was conducted to capture end-users' characteristics, awareness, trust levels, behavioral attitudes, and willingness to connect to a heat grid.

The survey design was based on insights from the literature review and case studies. The goal of this survey is to find out which drivers and barriers are most important and if/how this differs between different groups. Next to this, it is important to find out when these barriers occur and how they occur, so this will also be included in the survey. Lastly the participants will be asked about their preferences when it comes to being approached for a heat grid connection. The results of the participants will be divided into 4 groups, categorized based on them being approached for a heat grid connection and their willingness to connect for a comparison analysis table 8.

*Table 8: Categorisation based on survey answers (author)*

| Different groups | Approached | Willing to connect |
| --- | --- | --- |
| Group 1 | X | X |
| Group 2 | | X |
| Group 3 | X | |
| Group 4 | | |

### 3.2.4 Interviews

In addition to the case studies and survey, semi-structured interviews were conducted with relevant stakeholders to gain deeper qualitative insights into the challenges and strategies surrounding end-user engagement in heat grid projects. Interview participants included municipal project managers, energy company representatives, and experts in citizen participation. The interviews focused on the perceived barriers and enablers to user willingness, strategies for communication, and reflections on successful and unsuccessful project phases.
Furthermore, the interviews contributed to gaining a deeper understanding of the selected case studies. Interviewees provided valuable context regarding local dynamics, project development timelines, stakeholder interactions, and user engagement approaches, which complemented and validated the document analysis performed for the case studies.
The interview protocol was shaped by the findings from the literature review and preliminary case study analysis. This way, alignment with the research questions can be ensured. Interviews were conducted either face-to-face or via Teams calls, recorded with consent, and then transcribed to analyse.
The mixed-methods design allows for a comprehensive analysis of the problem by combining in-depth qualitative insights with broader quantitative validation.

## 3.3 DATA ANALYSIS

The collected data will be analyzed systematically to answer the research questions and to triangulate the findings across different methods. The literature review, interviews, case studies, and survey data will each contribute a different perspective to ensure robustness and validity. The literature review will provide a theoretical framework, the interviews will offer stakeholder-specific insights, the case studies will contextualize these insights within real project implementations, and the survey will validate patterns across a broader population. This triangulation shows an integrated and complete understanding of the end-users' perspectives towards willingness to connect to a heat grid.
The data analysis will primarily use abductive and inductive reasoning approaches. Inductive reasoning will be used to derive new insights from the collected empirical data, while abductive reasoning can be used for testing and refining existing theories in the context of heat grid projects (Bryman, 2016). This approach is particularly suitable for exploratory research, since conclusions must be grounded in both observed reality and theoretical frameworks.

The **literature review** will be analyzed thematically to identify existing theories, concepts, and frameworks that are relevant for heat grid implementation, stakeholder engagement, and behavioral drivers of energy transition participation. The focus will be on barriers and enablers for user willingness to connect, the role of trust, and the impact of communication strategies. These insights will be used to develop an initial conceptual model and form the basis for comparison with empirical findings from the case studies, interviews, and the survey later on.

The **case study** data, consisting of project documents, municipal reports, and interview insights, will be analyzed through a detailed document analysis combined with a cross-case comparison approach. Key themes such as stakeholder involvement, critical decision-making moments, barriers and enablers for user willingness to connect, and engagement strategies will be identified and compared across the selected cases. Special attention will be given to how end-user willingness influenced the progression of each project, and at which stages of the process participation was critical. The literature review will help set criteria for the case comparison. Projects at different phases (initiation, realization, completion) will be analyzed to capture variation over the project's timeline.

The **survey** responses will be analyzed quantitatively by using descriptive and inferential statistics. Descriptive statistics can be used to map the characteristics of the respondents, including building types, household compositions, ownership status, awareness levels, and general sustainability attitudes. Cross-tabulations can be conducted to explore differences in willingness to connect across various user groups (households with versus without prior energy-saving investments, for example). Furthermore, regression analyses can identify significant predictors of willingness to connect, such as building characteristics, trust in institutions, perceived costs and benefits, and behavioral motivations.

The **interview** results and content can be thematically analyzed. This iterative technique involves open coding in the first round to identify initial themes and patterns from the transcripts (Burnard et al., 2008). These themes will highlight the underlying narratives and perspectives across different stakeholders. In the second round, axial coding will be used to connect related themes across interviews and to reveal deeper relationships between barriers, enablers, and engagement strategies. The interviews will also provide more context for the case study analysis.

Finally, the findings from the literature review, case study analysis, survey data, and interview analysis will be **triangulated** to strengthen the validity of the conclusions. Differences and consistencies between the qualitative and quantitative results will be examined critically. Cross-validation between sources can be used to confirm key insights and ensure that practical recommendations for optimizing end-user engagement in heat grid projects are based on an evidence base.

## 3.4 DATA PLAN

This research will strictly gather only the necessary data required for the study, ensuring no excessive data collection. Interviewees will be thoroughly briefed on the research topic, process, and goals. Furthermore, they will be informed of any potential risks, their right to withdraw at any time, and their right to anonymity. Informed consent forms will be used, and every participant has to sign consent before participating in the research. Before publishing any data, participants will be asked for approval and can provide remarks. Especially for interviews this is important, since there can be a risk of misinterpretation involved.
All collected data will be processed and stored in accordance with TU Delft's Research Data Management Policy and the General Data Protection Regulation (GDPR). The data will be securely stored on the TU Delft Surfdrive, with access restricted to authorized personnel, including the researcher and the supervising mentors. All data will be processed and used in compliance with the participants' signed consent, making sure it is used in a legal and ethical way.
Upon completion of the research and the final report, only fully anonymized datasets will be preserved. These datasets will be made available through the TU Delft 4TU.ResearchData repository. Access to the full data will be restricted to authenticated and authorized users, such as TU Delft students, staff, and researchers from partner institutions. Metadata will be accessible to all users within the repository environment. Data management will follow the FAIR principles to ensure that the data are Findable, Accessible, Interoperable, and Reusable. To support interoperability, all data and metadata will be provided in English, and external datasets referenced during the research will be properly cited.
In this way, the research data will be legally and ethically managed, securely stored, and accessible for future academic purposes without compromising the confidentiality or rights of the participants.

## 3.5 ETHICAL CONSIDERATIONS

Due to the involvement of human participants in this research, making careful ethical considerations is crucial. The study prioritizes minimizing any potential ethical risks for participants. The collected data will be securely stored, and access is restricted to the research team only. Strict data security protocols according to HREC will be followed to guarantee the confidentiality, integrity, and lawful processing of all collected data. Participants will be fully informed in advance of their participation. A detailed interview protocol and an informed consent form will be developed to prepare the participants. Clear and transparent communication with participants is essential, therefore they will be informed about the study's goals, the voluntary nature of their participation, the potential risks, and their rights. Including the right to withdraw at any time without consequences.

The research will focus on opinions from various stakeholders, some of whom may hold conflicting perspectives. To address these sensitivities, anonymity will be maintained throughout the study. Direct quotes or statements from participants will not be traceable to individuals unless explicit consent is provided. Interviewees can be given the opportunity to review their transcripts, add remarks, or remove statements before

final analysis. Once approved, audio recordings will be deleted, and only anonymized transcripts will be retained.
Participants' safety, well-being, and autonomy will be safeguarded throughout the entire research process. With this approach, genuine and unbiased responses are hopefully promoted and any potential discomfort or risk to participants is minimized.

All ethical measures will be taken in alignment with TU Delft's Research Ethics Policy, the General Data Protection Regulation (GDPR), and the universal ethical principles of research integrity and responsibility as outlined by Blaikie and Priest (2019). These measures will ensure that the study meets the high ethical standards in the treatment of human participants.

# 4.
# RESEARCH OUTPUT

## 4.1 GOALS, OBJECTIVES AND DELIVERABLES

This research aims to reach several goals. These goals are all contributing to the overarching objective of exploring and addressing the barriers and enablers for end-users in participation in heat grid development in the Netherlands. The ultimate ambition is to develop practical solutions and strategies to tackle the formulated problem statement. To reach this goal, a set of sub-objectives has been formulated. First, a deeper understanding of the stakeholders involved in the energy transition, specifically their positions, interests, and roles in heat grid projects, is required. Building on this foundation, it is needed to identify the different end-user groups involved in heat grid development, including their household characteristics, building typologies, and behavioral factors. This objective is linked to the identification of the diverse needs, preferences, and decision-making profiles of end-users across suitable areas. Next, the study will explore the barriers and enablers that influence end-users' willingness to connect. These factors will be examined across user groups and project phases to gain insight into when and why participation becomes more or less likely. This includes understanding of institutional trust, financial concerns, awareness levels, and previously taken energy efficiency measures.
Ultimately, the research focusses on identifying strategies for stakeholder communication and engagement that can be tailored to different end-user groups. The goal is to create actionable recommendations for municipalities, energy providers, and housing associations on how to facilitate participation in a more effective way. By doing so, the research contributes not only to knowledge on end-user behavior but also to practical frameworks for accelerating the energy transition through better heat grid implementation process.
So, the main goal of this study is to explore the enablers and barriers to participating in heat grid development and translating this into tailored approach strategies for potential end-users.

The sub-objectives are:

Research objective 1

To understand the stakeholders' position and interest in heat grid projects. And to identify and categorize different end-user groups within suitable areas for heat grids, and understand their characteristics, needs, and preferences.

Research objective 2

To explore the barriers and enablers that influence willingness to connect to heat grids, and how these vary across end-user groups and decision-making and implementation phases.

Research objective 3

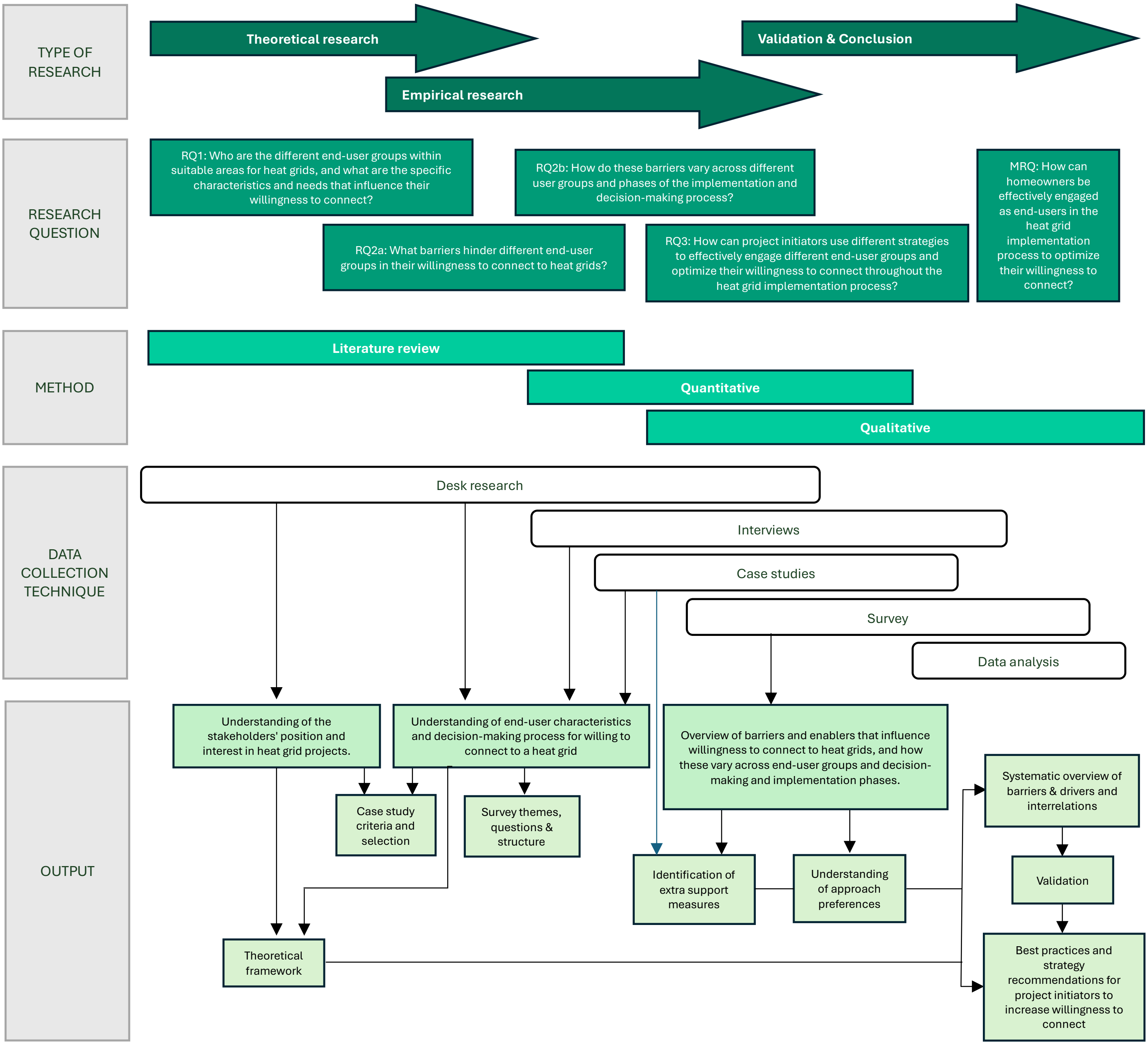
To formulate tailored engagement and communication strategies that can be used by project initiators to increase willingness to connect and support the implementation of heat grid projects.

## 4.2 DISSEMINATION AND AUDIENCES

The findings of this research can be relevant for several target groups involved in the energy transition and the development of heat grid projects in the Netherlands. The primary audience consists of municipalities, housing associations, and energy companies, as they are the main stakeholders responsible for initiating and implementing heat grid projects. The research will provide them with practical insights into how different end-user groups can be engaged more effectively throughout the decision-making and realization phases. By offering a better understanding of user profiles, barriers, enablers, and communication strategies, the research aims to support project initiators in optimizing participation rates and increasing project feasibility.
In addition to practitioners, the outcomes of this study will be valuable to policymakers working on national regulations related to both heat grids and the energy transition in general. The insights into end-user dynamics and willingness to connect will contribute to a better understanding of how regulatory frameworks possibly affect participation at the local level. Furthermore, the research will contribute to the academic discourse on energy transition governance, stakeholder management, and user-centered energy systems.
The dissemination of the results will primarily occur through the final thesis report, which will be made publicly available in the TU Delft institutional repository in line with open access principles. The research data will be anonymized and, where possible, shared according to the FAIR data principles (Findable, Accessible, Interoperable, and Reusable). In addition to the thesis submission, the findings may also be shared with the research participants (interviewees) when interested in the outcome.

By ensuring that the research outcomes are accessible to both practitioners and researchers, this study aims to bridge the gap between theoretical insights and practical applications.

# 5.
# RESEARCH PLAN



# 6. FINDINGS

## 6.1 METHODS OF ANALYSIS

### 6.1.1 Case study

To understand how heat grids have been implemented in practice, case studies of existing or past projects in the Netherlands are conducted. These case studies are selected based on the selection criteria, derived from the literature review. These criteria include geographical relevance (Dutch context), connection to renewable energy sources, status (initiated, realized, or cancelled), and the active involvement of end-users. The role of the leading stakeholder (municipality or housing association) is also considered in the selection. All criteria are shown in Table 9.

*Table 9: Case study selection criteria (author)*

| Criteria | Required | Desired |
|---|---|---|
| Located in the Netherlands | X | |
| Renewable energy source | X | |
| Ongoing, planned or completed | X | |
| (active)Involvement of end users | X | |
| Public-private partnerships | | X |
| Municipality as leading party | X | |
| Housing association as leading party | | X |
| Energy company as leading party | | X |
| Failed project (due to end-user related barriers) | | X |
| Succes project | X | |

The case studies analyze the process used to engage end-users, the effectiveness of the engagement strategies and their barriers or enablers encountered. This will help contextualize the findings of this research and contribute to the strategy framework development for optimizing end-user willingness to connect.

*Table 10: Selected case studies (author)*

| | CASE 1 | CASE 2 |
|---|---|---|
| **Location** | Delft Multatulibuurt | Rotterdam Bospolder Tussendijken |
| **Initiation** | Municipality + housing associations | Municipality (in close collaboration with energy company & housing association |
| **Status** | In progress | In progress |
| **Current phase / termination phase** | Wijk Uitvoerings Plan is just published | Construction |
| **Main target group** | Social housing tenants + students & VvE's + homeowners | Social housing tenants + homeowners |
| **Decision willingness to connect** | By housing association and homeowners | By housing association & homeowners |

Each case will be analyzed with a focus on when and how end-users were involved in the process. This timeline can be linked to an evaluation of the communication and participation strategies used, their timing, and their alignment with user needs.

### 6.1.2 Interviews

To provide a deeper understanding of the stakeholder dynamics, semi-structured interviews are conducted with relevant stakeholders such as municipal project managers. These interviews serve multiple purposes: first, they validate the reconstructed process timeline, provide insights into the rationale behind certain decisions, and reveal stakeholder perceptions of what contributed to or hindered user willingness. The interviews also help uncover informal or undocumented elements of engagement strategies that would not be apparent through desk research alone. And third, they served as input for the survey design and inspiration for the questions.
The interview protocol can be found in Appendix C.
The design of the first round of the survey was created in a way that the questions were adaptable during the interview and mostly focused on getting a better understanding of the context and timeline of the cases. On top of that, these interviews included questions about the barriers and drivers already, to map and compare this with literature findings. Furthermore, questions about possible other characteristics influencing the end-user willingness to connect and the overall challenges throughout the project timeline are discussed.

Later in the process, second interviews were conducted with the manager interviewees to adjust and confirm the framework. These interviews mostly validated the case study findings and seek confirmation of how the building, behavioral and demographical characteristics are related to the willingness to connect. The interviews with the potential end users were to discuss and confirm some of the survey outcomes and their view on how they experienced the approach process in the studied cases.
Table 11 shows an overview of the interviewees and how many times they were interviewed.

*Table 11: Interviewees (author)*

| # | Code | Role | Stakeholder | Times interviewed |
|---|---|---|---|---|
| *1* | *M1* | Project manager heat transition | Municipality | 2 |
| *2* | *M2* | Project manager participation | Municipality | 2 |
| *3* | *HA* | Project manager | Housing Association | 1 |
| *4* | *E-U 1* | Potential end user | End-users | 1 |
| *5* | *E-U 2* | Potential end user | End-users | 1 |
| *6* | *E-U 3* | Potential end user | End-users | 1 |
| *7* | *E-U 4* | Potential end user | End-users | 1 |
| *8* | *EC1* | Process manager | Energy company | 1 |

### 6.1.3 Survey

In addition to the qualitative case study analysis, a quantitative component in the form of a (potential) end-user survey is included. The survey is designed in a way to gather insights on the perspectives of potential end-users of heat grids, in particular

homeowners, in relation to their willingness to connect, their awareness and understanding of heat grids, and their preferences and concerns.
The survey design allows for the identification of generalizable patterns across different end-user groups. It covers variables such as building type, insulation level, ownership status, energy-related decision-making behavior, trust in institutions, and prior experience with energy transitions. These variables are analyzed with respondents' stated willingness to connect to a heat grid.
The collected survey data will be analyzed using descriptive and inferential statistical methods. Descriptive statistics will provide an overview of respondent characteristics and overall attitudes. Cross-tabulations will be used to examine differences across groups, and regression analysis will help identify significant predictors of willingness to connect.

The first grouping will be done by dividing the responds into three sub-categories (Table 12) based on their answers to the key-question in the survey, namely:
- *Are you currently willing to connect to a heat grid?*

*Table 12: Respondent grouping for analysis (author)*

| Different groups | Willing to connect | Neutral | Against connecting |
|---|---|---|---|
| Group 1 | X | | |
| Group 2 | | X | |
| Group 3 | | | X |

Based on this, the data can be further analyzed according to the key themes as mentioned in Section 3.2:
- Characteristics (building, household, behavioral)
- Barriers, drivers & support
- Process (heat grid implementation process & end-user decision-making journey)
- Approach

## 6.2 CASE A - Multatulibuurt Delft

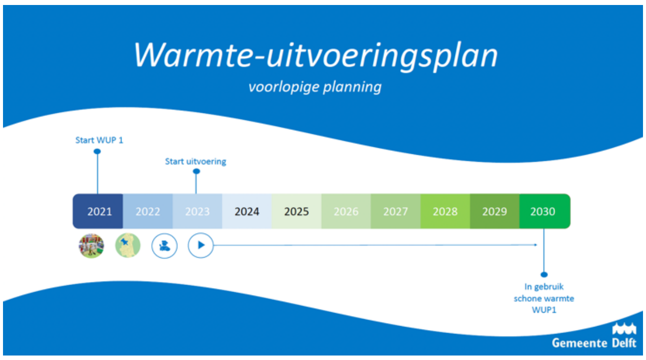
### 6.2.1 Introduction & context

The heat grid in the Multatuli neighborhood in Delft is part of a broader initiative towards the goal of a natural gas-free Delft in 2050, "Delft aardgasvrij". Multatuli is a, mainly residential, neighborhood located in the city of Delft, known for its diverse population and mix of housing types, including post-war apartment blocks and social housing units. This area has been selected as a designated pilot area within the broader municipal strategy to transition away from natural gas, in line with the goals set out in the Dutch Climate Agreement and the municipal Heatplan Delft 2021 (Warmteplan in Dutch). The intention is to connect buildings in the neighborhood to a sustainable heat source, possibly based on geothermal energy from a nearby source at the TU Delft.
Prior to this Warmteplan, back in 2018 already, there was a municipality-wide participation process where all the alterative options were explored. The municipality took the lead and the focus was on including all the stakeholders and coming up with a clear action perspective.  The main focus points were:

- "no regret measures". Like insulation and electric cooking options.
- affordability for everyone, without increasing socio-economic inequality.

Leading up to the completion of the Warmteplan in 2021, they Investigated available heat sources, mapped spatial developments across the city, examined opportunities from local initiatives, for example active residents, neighborhood associations and businesses and assessed the technical feasibility and cos-benefit aspects.
The main objective was to determine and substantiate, which neighborhoods should transition away from natural gas and in what way (Municipality of Delft, 2021).

Today, the Warmte uitvoerings plan (WUP) for the Multatuli neighborhood is the first formally approved WUP in Delft. The process of developing this plan took approximately two years and was coordinated by the municipality in collaboration with other stakeholders. Figure 10 shows the timeline of these developments.



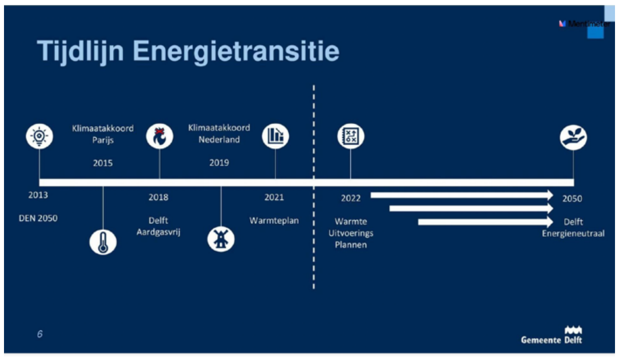




*Figure 12: Timeline Delft (Gemeente Delft, 2024)*

### 6.2.2 End-user groups & characteristics

The Multatulibuurt is located in the Voorhof district and contains 718 dwellings built between 1965 and 1974. Of these, 579 are owned by five housing corporations and the remaining 139 are privately owned (Figure 13). The neighborhood consists of flats, row


*Figure 13: Ownership structure Multatulibuurt Delft (Gemeente Delft, 2024)*

houses, and corner homes, and features a relatively high energy consumption with many dwellings labeled C, D, E or F in energy performance. The average household size is 2.1 persons, and gas consumption is 1,165 m3 for ground-based homes and 450 m3 for apartments (Gemeente Delft, 2024).
In the Multatuli case, the end-user landscape is defined by a mix of social tenants, private homeowners, and homeowners' associations (VvE's). Since a great part of the dwellings is owned and managed by housing corporations such as DUWO, Woonbron and Vidomes, these housing corporations represent a significant portion of the end-user base and are crucial intermediaries in shaping tenant engagement.
From the perspective of energy transition planning, these end-user groups exhibit a diversity of household types, socio-economic statuses, and levels of ownership. Moreover, a substantial portion of the area is already connected to an outdated collective heating system powered by gas-fired boilers, which further underscores the technical and infrastructural urgency of a sustainable alternative (Gemeente Delft, 2024).

**- Tenants (social housing & students):**
Have lower decision-making power over heating systems, especially in this area where there is a lot of collective heating present already. In these cases, the landlord/housing corporation decides on connecting to the heat network. Their primary concerns are **comfort, affordability** of heating, and assurance that the transition will not unduly raise their **rent or living expenses**.
Students (DUWO housing) were noted to prioritize ease and **low costs**; they expect the landlord to handle technical choices and mainly want a reliable, not-too-expensive

heating supply. Moreover, they are more interested in the **sustainability aspect** as well. Overall, tenants tend to be passive participants initially – they will not invest their own money, but they are concerned about **being used for testing new systems** or facing **higher bills** (personal communication #5).

**Interviewee #5:** "I'm fine with it as long as it doesn't increase my rent or reduce comfort. Sustainability is important, but so is cost."

**- Homeowners:**
This group has autonomy but also bears the costs and risks of transitioning their own property. In Multatulibuurt, private owners are mostly lower-income households (the WUP noted that many were not financially strong and unsure how to begin with sustainability measures). Their key motivations include maintaining or increasing **property value**, ensuring **affordability and payback** of any investment, and preserving **freedom of choice**. (Personal communication #2). Homeowners showed the most hesitation towards connecting to the heat network, often due to **cost concerns and trust issues**. Many prefer proven individual solutions (some mentioned they might rather install a heat pump later) unless the collective option is clearly advantageous (personal communication #4). This group is also diverse about sustainability. A part of the homeowners was already proactive in sustainability (insulating homes, installing solar panels, etc.), whereas others felt overwhelmed and waited for guidance (Personal communication #2).

**Interviewee #4:** "My biggest concern is being locked into a single provider with no control over future prices. Also, whether my investment pays off in case I move in the next five years. And the disruption of construction work."

**-VvE's (homeowner associations):**
These are collectively-owned apartment buildings where decisions (like switching to a new heating system) require consensus among multiple owners. VvE groups in Multatulibuurt were found to **move slowly in decision-making,** as they must coordinate views of different owners (personal communication #2) Their concerns overlap with individual homeowners (costs, technical feasibility) but more complex when organizing collective action. Some VvE's rely on a few active board members to liaise with the project. In such groups, even if the technical solution is provided, the challenge is **achieving agreement** internally. This often delayed commitments, making VvE's a cautious group.

**Interviewee #2:** "In the WUP, we have created a separate section that focusses on how to target the VvE in the Multatulineighborhood."

Other notable end-user stakeholders include local institutions like a primary school and small businesses in the area. Futhermore, the housingassociations, having a big ownership share and interest. According to personal communication #3, the questions the tenants ask are primarily about rent increases, disruption during construction, and future energy costs. Some tenants also questioned the comfort level of alternative heating systems. In buildings where we tested electric cooking or heat pump pilots, tenants were mostly positive

**Interviewee #3:** " We see these projects not just as energy transitions, but also as moments to improve living quality, indoor comfort, and even neighborhood social cohesion, because this is good for the value of our building portfolio and image. But this requires investment beyond just technical fixes"

The socio-economic profile of Multatulibuurt is mixed, but overall, it's a neighborhood with substantial social housing and modest-income households. **Trust** in authorities and providers, **prior experience** with energy projects, and general **awareness levels** varied across the community. As the project manager noted, not all residents perceived **risk and information** the same way: what reassured a tenant might not satisfy a homeowner, and vice versa (personal communication #2).

### 6.2.3 Process & approach

As mentioned in 6.2.1, the process of establishing the WUP for the Multatulibuurt itself took about 2 years and prior to this, from 2018 on, the wider plans were being made. During these years, there were several participation possibilities for end-users. When making the Warmteplan, there has been a questionnaire and "stadsgesprekken", during which interested people could actively think along and come up with ideas. Based on this, the Multatuli neighborhood was chosen as one of the first neighborhoods. The implementation of the heat grid will be done in 2 phases, in Phase 1 the dwellings owned by the housing associations will be connected and in phase 2 the private homeowners as well. It is to be noted that the housing associations can make this choice relatively easy for the buildings with an already existing collective heating system, since there are no works to be done in the dwellings itself and they don't need the 70% agreement rule.

For the homeowners it's more complex, they have to decide themselves. In the WUP, they explored four different alternative heating options that had the potential to be most efficient in the neighborhood (figure 12). These alternatives were chosen together with the homeowners and include bodemwarmtepomp, luchtwarmtepomp, airco with electric boiler and a heat grid connection. For all these options the pros and cons were carefully investigated.

Interviewee #2: "Residents really like the feeling of freedom of choice. So even if we know what the best possible solution is, it works better to involve them in the process"

Based on these outcomes, the conclusion was to take the trias energetica as starting point, since energy that you don't use, you don't need to produce. So regardless the best alternative for the homeowners' situation, they can start with insulating their house, to lower their energy demand, since this is needed for all the heating systems.

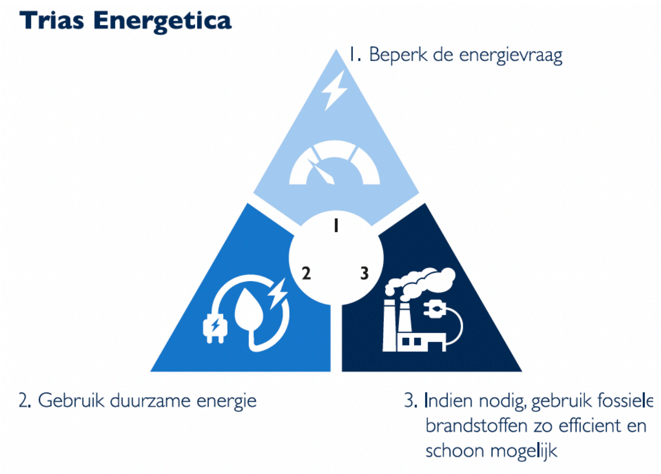



*Figure 14: Trias energetica (Gemeente Delft, 2024)*

Timeline:
The project is in different phases for different end-user groups. For tenants, it is already clear that their homes will be connected to the heat grid, as housing associations have committed to this transition. In contrast, for private homeowners, the decision has not yet been finalized, even though the heat grid infrastructure is already being constructed. This creates a situation where the project is technically in the implementation phase, yet the decision-making phase for end-users is still ongoing.
For homeowners specifically, many remain in what can be considered the consideration or acceleration phase. They are aware of the upcoming transition, but no definitive decisions have been made yet at the individual level. This mismatch in timing, between infrastructure development and end-user commitment, presents a challenge for communication, trust, and engagement strategies (personal communication #2 & #3)

WijkvanNu led the participation sessions for creating the WUP in an objective manner. The first step in communication was informing residents about the intention to develop a warmte-uitvoeringsplan. This was done through neighborhood flyers, municipal newsletters, and online platforms. These materials explained the broader ambition of Delft to become gas-free, introduced the selection of Multatulibuurt as a pilot area, and provided an initial timeline of the process.
The municipality conducted a door-to-door survey targeting homeowners, which also served as an engagement tool. Of the 129 households approached, 65 responded. Residents were asked about their current heating systems, awareness of the project, openness to alternatives, and their preferred decision-making support. Surveyors explained the WUP during visits, providing context and answering real-time questions. The survey revealed that while most residents were aware of the project, they still had unanswered question, especially about costs and installation logistics.

Closing Session (November 2024):
As the final version of the WUP neared completion, a closing information session was held to present the key outcomes, implementation strategy, and next steps. Attendees received a summary of all resident input and visualized scenarios. Importantly, residents were informed that while the infrastructure would be built, private homeowners retained the right to choose whether to connect, at least under current legislation. This transparency helped build trust.

**Now:** Think-Along Group (Meedenkgroep):
In 2025, a structured participation format was introduced: the "Meedenkgroep" (resident think-along group), consisting of approximately 25 residents representing various demographics and housing types. The group met several times across themed sessions (like affordability, technology, sustainability), and discussions were structured around clear input questions from the project team. Participants received detailed, plain-language information including visual explanations of technical systems, comparative cost models, and practical renovation advice. Participants were compensated and their feedback was summarized in newsletters for broader dissemination.

"What would you need to know about connecting to a heat grid?"
**Interviewee #4: "**Maybe just a one-pager that says: here's what changes for you, here's what stays the same. And who pays for it"

### 6.2.5 Barriers, drivers & support

The diversity in ownership types in the neighborhood also translates into a diversity of interests, sometimes conflicting ones. For example, housing associations need to inform their tenants, while the municipality mainly focuses on private homeowners, who are generally harder to activate. A neighborhood center was established to facilitate engagement, but turnout remained limited and tended to consist of a specific subgroup, such as elderly residents dealing with loneliness or individuals with unrelated frustrations towards the municipality. Nonetheless, the discussions did provide valuable insights (personal communication #2).

According to municipal research, environmental impact was cited as the main reason for wanting to disconnect from natural gas. However, in the context of the Multatulibuurt, it became evident that costs and financial benefits were far more important to most residents. This discrepancy could be explained by differences in the socio-demographic makeup of the neighborhood (personal communication #4). Housing associations and younger residents (such as students), on the other hand, indicated that environmental considerations were indeed important to them (personal communication #3 & #4).

One of the biggest challenges was effectively reaching out to residents and encouraging them to participate in the process. Often, the same individuals participate, which can result in a skewed representation of the neighborhood's diversity. The real challenge lies in ensuring that every voice is heard and that participation activities reflect the true socio-demographic composition of the community (personal communication #2).

Given the long-term nature of the project and the variety of possible future scenarios, the strategy was to start with no-regret measures, which are actions that could already be implemented regardless of the eventual heating solution. A frequently asked question from residents was: “My boiler is broken, what should I do now?” In such cases, residents were advised to consider renting a boiler to allow for future flexibility (personal communication #2). In addition, insulation was always recommended as a first step, as it benefits all possible heating options. Several local initiatives were available to support residents in this, like 015 Duurzaam and Deelstroom Delft.

One particularly effective strategy in this neighborhood was the use of a key figure or local ambassador. Especially among private homeowners, this approach proved successful. One resident opened up their home as a demonstration house, allowing neighbors to see which measures had been implemented and how they might look in their own homes. This combination of personal experience and visible results, shared by a trusted peer, helped to build trust and inspire others to take action (personal communication #2).

## 6.3 CASE B - BoTu Rotterdam

### 6.3.1 Introduction & context

Bospolder-Tussendijken (often abbreviated as BoTu) is a densely populated, post-war neighborhood in Rotterdam known for its socio-economic challenges. It was selected as one of Rotterdam’s pilot “aardgasvrije wijken” (natural gas-free districts) under the national goal to eliminate natural gas by 2050 (duurzaam010.nl). The choice for BoTu was strategic: connecting this area to the existing district heating network was identified as the most feasible and cost-effective solution, given that a main Eneco heat pipeline runs nearby and can be extended into the district.

A partnership was formed between the Rotterdam municipality, housing association Havensteder, and energy company Eneco, who began working in early 2019 on a coordinated plan to transition a section of BoTu away from gas.

This area-based approach in BoTu was part of a broader city strategy to target neighborhoods where a collective heat solution is viable and can align with other urban infrastructure works or maintenance measures. From the start, the BoTu heat transition was conceived not just as a technical conversion, but as an integrated neighborhood improvement project. The municipality saw the energy transition as an opportunity to improve local livability and address social issues as well. In BoTu, the gas-free program was linked to the existing “Veerkrachtig Bospolder-Tussendijken 2028” initiative, which is a ten-year resilience program aiming to raise the neighborhood’s social index (quality of life indicators) to the city average by 2028. This meant that alongside implementing heat grid, the project also aimed to create social and economic co-benefits. For example, by coordinating with public space upgrades (more green/play areas) and exploring job opportunities for residents stemming from the energy transition.

In short, the context of BoTu’s heat transition is one where technical, financial, and social objectives are tightly interrelated. The neighborhood’s characteristics, an older building stock with many multifamily units, a high density of social housing, and significant socio-economic vulnerabilities, shaped a top-down yet community-informed approach with a focus on making the switch to sustainable heat would be "haalbaar en betaalbaar" (feasible and affordable) (personal communication #1).

### 6.3.2 End-user groups & characteristics

The end-users in this neighborhood are mainly the local residents and property owners. The ownership structure is a mix between private homeowners and housing association dwellings, with some public buildings and small businesses.

**- Tenants(social housing):**
A large portion of BoTu's housing is owned by Havensteder, meaning many residents are tenants in social-rental apartments. These tend to be **lower-income** households. They have relatively little direct agency in the heat transition – the decision to disconnect from gas and connect to the district heat is made by the landlord (Havensteder) – but they are ultimately the daily users of the new system, and the housing association needs 70% approval in order to make the switch. Key concerns for tenants include assurance of **comfort and reliable service,** and that their **monthly costs** will not increase as a result of the transition.
Indeed, the project agreement stipulated that tenants pay nothing extra for the switch (no hookup fee and no rent increase). The outcome is that maintenance and energy delivery costs are shifted into the heating company's fees (with Eneco providing a discounted fixed fee for heat) so that tenants' total monthly expense remains neutral (personal communication #1). This arrangement addresses the affordability barrier for tenants and seeks to gather and maintain support among this group.

**Interviewee #6:** "I am a tenant. If my rent is not increased and I can reasonably heat my house, I'm fine. I don't need to understand everything"

- **Homeowners:**
Intermixed in the neighborhood are **owner-occupiers**, who bear full responsibility for making their own dwelling gas-free. In BoTu, many of these owners have modest incomes and may lack the capital or knowledge to invest in alternatives like heat pumps on their own. For these individuals, the switch to district heating was presented as a *voluntary* opportunity, but one heavily incentivized by public support. The municipality made a **financial offer** to private homeowners in the target area: they could connect to the new heat grid for a flat fee of just **€1,500** (duurzaam010.nl.) This is a fraction of the actual cost (estimated over €15,000 per home), the remainder is being subsidized by government programs (Nationaal Programma Lokale Warmtetransitie, European ELENA funds) and contributions from the Municipality.
€1,500 was deliberately set to roughly match the typical cost of replacing a gas boiler, framing the offer as an attractive like-for-like swap. Homeowners also received support such as an interest-free **energy transition loan** to cover any additional retrofit costs (available through 2025) and a €500 grant for switching to an electric cooking setup (personal communication #1). Despite these incentives, a barrier for this group was **trust and autonomy**, some owners were hesitant about committing to a collective system and worry about possible future cost increases. The project addressed this by intensive personal outreach: the municipality used local energy coaches to meet with

homeowners one-on-one, explain the options (including the alternative of installing a heat pump), emphasize that participation was voluntary, and highlight that **"now is the chance"** to benefit from the generous support on a connection.

**Interviewee #7:** "For me, it's important that I'm not tied to Eneco. What if it gets more expensive later? I want to keep the freedom to choose my heat supplier"

**Interviewee #7:** "I don't have enough money to invest in a heat pump, but now I can switch for 1500 euros, that is a great opportunity for my situation"

- **Homeowners' associations (VvE's):**
Some apartment blocks in BoTU have multiple owners and fall under a VvE (Vereniging van Eigenaren). For these, collective decision-making is required to change the heating system. A known barrier for VvE groups is the difficulty of achieving consensus and financing joint investments. In BoTu, the approach was to remove as many hurdles as possible. The municipality covered the cost of the heat system in the **common areas** of the building (so VvE members wouldn't have to pay for pipes in shared halls or facades) Subsidies were offered for VvE's that proceeded to implement energy-saving measures (for example, insulation) alongside routine maintenance, thereby leveraging the heat transition to improve the quality of the building (personal communication #1). The Municipality also provided a dedicated VvE support officer (through the **VvE010** service) to advise associations on decision-making, technical options, and even mediate conflicts. This hands-on guidance and financial aid turned the heat transition into an *opportunity* for VvE's to catch up on maintenance and reduce energy waste, focusing on increasing comfort. Still, VvE boards had to be activated.

**Interviewee #1:** "There were a few 'old white men' who disrupted every meeting. But we kept involving them – listening, explaining."

**- Private landlords and small businesses:**
A smaller segment of end-users included private landlords (who rent out homes) and local business owners in the area. Private landlords faced a **split incentive** dilemma; they own the property and would pay for upgrades, but tenants reap the benefits of lower carbon heat. To encourage their participation, the project pointed them to the national **SAH subsidy** (Stimuleringsregeling Aardgasvrije Huurwoningen) which helps landlords finance making rental units gas-free. Landlords, like owner-occupiers, were free to choose between district heating or other solutions, but given the coordinated rollout on their street, it was made clear that joining the collective system during the project would be most cost-effective. They were also required to ensure their tenants could cook electrically if gas was removed (duurzaam010.nl.) As for small businesses in the neighborhood, they were included in the area plan and offered the option to connect to the heat network if it passed their building. The primary consideration for businesses, especially restaurants, was adaptation of equipment, switching to electric cooking for example (personal communication #). These non-residential end-users were fewer in number but received similar communication and support tailored to their circumstances.

**Interviewee #1:** "There were a few 'older residents" who disrupted every meeting. But we kept involving them – listening, explaining."

#### 6.3.3 Process & approach

The idea to make BoTu gas free originated around 2018 from the municipality of Rotterdam, aligned with the city's Transitievisie Warmte 2021, which identified BoTu as a pilot area for the PAW-subsidie (Proeftuin Aardgasvrije Wijken). The municipality began conducting a feasibility exploration for BoTu, analyzing technical options, costs, and social factors. During this time, the groundwork for partnership was laid: Havensteder and Eneco were brought to the table early. The parties realized that a collaborative area-based approach would be more efficient and acceptable than fragmented efforts. "Together is better, share costs and only dig up the streets once, instead of each doing separate projects"

**Interviewee #1:** "People don't have room for expensive heat pumps, don't have the money, and on top of that, there's also the issue of grid congestion!"

About six years ago (circa 2019), a small joint team was formed – "1 person from each party" – to build trust and work out a concept plan. Notably, initial trust was low and had to be earned through open dialogue and transparency. To craft a viable business case for the district heating network, the partners agreed to share sensitive cost data under NDAs (non-disclosure agreements). This allowed them to understand the true cost structure (instead of just a flat connection fee per house) and explore how to allocate costs and risks fairly. The outcome was a "socialized" business case in which the costs of connecting each home were averaged out across the project.

**Interviewee #1:** "At first, there was no trust at all, but we started with just one person from each party – the municipality, Havensteder, Eneco – and gradually structure and trust emerged."

During this planning phase, end-user involvement was limited but not ignored: the municipality kept the local government (gebiedscommissie) informed and made sure the plan aligned with any existing neighborhood initiatives. In terms of direct communication, once the project idea had matured, an initial newsletter was sent to residents to inform them that the city was exploring possibilities for a heat solution in BoTu. This early message set expectations that nothing would change immediately and that residents would hear more in about a year's time when there was concrete information. Essentially, the initiation stage was top-down (driven by municipal policy and expert studies) but with an eye on future resident buy-in by being transparent from the beginning.

The transition entered an active phase in early 2021 when formal agreements were signed. A Gebiedsovereenkomst (area agreement) was concluded among the major stakeholders – the municipality of Rotterdam, Havensteder, and Eneco. In parallel, a unique Samenwerkingsovereenkomst (collaboration contract) was signed. This agreement, often referred to as SOK BoTu, established a framework for resident participation and social support alongside the technical project. A local project hub called De Verbindingskamer ("Connection Room") was set up as a physical and organizational space to facilitate ongoing engagement with the potential end users. The Verbindingskamer pulled together networks of community initiatives, volunteers, and even funding from all partners (municipality, housing corporation, energy company) to support social projects in the neighborhood. The idea behind it was that making the heat transition succeed in BoTu required addressing residents' broader needs and building social cohesion – essentially, creating a resilient community that could handle the disruption of the transition and participate in it. As one interviewee reflected, "everyone, even the energy company, put money into enabling social initiatives…to get behind the front door, pick up signals of problems people have"

**Interviewee #1:** "*We discovered that 1 in 3 households in three apartment blocks were dealing with serious problems, and a quarter of those were completely unknown to social services. You can't separate the energy transition here from other personal problems like debt, language barriers, and financial insecurity.*"

This insight reinforced the approach of coupling the energy project with social work – by helping residents with pressing issues (via social workers, energy coaches, etc.), the project team could build goodwill and capacity to engage with the heat transition. In terms of technical preparation, 2021 was spent on detailed design and coordination with other infrastructure plans. A critical synergy was with the city's sewer replacement schedule. BoTu originally had a sewer upgrade planned for later years, but since Havensteder needed to replace many gas boilers in its buildings by a certain date (or ideally avoid doing so by switching to district heat), the sewer works were pulled forward to align with the heat network rollout. This kind of "werk met werk maken" (combine works) approach is a great example of Rotterdam's integral strategy. It meant that roads would only be dug up once to both replace old sewers and install heat pipelines, minimizing inconvenience for residents and making efficient use of budgets. The integrated plan aimed for a five-year execution window (2021–2025) with a one-year contingency, to meet the criteria of government subsidies and Havensteder's timelines. During this contracting/preparation phase, resident involvement intensified: towards the as the first construction areas were identified, homeowners in those blocks received the personal offer letters about connecting for €1500. Community meetings were also held to explain the upcoming project. The initial tone was still that participation for private owners was voluntary, but strongly encouraged given the favorable terms. In summary, by the end of 2022 the groundwork was laid both technically (plans, contracts, resources) and socially (initial communication, offers, community partnerships) to move into execution. Actual construction and conversion of homes began in 2023, proceeding in phases by sub-neighborhood.

Nowadays, the construction is still on schedule. Co-benefits were communicated to residents as added value of the project, demonstrating that the inconveniences of construction would yield multiple positive outcomes for the community. Throughout execution, communication with end-users was intensive and ongoing. Before any construction began on a given street, residents received hand-delivered letters and newsletters explaining the schedule, what to expect (road closures, utility interruptions, etc.), and whom to contact for questions. Meanwhile, the housing association

coordinated closely with its tenants, arranging access to install in-home heat exchangers and radiators as needed. For private homeowners who agreed to connect, the energy company and the municipality provided a turnkey service, which meant handling the technical conversion (installing a heat interface unit, electric cooktop if required, etc.) so that the barrier to participation remained low. Notably, by the time of execution, the business model for end-users was still evolving; while social renters and the housing corporation's involvement were secured from the start, the full enrollment of private owners was an ongoing process. An interesting note is that the project chose to "in the area, take EVERYTHING along – no cherry-picking later".
The project team also maintained a steady cadence of newsletters beyond the construction period, updating the community on progress and next steps, which helps sustain transparency. Moreover, to assist residents during operation, an energy cost comparison tool was provided on the project website, allowing households to calculate what their new heating costs are versus the old gas costs. If residents were unsure, they could use this tool with an advisor in person by appointment, ensuring that the end-users fully understand and can manage their new utility expenses. Lastly, institutionalizing the engagement, the project set up weekly walk-in consultation hours at the local community center (buurthuiskamer): with representatives from Havensteder, Eneco, and the municipal team are present on-site to answer questions or help residents, effectively providing continued customer care at the neighborhood level. This ongoing presence is critical in BoTu, given the vulnerable population – it builds trust that "the team is still there for you" even after your home has been converted. By mid-2025, BoTu's heat transition is in a mixed phase: parts of the neighborhood are in full operation on district heat, while other parts are in active construction. The approach has been to learn and adjust in real-time, keeping end-users involved not only in celebrating milestones but also in flagging problems. This marks the BoTu approach: rather than a linear top-down approach, it became a continuous co-production with the community, that balanced the structure of a top-down plan with the flexibility of bottom-up feedback.

> **Interviewee #1:** "At first, there was no trust at all, but we started with just one person from each party – the municipality, Havensteder, Eneco – and gradually structure and trust emerged."

The project adopted a phased and differentiated communication strategy tailored to the vulnerability an diversity of different end-user groups: social tenants, owner-occupiers, VvEs, and small private landlords. Initially, general information was distributed via **newsletters,  and local energy transition events.** Once the planning matured, more targeted methods were used.

All potential end users had **kitchen table conversations** facilitated by social counselors. They were also invited to open info sessions and walk-in consultation hours at the local community center, the "Verbindingskamer" as mentioned before. All homeowners werenapproached individually by the municipality, with offers to connect to the heat grid for a heavily subsidized fee of €1,500 (compared to a real cost of over €15,000). If needed, a **10-year interest-free loan** was offered. Plain-language

explanations of technical, financial, and legal implications were provided during one-on-one conversations.
VvE's received **group support including financial planning assistance** (up to €50,000 for co-investments), guidance on organizing consensus among members, and technical coordination.

> **Interviewee #1:** "We only started talking to residents after everything was clear: costs, planning, responsibilities. Only then can you tell a good story. This is in contrast to current theoretical models, in which participation often takes place before the contracting phase. BoTu shows that participation later on, if carefully planned and prepared, can also be successful."

The municipality also organized **low-threshold neighborhood activities**, such as induction cooking workshops and heat transition stands during festivals, **to raise awareness and build trust**. This all was organized in collaboration with local figures and "milieucoaches", who were often women from the neigborhood who were trained to conduct this door-to-door outreach in **multiple languages**. They were also focusing on energy saving measures, since a lot of people have troubles paying the energy bill and **lowering their energy consumption** will help them.

> **Interviewee #6:** "At first, we didn't understand what was going to happen and what our responsibilities were, but then someone who spoke our language and shared our principles came by to explain everything and we decided to connect our house to the heat grid."

> **Interviewee #7:** "It's not that I could decide about everything, but more that I felt that someone was actually listening to me and my concerns."

During the sessions, at workshops and at the community center walk in hours, residents frequently raised concerns about **affordability, disruption** during construction, and long-term **control over heating costs**. But some people were also concerned about **electric cooking,** they didn't have experience with this form of cooking for their traditional dishes. The municipality tailored follow-up information accordingly and ensured consistent messaging across all involved parties.

#### 6.3.4 Barriers, Drivers & Support

A major challenge was ensuring inclusiveness in a socio-economically vulnerable neighborhood. The area includes a high number of residents facing language barriers, **debt, or mental health problems**. These conditions made it difficult to focus communication solely on technical aspects of the heat transition, there is a need to see and act upon their priority problems.
Thereby, residents also varied in their motivations. For tenants and low-income owners, **affordability and comfort were key**. For some owner-occupiers and VvE members, long-term **autonomy and transparency around costs** were equally important.
Skepticism due to **negative newsflashes** about heat grids and towards institutions in general meant **trust-building** was essential and was going to take years of just being present and open and approachable to people, while at the same time keeping them

informed and up to date with the plans they were making. The **lack of trust** was present from the beginning– both **between institutions** and **between institutions and residents**. Initially, even the main partners did not fully trust each other's intentions or data. As noted, they overcame this by investing time in the partnership (placing dedicated staff to work together) and by increasing transparency (sharing cost data under NDAs). This trust-building was essential to formulate a unified strategy and present a "one team" face to the community (personal communication #1). One interviewee noted: *"People in this neighborhood have been burned before. If you're not transparent and consistent, they'll shut the door on you."* Futhermore, the buildings in this neighborhood are quite old and mainly not well maintained or well insulated, meaning the heat grid should be high temperature in order to be sufficient.

The BoTu case shows the importance of combining a technically robust approach with a socially sensitive one. Key lessons include that the **financial support was essential**, the €1.500 offer (plus loan options) was a critical enabler for homeowners. Without this, participation would likely have been much lower. Since this offer could only be made with the availability of the subsidie from "Proeftuin Aardgasvrije Wijken" and the support of the municipality, it can be stated that the financial feasibility of such projects is still super **uncertain and risky for market parties**.
**Trust is built through presence**. Regular walk-in hours, door-to-door conversations, and consistent collaboration with local figures, in this case the **language coaches,** created **credibility.**
Integrated social policy strengthens support for transitions, the Verbindingskamer allowed the project to simultaneously address energy poverty, debt, and other **challenges behind the front door**, while also organizing fun and community building activities for the local residents.
**Participation must reflect local diversity**. A one-size-fits-all approach would have excluded key groups. This is resource-intensive and takes long, but necessary.

One of the most telling observations came from the technical project lead: *"I only agreed to manage the project because I knew how strong the social foundation was. Without that, it would have failed."*

This case suggests that in vulnerable neighborhoods, heat transition projects require an integrated, long-term approach that goes beyond technical fixes. Future efforts elsewhere should consider not only the technical feasibility of a heat network, but also the community's **social readiness**, support needs, and the trust dynamics.

**Interviewee #8: "Due to the long preparation and collaboration with the Municipality for better insights into the risks, we were able to make an offer that they couldn't refuse."**

## 6.4 CROSS CASE ANALYSIS & CONCLUSION

### 6.4.1 Cross case analysis

*Table 13: Case studies overview (author)*

| Aspect | Case A: Multatuli | Case B: BoTu |
|---|---|---|
| *Phase of end-user engagement* | During initiation & feasibility | Project manager heat transition |
| *Leading/initiating partie(s)* | Municipality & housing association involved | Initiated by municipality, in close collaboration with housing association & energy company |
| *Project status & phase* | Ongoing – WUP published, implementation for housing corporations, decision phase for homeowners | Ongoing, decision phase for homeowners |
| *Heat grid type* | Geothermal well | Waste heat |
| *Preliminary end user groups* | Housing association tenants (great share of students) & homeowners | Mainly social housing tenants, homeowners with diverse profiles |
| *Communication/participation* | Letters, workshops, community building in neighborhood, compensated participation sessions, co-creation, survey, information sessions | Newsletters, key community figures, local language coaches, Verbindingskamer |
| *Key Barriers* | Cost concerns among homeowners; fragmented trust; complex VvE dynamics | Coordination delays, planning issues, mistrust, net congestion, cost concerns, personal problems, negative newsflashes |
| *Key Drivers* | Financial incentives, increased comfort, sustainability | Financial support, trust building, key figures as coach, price stability guarantees |
| *User decision-making phase* | Homeowners still in consideration phase; no mandate | Decided |
| *Building typology* | Mix of 1960s flats and single-family homes; outdated collective systems in some buildings | Mainly post-war apartments, dense social housing blocks; row houses in clusters |
| *Socio-economic profile* | Mixed, modest-income households; some sustainability pioneers | Low-income, high diversity, many with language barriers and other problems |
| *Communication challenges* | Technical complexity, fragmented messages, VvE inertia | Low trust, multilingual needs, skeptical homeowners, illiteracy |
| *Unique approach* | WijkvanNu as independent participation party. Use of small-scale participatory formats with feedback loops. Key figure with open house. Meedenkgroep, trusted locals, and neighborhood-specific guides | Integral approach, social community building and trust gaining, language and sustainability coaches, individual approach with kitchen table conversations. Haalbaar & Betaalbaar |

### 6.4.2 Barriers & Drivers

Based on the case studies and interviews, the barriers and drivers list derived from literature can be validated for use in the survey. The highlighted barriers & drivers are mentioned several times in both cases and therefore most important.

*Table 14: Barriers & drivers from the case studies (author)*

| Category | Barriers | Case A | Case B |
|---|---|---|---|
| Informational & Organizational | 1. Lack of information | X | |
| | 2. Accessibility of information | X | |
| | 3. Information overload | X | |
| | 4. Lack of awareness | X | X |
| | 5. Nuisance | | X |
| Behavioral & Social | 6.Lack of trust in leading party | X | X |
| | 7.Preferring individual heating solutions over collective systems | X | |
| | 8.Skepticism about system performance | | |
| | 9.Resistance to change from existing heating system | | X |
| | 10.Influence of negative experiences from peers | | |
| | 11.No renewable energy source | X | |
| | 12.Too much effort preparing for the connection | X | X |
| Economic & Financial | 13.High initial cost | X | X |
| | 14.Uncertainty about long-term cost savings compared to current heating system | | X |
| | 15. Perceived risk of monopolistic pricing | X | |
| | 16. Future cost | X | X |
| | 17.Costs of alternatives | X | |
| Legal & Technical | 18.Changing policies | | X |
| | 19.Unclear contractual terms, leading to a lack of understanding rights and obligations when connecting to a heat grid | X | |
| | 20. Legal uncertainties around ownership and responsibilities related to the heat network infrastructure and services | X | |
| | **Drivers** | | |
| Informational & Organizational | 1.Clear overview of the benefits for their household | | |
| | 2.Accessible and understandable information about the system | X | X |
| | 3.Transparency about project timeline and connection process | | X |
| | 4. Availability of user-friendly support before, during and after connection | X | X |
| Behavioral & Social | 5. Social norm campaigns, people don't want to be left behind from their peers | X | |
| | 6. Positive word-of-mouth recommendations from friends/family/neighbors | X | |
| | 7.Trust in leading party | X | X |
| | 8. The feeling of contributing to sustainability goals | X | |
| | 9. Increased level of comfort in my house | | |
| Economic & Financial | 10. Lower energy bills | X | X |
| | 11. Increased property value | | X |
| Legal & Technical | 12. Energy independence (less reliance on fossil fuels) | X | |
| | 13. Compatibility of heat network with existing (heating) systems | | X |
| | 14. Flexibility to combine heat network connection with other measures (energy efficiency measures like insulation or window replacement / aesthetic measures like new kitchen or bathroom) | X | |

### 6.4.3 Support measures

Furthermore, an additional list of support measures has been made to include in the survey to find out what additional support people would actually prefer in their decision-making journey. This list is based on the most mentioned drivers and barriers during the interviews and the approach and process of the case study projects.

*Table 15: Support measures (author)*

| ***Support measures*** |
|---|
| 1.Clear information and education about the benefits and operation of heat grid |
| 2.More insights about the actual initial investment and other cost |
| 3. Increased trust in leading parties |
| 4. Community engagement with feedback opportunities |
| 5. Customer support incl. service and maintenance |
| 6. Participation opportunity about the connection process beforehand |
| 7. Usage price stability guarantees |
| 8. More financial incentives or subsidies |
| 9.Option to use heat network for cooling |
| 10.Additional legislation that makes a heat grid connection more attractive |

### 6.4.4 Conclusion

The two case studies reveal how contextual differences in socio-economic profile, housing stock, and institutional leadership shape end-users' engagement with heat grid projects. Multatulibuurt (Case A) is a relatively mixed-income neighborhood, and the project is led by the municipality with active housing association involvement, whereas BoTu (Case B) is a high-density, lower-income area tackled through a strong public private partnership.

In Multatulibuurt, the process was deliberative and co-creative: residents participated via surveys and workshops and explored multiple heating options, creating a feeling of having something to say. The strategy emphasized "no-regret" measures (especially insulation) that benefit any future solution. This participatory approach helped build trust and generate local ambassadors (for example, the homeowner who opened his house as demonstration site).

On the other hand, BoTu's approach was more top-down but highly integrated with social policy. After initial planning, the project offered very strong incentives in the form of a €1,500 flat fee with subsidized loans to overcome initial investment affordability barriers. Engagement in BoTu was shaped by intensive one-on-one approach: kitchen-table conversations, community workshops, and multilingual, local energy coaches in the neighborhood. In sum, Delft's process was collaborative from the start whereas Rotterdam's relied on a phased rollout once technical and financial details were certain, supported by being present, updating about the process and gaining trust while the plans were being made. These differences yielded distinct barriers and drivers. In both cases, financial concerns and trust topped the list, but they played out differently. In Multatulibuurt, private homeowners feared being locked into a single provider and doubted whether the collective project would negatively influence their property value. Their primary information demand was clarity on costs and autonomy in decision-making. In BoTu, many households face tight budgets and language or literacy challenges; here, even minor cost increases or unfamiliar technology (like electric

cooking) could quickly erode support. Additionally in each case drivers were also mentioned. Delft residents, especially tenants and younger adults, expressed genuine environmental concern and hope for sustainable heating alternatives.
In Rotterdam, the promise of “haalbaar en betaalbaar” heat and additional benefits (free cooking workshops, neighborhood improvements) motivated many. In both cases, clear financial incentives (guaranteed no rent increase for tenants, flat low connection fee for homeowners) were critical enablers.
Support measures likewise reflected context. Delft made heavy use of participatory forums (like the 25-member meedenkgroep and regular feedback loops) and local ambassadors to spread trust
BoTu, in contrast, invested in integral social supports. Multilingual coach teams, debt counseling, and a permanent community hub (“de Verbindingskamer”) to address residents’ broader needs alongside the heat project
Both cases show that a one-size-fits-all strategy fails: Delft’s methods would have left BoTu’s vulnerable residents behind, just as Rotterdam’s highly resourced approach would be unnecessarily complex for a more engaged neighborhood. In practical terms, these findings suggest that heat-transition strategies must be tailored to local conditions. Mixed-tenure neighborhoods may benefit most from early, transparent co-design processes that build consensus and explain technical options, while socio-economically vulnerable areas require integrated social programs and strong subsidies to ensure inclusivity. In either case, addressing the mismatch between infrastructure roll-out and resident decision-making is crucial: as seen in Delft, constructing network lines before homeowner commitments were final created uncertainty and trust issues, while BoTu’s approach of clarifying costs transparently upfront created more support.

Finally, it should be acknowledged that distinguishing and analyzing end-user decision-making phases (awareness, consideration, decision, execution, experiencing) from project implementation phases (initiation, feasibility, contracting, realization, operation) is challenging. These phase categories are theoretical and in reality, project timelines are dynamic, and households conduct their decision journeys at different paces, often out of sync with formal project milestones. For example, a neighborhood project may be well underway before some residents even become aware of it, whereas other homeowners may decide to connect (or not) before the project formally begins. This is something that has been mentioned by several interviewees during the case studies. This issue will be discussed in more depth in the discussion and limitations section.

## 6.5 SURVEY OUTCOMES

To complement the qualitative case study analysis and expert interviews, a quantitative survey was developed to gain broader insight into the perspectives of potential end-users regarding their willingness to connect to heat grids. This was essential to validate and expand upon earlier findings, and to investigate the relationships between user characteristics, perceived barriers, and engagement strategies statistically.

*Survey design*

The design of the survey (Appendix F) was based on a triangular approach, drawing from the theoretical framework, findings from preliminary exploratory interviews and observations from the case studies. Starting with the socio-demographics, followed by the household characteristics, building characteristics and behavioral characteristics, the structure of the survey follows the same thematic approach as the literature.
Starting with the end user characteristics, a section about the drivers & barriers, to then continue with assessing their willingness to connect to a heat grid and the approach of engagement and communication experiences or preferences.
Importantly, the survey also contained phase-specific questioning, where respondents were asked to indicate when they experienced particular barriers or preferred interventions. These phases were aligned with the project and decision-making phases.

*Sample and data collection*

The survey targeted Dutch homeowners, as they have the decision-making authority to connect to heat grids. The sample was recruited via Panel Inzicht, this was possible because the survey is part of the research project Integrale Energietransitie BestaandeBouw (IEBB). This overarching project aims to support a just and effective energy transition in the existing building stock.
A total of 1754 valid responses were collected.

*Analysis*

Since the goal of this research is to find out how different variables influence the willingness to connect to a heat grid across different end-user groups, first an overview of the total willingness levels of this sample are shown in table 16.

*Table 16: Grouped by willingness (author)*

| Group | Willingness to connect | #n | Percentage |
|---|---|---|---|
| *1* | Against | 733 | 50,8 |
| *2* | Neutral | 510 | 35,3 |
| *3* | Willing | 201 | 13,9 |

A total of 17.7% of respondents did not indicate their willingness to connect to a heat grid. These were excluded from further group-based analysis later on.
Since the willingness groups are unevenly distributed in the sample, interpretation of the data analyses is based on within-group percentages rather than absolute counts. This avoids skewed interpretation due to group size imbalance.

### 6.5.1 Socio-demographic household characteristics.

This section outlines the socio-demographic profile of the 1754 Dutch homeowners who participated in the survey, see table 17. The data provides valuable insights into the composition of the respondent group, helping to contextualize patterns in willingness to connect to a heat grid across different personal and financial backgrounds.

*Table 17: Socio-demographic outcomes survey (author)*

| ***Variables*** | ***Category*** | ***N*** | ***Total %*** | ***Against %*** | ***Neutral %*** | ***Willing %*** |
|---|---|---|---|---|---|---|
| Age | 18- 34 years | 130 | 7,4 | 2,7 | 5,3 | 7,5 |
| | 35-54 years | 696 | 39,7 | 28,4 | 46,7 | 47,3 |
| | 55 years or older | 927 | 52,8 | 68,9 | 48 | 45,2 |
| **Composition** | Couple without children | 726 | 41,4 | 37,3 | 39,2 | 50,8 |
| | Family | 637 | 36,3 | 37,8 | 40,2 | 28 |
| | One-person household | 313 | 17,9 | 15,9 | 17,1 | 18,3 |
| | Single-parent household | 70 | 4 | 8,5 | 3,3 | 2,5 |
| | Non-family household | 7 | 0,4 | 0,5 | 0,2 | 0,5 |
| **Education level** | High (HBO, WO, HAVO VWO) | 1.089 | 62,4 | 72,7 | 60,8 | 57,9 |
| | Middle(MBO, VMBO) | 649 | 37,2 | 26,4 | 38,6 | 40,8 |
| | No diploma | 7 | 0,4 | 0,4 | 0,5 | 0,5 |
| **Employment status** | Employed full-time | 701 | 40 | 48,3 | 38 | 28,1 |
| | Retired | 458 | 26,1 | 18,9 | 23,5 | 35,9 |
| | Employed part-time | 332 | 19 | 18,4 | 22,2 | 19 |
| | Self-employed | 97 | 5,6 | 6,5 | 6,9 | 4,4 |
| | Housewife / Houseman/ full-time carer | 83 | 4,9 | 2,5 | 5,3 | 6,5 |
| | Unable to work | 48 | 2,8 | 2,5 | 2,7 | 3,7 |
| | Unemployed | 14 | 0,8 | 1,5 | 0,6 | 1 |
| **Gender** | Male | 999 | 57 | 57,2 | 54,7 | 57,3 |
| | Female | 754 | 43 | 42,8 | 45,3 | 42,7 |
| **Free disposable income** | 0-30% | 786 | 44,8 | 50,7 | 46,3 | 41,9 |
| | 31-60% | 575 | 32,8 | 32,8 | 32,7 | 30 |
| | Over 60% | 236 | 13,5 | 12,4 | 13,3 | 15,1 |
| | Prefer not to say | 156 | 8,9 | 4 | 7,6 | 13 |
| **Total income** | €40.000 – €60.000 | 493 | 28,1 | 24,4 | 27,3 | 27 |
| | Less than €40.000 | 376 | 21,4 | 19,9 | 21,2 | 21,3 |
| | €60.000 - €80.000 | 299 | 17,1 | 20,9 | 17,3 | 16,1 |
| | Prefer not to say | 244 | 13,9 | 10,4 | 12,4 | 19 |
| | €80.000 - €100.000 | 183 | 10,4 | 13,4 | 11,8 | 8,3 |
| | €100.000 or more | 158 | 9 | 10,9 | 10,2 | 8,3 |
| **Savings** | Less than €20.000 | 444 | 25,3 | 20,8 | 30,2 | 25,2 |
| | Prefer not to say | 356 | 20,3 | 11,4 | 19,6 | 27,3 |
| | €20.000 - €40.000 | 326 | 18,6 | 22,4 | 18,3 | 14,5 |
| | €40.000 - €80.000 | 305 | 17,4 | 22,4 | 14,3 | 14,6 |
| | €100.000 - €200.000 | 129 | 7,4 | 9 | 8 | 6,7 |
| | €200.000 or more | 108 | 6,2 | 6,5 | 5,7 | 7,6 |
| | € 80.000 - €100.000 | 85 | 4,8 | 7,5 | 4 | 4,1 |
| **% savings willing to invest EER** | 20-40% | 648 | 37 | 45,3 | 38,4 | 32,3 |
| | 0-20% | 482 | 27,5 | 29,4 | 26,1 | 27,6 |
| | 40-60% | 221 | 12,6 | 10 | 13,9 | 11,6 |
| | Prefer not to say | 181 | 10,3 | 3 | 9,8 | 14,3 |
| | 60-80% | 172 | 9,8 | 10,4 | 9 | 10,6 |
| | Over 80% | 49 | 2,8 | 2 | 2,7 | 3,5 |
| **Total** | | **N=1.754** | | **N= 201** | **N=510** | **N=733** |

A first observation concerns the age composition of the sample. A majority (52,8%) of respondents are aged 55 or older, while only 13,4% fall into the 18–34 age group. This

indicates that the survey primarily reached older homeowners, a group typically more settled in their living environment, but potentially more cautious when it comes to investing in long-term or technically complex transitions. Interestingly, this also aligns with homeownership patterns in the Netherlands, where older people are more likely to own their homes mortgage-free, possibly offering more financial flexibility, but also more resistance to changes that disrupt their comfort or routine.
Age appears to be an important factor in shaping willingness. Older individuals aged 55 years and above form the largest age group (52,8%) and are notably overrepresented in the against group (68,9%). In contrast, younger respondents aged 18–34 years represent only 7,4% of the sample but account for 7,5% of the willing group, suggesting that younger individuals may be more open to sustainable innovations or long-term energy solutions.

Differences in household structure are also notable. Couples without children make up 41,4% of the total sample but are highly overrepresented among those willing to connect (50,8%). This group may experience fewer constraints in decision-making and finances. On the other hand, single-parent households, only 4% of the total sample, are overrepresented in the against group (8,5%), potentially due to financial vulnerability or limited time to engage with new infrastructure plans. Families with children and one-person households are more evenly distributed across all willingness levels.

One of the most prominent characteristics of this sample is its high education level. A substantial 62,4% of respondents have completed higher education (HBO, WO, or HAVO/VWO) and this group is even more represented in the against group (72,7%). This may indicate a more critical or analytical perspective toward new technologies or the institutional context of heat grids. Conversely, those with middle-level education (37,2%) are more represented among the willing group (40,8%), which may suggest that this group is more responsive to practical information or financial incentives.

The employment status of respondents shows a split between economically active and retired individuals. While 40,4% are employed full-time and 19,1% part-time, more than a quarter (26,4%) are retired. This again reflects the older skew of the sample, but also represents the average Dutch population. Retired respondents, while comprising 26,1% of the total sample, make up 35,9% of the willing group. In contrast, full-time employed respondents are strongly represented in the against group (48,3%).

The gender distribution is consistent across all three willingness groups: 57% of respondents are male and 43% female. This alignment with the total sample proportions indicates no significant gender-based differences in willingness to connect to a heat grid.

Financial capacity was assessed through free disposable income, total income, and household savings. About 45% of respondents give an indication of having less than 30% of their income freely disposable each month, with another 32,8% has a free disposable income between 31–60%. Only 13,5% indicate having a high level of financial flexibility (over 60%), and 8,9% preferred not to answer. This suggests that although the majority of respondents are not in immediate financial distress, they also do not have a large financial buffer for costly interventions. This means affordability is a crucial aspect of heat grid implementation. Lower disposable income appears to be associated with greater reluctance. Respondents with 0–30% free disposable income represent 44,8% of the total sample but account for 50,7% of the against group, indicating that financial limitations are likely a key factor in non-willingness. Interestingly, those who preferred not to disclose their income form a higher share of the willing group (13%), possibly pointing to hidden wealth or a stronger environmental mindset that outweighs financial disclosure concerns.

In terms of total household income, the majority earn between €40.000 and €60.000 (28,1%), followed by those earning less than €40.000 (21,4%). A smaller but significant group earns more than €80.000 (19,4% combined). An interesting observation is that 13,9% preferred not to share their income, a relatively high rate that might indicate sensitivity around financial transparency. This can be an important consideration for how financial offers and subsidies should be communicated in in projects. The relationship between total income and willingness is less straightforward. Respondents earning €60.000–€100.000 are somewhat overrepresented in the against group, while those earning less than €40.000 are more evenly distributed. Notably, a large number of respondents in the willing group (19%) preferred not to disclose their income, again suggesting either financial uncertainty or privacy among those more open to change.

Regarding savings, a quarter of the sample (25,3%) reported having less than €20.000, and nearly 40% reported between €20.000 and €80.000. Only 18,4% reported savings over €100.000. This range points to a broad spread in financial resilience. Notably, 20,3% of respondents preferred to not share their amount of savings. This may reflect concerns about privacy or uncertainty about their exact financial situation. Respondents with savings between €20.000–€80.000 are overrepresented in the against group, while those with over €200.000 are slightly more prevalent in the willing group (7,6%). However, the largest share of willing respondents (27,3%) did not disclose their savings. This may indicate that the willingness to connect does not necessarily depend on available capital, or that households are hesitant to reveal their financial status.

When asked how much of their savings they would be willing to invest in energy-saving measures, 37% indicated they would allocate 20–40%, while another 27,5% would only invest up to 20%. Only 12,6% were willing to invest between 40–60%, and even fewer (2,8%) were open to investing more than 80%. These figures highlight a cautious but present willingness to invest. The against group surprisingly reported the highest share (45,3%). The willing group also had a considerable portion (32,3%) indicating willingness to invest at this level. Once again, a significant number of willing respondents preferred not to answer this question (14,3%), possibly due to uncertainty or strategic discretion. Overall, the survey respondents form a relatively well-educated and financially stable group, most of whom own their home and live in a stable household situation. At the same time, their financial flexibility is not unlimited, and age clearly plays a role in how people view change and investment.

Overall, the analysis reveals that age, household type, financial position, and education level are significant in explaining variation in willingness to connect. Higher willingness is associated with younger age groups, couples without children, mid-level education, and those with greater or undisclosed financial flexibility. On the other hand, resistance is strongest among older, single-parent or lower-income households, and full-time worker, groups who are more likely to face higher perceived or actual barriers.

### 6.5.2 Building characteristics

The building characteristics of respondents' homes provide valuable context for understanding how physical housing characteristics influence the willingness to connect to a heat grid. An overview is shown in Table 18.

*Table 18: Building characteristics of the survey respondents*

| ***Variables*** | ***Category*** | ***N*** | ***Total %*** | ***Against %*** | ***Neutral %*** | ***Willing %*** |
|---|---|---|---|---|---|---|
| **Dwelling age** | 1971 – 1985 | 425 | 24,2 | 30,3 | 27,3 | 23,3 |
| | 1986 – 2000 | 399 | 22,8 | 17,4 | 21,8 | 22,9 |
| | 1945 – 1970 | 268 | 15,3 | 11,4 | 18,2 | 15,4 |
| | 2001 – 2010 | 233 | 13,3 | 18,4 | 13,1 | 13 |
| | before 1945 | 210 | 12 | 15,4 | 10 | 12,8 |
| | 2011 – 2020 | 143 | 8,2 | 3,5 | 7,5 | 8,2 |
| | 2020 or later | 58 | 3,3 | 2,5 | 1,8 | 3,4 |
| | I don't know | 17 | 1 | 1 | 0,4 | 1 |
| **Moving plans** | I do not plan to move, out of my current home | 873 | 49,8 | 36,8 | 49,6 | 61,5 |
| | I don't know | 228 | 13 | 10,9 | 15,3 | 12,6 |
| | I plan to move out of my current home, in over 5 years | 181 | 10,3 | 13,9 | 12,4 | 10,2 |
| | I plan to move out of my current home, within 5 years | 308 | 21,3 | 38,3 | 22,7 | 15,6 |
| **Size** | 100m2 – 149m2 | 723 | 41,2 | 49,3 | 40,6 | 41,3 |
| | 150m2 – 200m2 | 303 | 17,3 | 17,4 | 16,1 | 19,8 |
| | 75m2 – 99m2 | 294 | 16,8 | 15,4 | 15,9 | 14,9 |
| | 50m2 – 74m2 | 155 | 8,8 | 6 | 9,4 | 7,2 |
| | over 200m2 | 128 | 7,3 | 5,5 | 8,6 | 7,6 |
| | I don't know | 115 | 6,6 | 4 | 7,3 | 8 |
| | 30m2 – 49m2 | 27 | 1,5 | 2 | 1,4 | 1 |
| | less than 30m2 | 8 | 0,5 | 0,5 | 0,8 | 0,1 |
| **Type** | Terraced house | 552 | 32,2 | 34,3 | 32 | 30,3 |
| | Apartment | 321 | 18,7 | 12,4 | 18,8 | 21,4 |
| | Detached house | 313 | 18,3 | 12,9 | 16,7 | 17,3 |
| | Semi-detached house | 271 | 15,8 | 18,9 | 13,3 | 15,3 |
| | Corner house | 239 | 14 | 16,4 | 15,7 | 13,1 |
| | Maisonette | 17 | 1 | 2,5 | 1 | 0,1 |
| **Future EER** | No, I don't have any plans | 635 | 36,2 | 20,9 | 30,2 | 50,9 |
| | Maybe, depending on subsidies or new regulations | 404 | 23 | 27,9 | 30,2 | 18,7 |
| | Yes, I am currently exploring my options | 399 | 22,8 | 37,8 | 23,5 | 11,9 |
| | I don't know / I have not thought about it yet | 160 | 9,1 | 5 | 8,4 | 12 |
| | Yes, I am already working on it or have concrete plans | 153 | 8,7 | 8 | 7,6 | 6,5 |
| **Past EER** | Yes, 2 years ago (2023) | 373 | 21,3 | 24,9 | 24,1 | 19,2 |
| | Yes, just recently (2024 & 2025) | 370 | 21,1 | 28,9 | 18,4 | 19,4 |
| | No, I never took any measures for a more energy efficient house | 352 | 20,1 | 16,9 | 21 | 21,4 |
| | Yes, more than 5 years ago | 275 | 15,7 | 10,9 | 15,1 | 20,9 |
| | Yes, 3 years ago (2022) | 210 | 12 | 11,4 | 10 | 10,2 |
| | Yes, 4 years ago (2021) | 90 | 5,1 | 3 | 5,7 | 4,2 |
| | Yes, 5 years ago (2020) | 83 | 4,7 | 4 | 5,7 | 4,6 |
| **VvE** | No, I am not | 1.299 | 74,1 | 74,6 | 79 | 81,9 |
| | Yes, I own my home as part of a VvE (Vereeniging van Eigenaars / Homeowner association) | 451 | 25,7 | 24,9 | 21 | 18,1 |
| **Total** | | **1.754** | | | | |

The largest share of respondents live in homes that were built between 1971 and 2000 (47%), followed by a large share built between 1945 and 1970 (15,3%). Only a small part (12%) lives in pre-war homes built before 1945, and just 3,3% of homes were constructed after 2020. This suggests that most respondents live in relatively modern housing stock, though a significant part still resides in homes that may be less energy efficient by default, because they were built at a time that insulation standards were significantly lower than they are today. Homes built before 1945 and between 2001 and 2010 also show slightly elevated against responses (15,4% and 18,4% respectively). In contrast, homes built in more recent years (2011 or later) are more common in the willing group (up to 8,2%). This suggests that older or mid-aged housing stock may face more technical or financial barriers, whereas newer homes, often better insulated and technically compatible, are associated with greater openness to connection.

A strong relationship is visible between mobility intentions and willingness. Respondents who do not plan to move represent 61,5% of the willing group, significantly higher than their overall sample share (49,8%). In contrast, those who plan to move within 5 years are overrepresented in the against group (38,3%). These results suggest that perceived permanence in the home supports long-term investment decisions such as connecting to a heat network.

When looking at dwelling size, the majority lives in medium to large homes: 41,2% of homes fall within the 100–149 $m^2$ range, a category that aligns proportionally with the willing group (41,3%). Another 25,6% are between 50–99 $m^2$. Larger homes (150–200 $m^2$ and above) are also well represented (24.6% combined), whereas only 2% of respondents live in very small dwellings under 50 $m^2$.
This indicates that technical possibilities for interventions are generally present, although larger homes might also bring higher complexity and investment requirements when it comes to connecting to a heat network. Larger dwellings (150–200$m^2$ and over 200$m^2$) are more frequently reported among the willing, while smaller homes (under 75$m^2$) are slightly overrepresented in the against group.

In terms of dwelling type, most respondents live in terraced houses (32,2%) or semi-detached/corner houses (29,8%), followed by detached houses (18,3%) and apartments (18,7%). The relatively low share of apartment dwellers is relevant since collective heating solutions often gain efficiency at scale in multi-family buildings. This points out a need for a differentiated approach, as many of the households live in individual, ground-bound dwellings that require more tailored connection and communication strategies. Apartments, often part of multi-owner buildings, are more prevalent in the willing group (21,4%) than in the against group (12,4%),

When it comes to energy efficiency behavior, the majority of respondents (64,2%) have already taken measures in the past five years, showing a generally proactive attitude towards sustainability. However, 20,1% have never taken any such measures, and 15,7% did so more than five years ago. This indicates that a significant group is still behind. Renovation history shows that respondents who recently took EER measures (2023–2025) are most often found in the against group (up to 28,9%), possibly because they see no immediate need for additional investment. Those who made changes longer ago (more than 5 years ago) are more represented in the willing group, suggesting they may view heat grid connection as a next step.

As for future plans, 36,2% currently don't have the intention to take action, while 23% say they might act depending on subsidies or new regulation. Another 22,8% are actively exploring options, and just 8,7% are already implementing or planning concrete steps. The remaining 9,1% have not yet thought about it. There are clear differences between groups when it comes to future EER plans. Over half of the willing respondents (50,9%) indicate they do not plan further measures, possibly because they already feel their homes are sufficiently prepared. In contrast, a large share of the against group (37,8%) are currently exploring their options, indicating uncertainty rather than rejection. Respondents who are waiting for subsidies or new regulations are overrepresented in the neutral group (30,2%), suggesting this segment is particularly policy-sensitive and may be activated with the right incentives.

Only a quarter (25,7%) of respondents are part of a homeowners' association (VvE), which means that most make individual decisions regarding energy-related upgrades. This reduces the potential for collective negotiation but increases the importance of direct and well-timed communication strategies. A substantial 81,9% of the willing group are not part of a VvE, suggesting that autonomy in decision-making is an important enabler. VvE members, typically apartment owners, are underrepresented in the willing group (18,1%) and more often neutral or against. This may reflect perceived collective complexity or delays in reaching consensus within associations.

Building characteristics clearly influence willingness to connect. Willingness is higher among homeowners who live in larger, newer dwellings, who plan to stay long-term, and who do not depend on collective decision-making structures like VvEs. Meanwhile, resistance is more common among residents in mid-aged or smaller homes, those planning to move, and those who recently invested in individual energy upgrades. These findings highlight the importance of tailoring strategies not only to user attitudes but also to physical dwelling conditions and ownership structures. Almost half of the respondents are potentially open to suggestions and many respondents appear to be in a consideration phase, meaning that a well-timed approach with the right financial and practical incentives could still shift them towards active participation. Overall, this profile confirms that while most homes in the sample are suitable for connection in terms of size, type and age, the decision to connect will most likely depend on addressing other perspectives like perceived risks, cost concerns, and trust.

### 6.5.3 Behavioral characteristics

The behavioral characteristics of respondents provide important insights into their attitudes toward heat networks, levels of awareness, mobility, and the effect of communication or personal contact. These factors are essential to understanding where opportunities for engagement lie and what still holds people back from considering a connection. Table 19 shows an overview of the findings from the survey

*Table 19: Behavioral characteristics of the survey respondents*

| ***Variables*** | ***Category*** | ***N*** | ***Total %*** | ***Against %*** | ***Neutral %*** | ***Willing %*** |
|---|---|---|---|---|---|---|
| Heat grid connection | I am not connected to a heat grid and not in the process of getting a connection | 1.444 | 82,3 | 41,7 | 29 | 11,3 |
| | I am already connected to a heat grid | 201 | 11,5 | / | / | / |
| | I am in the process of being connected to a heat grid | 108 | 6,2 | / | / | / |
| | Is your house connected to a heat grid? | 1 | 0,1 | | | |
| Current heating system | Natural gas boiler (CV ketel) | 1.174 | 81,1 | 80,6 | 82,9 | 75,7 |
| | (Hybrid) Heat pump | 216 | 14,9 | 13,4 | 7,5 | 13,5 |
| | Collective heating (blokverwarming) | 48 | 3,3 | 1,5 | 2,7 | 1,5 |
| | Solar Heater or PVT | 10 | 0,7 | 1 | 0,6 | 0,5 |
| Moving plans | I do not plan to move, out of my current home | 873 | 49,8 | 36,8 | 49,6 | 61,5 |
| | I don't know | 228 | 13 | 10,9 | 15,3 | 12,6 |
| | I plan to move out of my current home, in over 5 years (after 2030) | 181 | 10,3 | 13,9 | 12,4 | 10,2 |
| | I plan to move out of my current home, within 5 years (before 2030) | 471 | 26,9 | 38,3 | 22,7 | 15,6 |
| Awareness about heat grids | No, I am not familiar | 740 | 44,7 | 33,8 | 53,5 | 47,7 |
| | Yes, from news & media | 406 | 24,5 | 24,4 | 22,5 | 29,2 |
| | Yes, out of own interest | 224 | 13,5 | 15,4 | 8,2 | 8,5 |
| | Yes, municipality campaign | 131 | 7,9 | 7,5 | 6,5 | 4,6 |
| | Yes, from family / friends / neighbors | 96 | 5,8 | 9 | 5,1 | 5 |
| | Yes, energy company advertisement | 59 | 3,6 | 3,5 | 2,2 | 1,5 |
| Personally approached | No | 1.588 | 90,5 | 93,5 | 97,1 | 98,5 |
| | Yes | 165 | 9,4 | 6,5 | 2,9 | 1,5 |
| Reason not willing to connect | I am satisfied with my current heating system | 379 | 56,7 | / | / | 51,7 |
| | I don't expect a heat grid connection to lower my monthly energy bill | 150 | 22,5 | / | / | 20,5 |
| | I don't consider a heat grid to be reliable | 62 | 9,3 | / | / | 8,5 |
| | I have already invested in an alternative heating system | 39 | 5,8 | / | / | 5,3 |
| | I don't have the financial means for the initial investment | 37 | 5,5 | / | / | 5 |
| Survey influence | No, not at all | 1.157 | 66 | 47,3 | 68,6 | 82,9 |
| | Yes, I feel more positive about connecting to a heat network | 453 | 25,8 | 51,2 | 27,1 | 3,8 |
| | Yes, I feel more negative about connecting to a heat network | 143 | 8,2 | 1,5 | 4,3 | 13,2 |
| Willingness to connect | I am neither in favor nor against being connected to a heat grid | 510 | 35,3 | / | 510 | / |
| | I am totally against being connected to a heat grid | 486 | 33,7 | n=486 | / | / |
| | I am against being connected to a heat grid | 247 | 17,1 | n= 247 | / | / |
| | I am willing to connect to a heat grid | 151 | 10,5 | / | / | n=151 |
| | I am very willing to connect to a heat grid | 50 | 3,5 | / | / | n=50 |
| VvE | No, I am not | 1.299 | 74,1 | 74,6 | 79 | 81,9 |
| | Yes, I own my home as part of a VvE (Vereeniging van Eigenaars / Homeowner association) | 451 | 25,7 | 24,9 | 21 | 18,1 |
| **Total** | | **1.754** | | | | |

Most respondents (82,3%) are currently not connected to a heat grid and are not in the process of being connected. Only 11,5% are already connected, and 6,2% are in the process of getting connected. This confirms that most respondents are still in the awareness or consideration phase, which presents both a challenge and an opportunity.

The current heating systems used by respondents presents this challenge and opportunity as well: 81,1% still rely on a traditional natural gas boiler (CV ketel), compared to 14,9% who already use a (hybrid) heat pump. Collective heating systems such as block heating (3,3%) and alternatives like solar thermal (0,7%) are rare in the sample. This shows that most households still operate on an individual, gas-based system, which highlights the potential impact of a successful heat grid project, but also the scale of behavioral and technical change required to make the transition. Interestingly, respondents with alternative heating systems (like a heat pump or solar heater) are more likely to fall into the neutral or willing groups, suggesting that past investment in alternatives may increase openness to future transition.

Nearly half (49,8%) of respondents do not plan to move out of their current home, and an additional 10,3% only plan to move after 2030. These homeowners are the primary target group for long-term investments such as heat network connections. However, 26.9% intend to move within five years, and 13% are unsure. These groups may hesitate to invest in changes with long payback times. Intentions to move show a strong correlation with willingness. Among the willing group, 61,5% indicate they do not plan to move, versus only 36,8% in the against group. On the other hand, 38,3% of those against connecting plan to move within five years.

A key barrier remains the lack of awareness: 44,7% of respondents are not familiar with the concept of heat grids. Among those who are, most first heard about it via the news or media (24.5%) or through their own interest (13,5%). Only a small minority learned about heat grids through a municipal campaign (7,9%), from friends or neighbors (5,8%), or through an energy company (3,6%). In addition, only 9,4% of all respondents have ever been personally approached with information about a potential connection. While 44,7% report not being familiar with heat grids, this figure is especially high among the neutral group (53,5%). The willing group appears slightly better informed, with 29,2% reporting knowledge via news or media. These results suggest a missed opportunity for proactive communication and engagement strategies, particularly among neutral or undecided residents.

The great majority of respondents (90,5%) indicate they have not been personally approached regarding connection to a heat grid. 98,5% of the willing group has not been approached, indicating that willingness does not result from outreach, but possibly from intrinsic motivation or external information sources. The against group is slightly more likely to have been approached (6,5%), though this may have occurred too late in their decision-making process.

When asked about their reasons for not wanting to connect, the top response by far was satisfaction with their current heating system (56,7%). Other commonly chosen reasons were the expectation that a heat grid would not reduce energy costs (22,5%), concerns about reliability (9.3%), prior investments in alternative heating systems (5.8%), and lack of financial means (5.5%). These concerns reflect not just financial barriers but also behavioral resistance. So the perceived convenience and confidence in the heat grid system are important factors.

The survey itself had an influence on attitudes, namely 25,8% of respondents felt more positive about connecting to a heat grid after completing it, against only 8,2% who felt more negative. For the majority (66%), the survey had no effect. Still, the fact that a quarter of respondents shifted their perception positively suggests that well-structured information, even in survey form, can influence how people see such systems and projects. However, a notable 13,2% of the willing group reported feeling more negative afterward, perhaps due to increased awareness of complexity or costs.

Finally, the direct willingness to connect remains limited. 35,3% are neutral, they are neither for nor against connecting. One-third (33,7%) are totally against it, and another 17.1% are generally against it. Only 10.5% of respondents are willing, and 3.5% are very willing to connect. While the total “willing” group is relatively small, the large neutral segment is highly relevant: this group is still undecided and could be influenced with the right approach in order to increase their willingness to connect. It’s here that municipalities, energy providers, and other stakeholders can make a difference—if communication is timely, credible, and responsive to real concerns.

This analysis reveals that current connection status, heating system, and mobility intentions have a strong relationship with willingness to connect to a heat grid. Moreover, lack of personal outreach and limited familiarity appear to contribute to neutral or skeptical attitudes. Still, the survey itself proved to be a valuable engagement tool, particularly for those initially opposed. Overall, the data clearly show that willingness to connect is still low, and knowledge levels are limited. Most respondents are not familiar with heat grids, have not been personally approached, and remain satisfied with their current system. However, the large group of neutral respondents, combined with the positive effect of the survey on attitudes, suggests that behavioral change is possible.

## 6.6 SURVEY ANALYSIS

### 6.6.1 Barriers, drivers and extra support per phase

#### 6.6.1.1 Barriers

This section analyses the specific barriers and drivers that affect end-users' willingness to connect to a heat grid. An analysis was conducted across 18 identified barriers, each categorized by the phase in which the barrier is experienced: Awareness, Consideration, Decision-making, Execution, Experiencing, or No barrier experienced. Figure 14 presents the number of respondents who associated each barrier with a specific phase in the decision-making journey. The results show that different types of concerns arise at different stages, however there is a clear concentration of perceived barriers visible in the early phases of the heat grid adoption process.

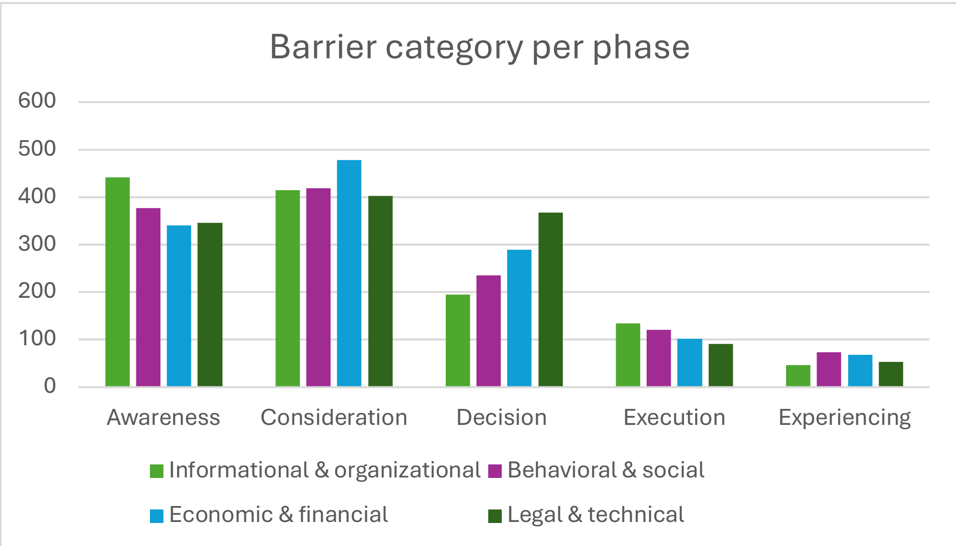


*Figure 14: Barrier categories per phase (author)*

Figure 14 also shows the distribution of the four main barrier categories, Informational & Organizational, Behavioral & Social, Economic & Financial, and Legal & Technical, across the five key phases of the decision-making journey: Awareness, Consideration, Decision, Execution, and Experiencing.

The data reveal that the majority of barriers occur during the early phases, particularly Awareness and Consideration. In the Awareness phase, Informational & Organizational barriers dominate, with over 400 mentions. This indicates that many respondents felt they lacked sufficient information or clarity when first introduced to the concept of a heat grid. Behavioral & Social barriers follow closely, highlighting early concerns such as lack of trust, negative attitudes, or perceived complexity. Economic & Financial and Legal & Technical barriers were reported less frequently in this phase, suggesting that financial or contractual concerns typically emerge later in the process.

During the Consideration phase, when end-users begin actively evaluating the heat grid option, all four barrier categories peak, especially Economic & Financial barriers, which surpass all others. This reflects that financial feasibility becomes a critical concern when individuals start weighing the pros and cons. Still, Informational, Behavioral, and

Legal & Technical concerns remain significant, underscoring the complexity of this evaluative phase.

In the Decision phase, a clear shift occurs: Economic & Financial and Legal & Technical barriers become most prominent, particularly the latter, which reaches its highest point here. This suggests that respondents encountered obstacles related to costs, contracts, or uncertainties about legal responsibilities when making a final decision. Meanwhile, Informational and Behavioral barriers decline in this phase, indicating that those who progressed this far had likely resolved earlier doubts related to information and trust.

The Execution phase sees a notable drop in total barrier mentions across all categories, though Informational & Organizational barriers remain the most cited. This may relate to confusion around installation logistics or lack of clear communication during implementation. Other categories are mentioned less frequently, reflecting that fewer respondents reach this stage or perceive barriers at this point.

Finally, the Experiencing phase, so after connection, has the fewest barriers overall, suggesting that post-implementation problems are either less frequent or less visible in the decision process. Each category registers under 100 mentions, with only minor variation.

In summary, the figure highlights that barriers are mainly represented in the early phases in the user decision-making journey, with informational and behavioral concerns dominating at first, and economic and technical barriers emerging later on in the process.

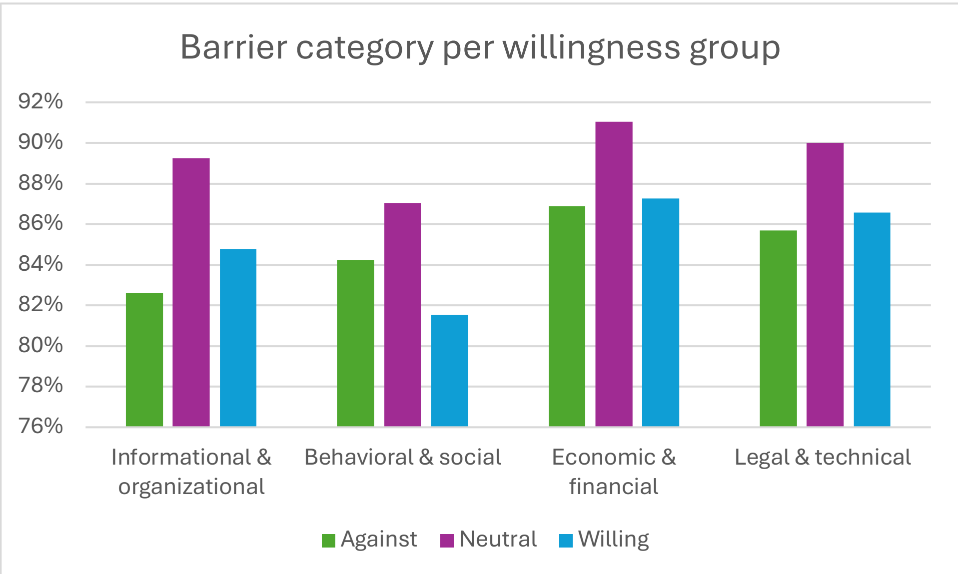



*Figure 15: Barrier categories per willingness group (author)*

Figure 15 presents the percentage of respondents within each willingness group who reported experiencing barriers from each of the four main categories.

The results reveal that barriers are reported across all categories and all groups, but their intensity and prevalence differ. Notably, the Neutral group consistently reports the highest percentages of experienced barriers in every category, with values ranging from 87% to 91%. This pattern suggests that individuals who are undecided are particularly sensitive to multiple forms of resistance and may feel overwhelmed or unconvinced across various dimensions. For this group, no single category stands out.

The Against group also reports high percentages across all categories (around 82–87%), though slightly lower than the Neutral group. This indicates that while those who oppose connection do face many of the same barriers, their stance may be more solid, perhaps reflecting earlier decisions made based on fewer but more decisive barriers like distrust, lack of information, or cost fears.

Interestingly, even the Willing group, those already open to connecting, report barrier experiences at relatively high rates (between 82% and 88%). This indicates that willingness does not imply a lack of perceived barriers. Instead, it could suggest that supportive individuals are either more willing to tolerate or overcome these barriers. In particular, nearly 88% of willing respondents acknowledged Economic & Financial barriers, indicating that even among supportive users, cost concerns remain relevant and cannot be ignored in implementation strategies.

In summary, this figure shows that perceived barriers are widespread and cross-cutting, even among those inclined to adopt. However, the Neutral group emerges as the most barrier-sensitive across all themes, making them a key audience for targeted interventions. Addressing the broad range of concerns experienced by this group, from information deficits to financial and technical doubts, may be the most effective path towards increasing overall willingness.

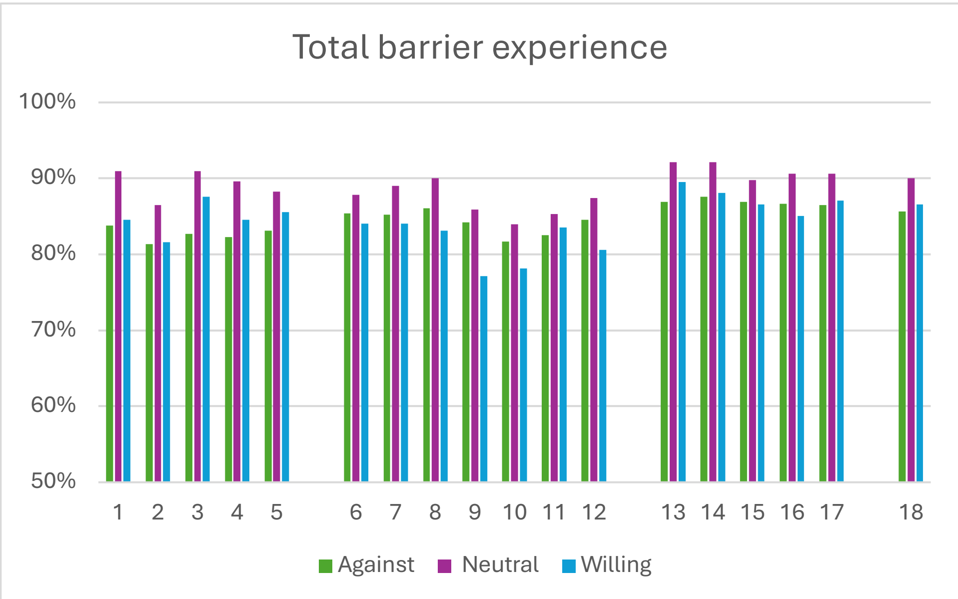



*Figure 16: Barriers per willingness (author)*

Figure 16 presents the total percentage of respondents in each willingness group who reported experiencing each of the 18 identified barriers (Section 6.4.2). The chart highlights the prevalence of each barrier and how consistently they are encountered across all user segments.

Overall, the data show that barriers are experienced at high rates across all three groups, with most values falling between 80% and 95%. This indicates that all respondents, regardless of their willingness to connect, recognize multiple obstacles in the heat grid adoption process.

The Neutral group consistently reports the highest percentage of barrier experiences across nearly all items, with several barriers like lack of information, resistance to change, high initial cost, unclear contracts, and future cost concerns) exceeding 90%. This confirms that neutral individuals tend to perceive a wide range of barriers, which may contribute to their indecision. They are neither fully opposed nor fully convinced, but feel hindered on multiple fronts.

The Against group also shows high prevalence of barriers, though slightly lower than the neutral group in most cases. Their strongest reported barriers include lack of trust (barrier 6), skepticism about system performance (barrier 8), high initial costs (barrier 13), and future cost risks (barrier 16) all above 85%. This pattern aligns with previous findings that opposition is often rooted in early distrust and financial concerns.

Even the Willing group reports experiencing barriers. While their values are slightly lower overall, they still approach or exceed 80% on most barriers. Notably, accessibility of information (barrier 2), too much effort (barrier 12), and uncertainty about future costs (barrier 14) remain prevalent even among supportive respondents. This suggests again that willingness does not stem from a barrier-free experience, but rather from a greater resilience or capacity to overcome these issues.

In conclusion, the Neutral group emerges as the most barrier-sensitive, encountering both informational and financial hurdles at a very high rate. Engagement strategies should therefore prioritize barrier reduction, particularly around trust, clarity, effort, and cost, to improve user experience toward connection

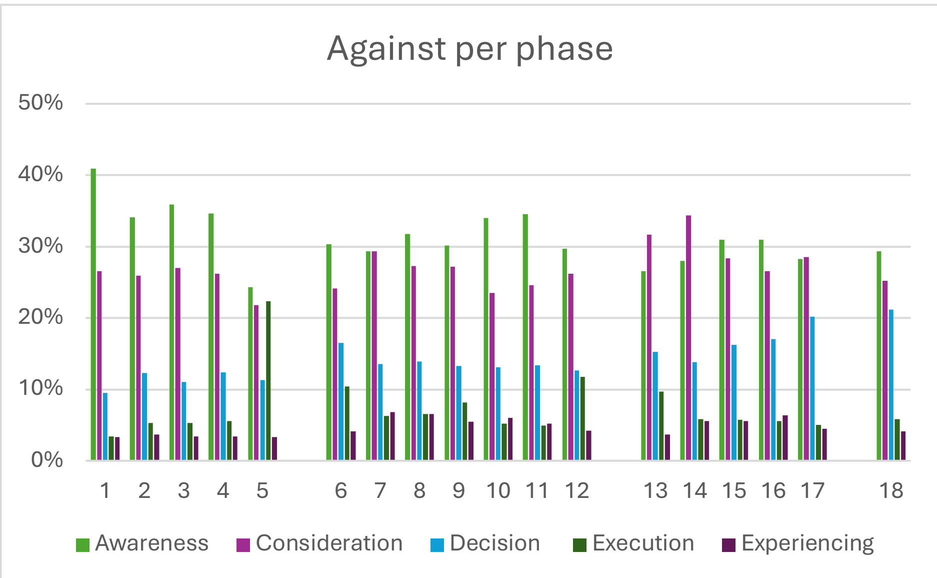


*Figure 17: Against group barriers per phase(author)*

Figure 17 shows that respondents in the Against group experienced most barriers during the Awareness and Consideration phases. Key early obstacles include lack of information, lack of trust, and skepticism about system performance, each cited by over 30% of this group. In the Consideration phase, high initial costs, resistance to change, and effort required become more prominent. Barriers in later phases (Decision, Execution, Experiencing) are reported less frequently, suggesting most opposition forms early. This highlights the need for early-stage interventions focused on information clarity, trust-building, and financial reassurance.

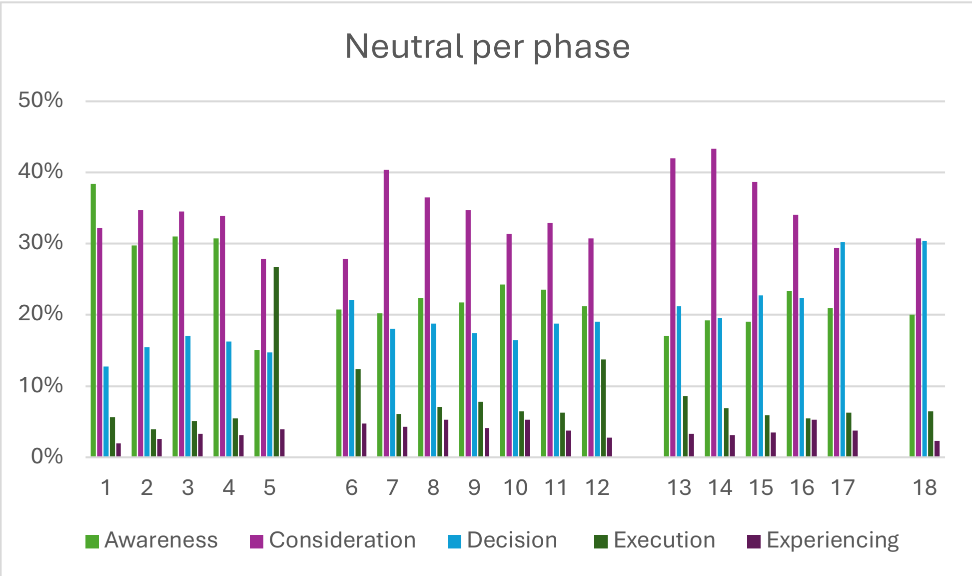



*Figure 18: Neutral group barriers per phase (author)*

Figure 18 shows that Neutral respondents experience barriers across all phases, with a clear peak in the Consideration phase. Key barriers include high initial cost, uncertainty, lack of trust, and resistance to change, most of which reach over 30% during consideration. In the Awareness phase, lack of information and accessibility issues are also prominent. Compared to the Against group, Neutral respondents continue further in the process, facing new doubts in the Decision phase (like legal barriers and financial risks). This group is highly barrier-sensitive, making them a critical target for tailored informational and financial support during evaluation.

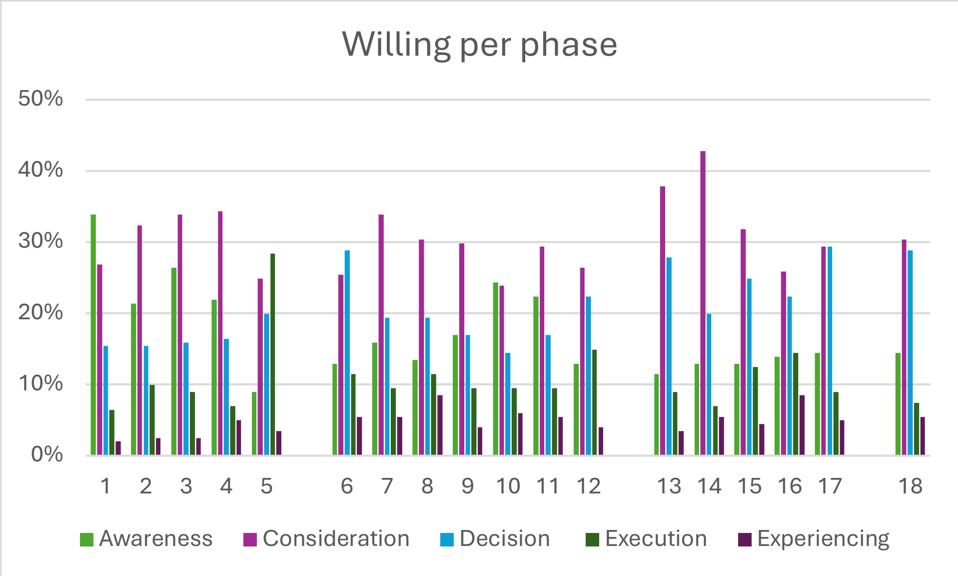


*Figure 19: Willing group barriers per phase (author)*

Figure 19 shows that even Willing respondents experience a range of barriers, though generally at lower levels. Barriers are again most often reported during the Consideration and Awareness phases, particularly lack of information, uncertainty, and high initial cost, each peaking around 25–30%. In the Decision phase, concerns like future costs and legal clarity remain relevant but less dominant. Barriers in Execution and Experiencing are minimal. Overall, this group perceives fewer obstacles, but still requires clear information, financial transparency, and smooth implementation to stay committed.

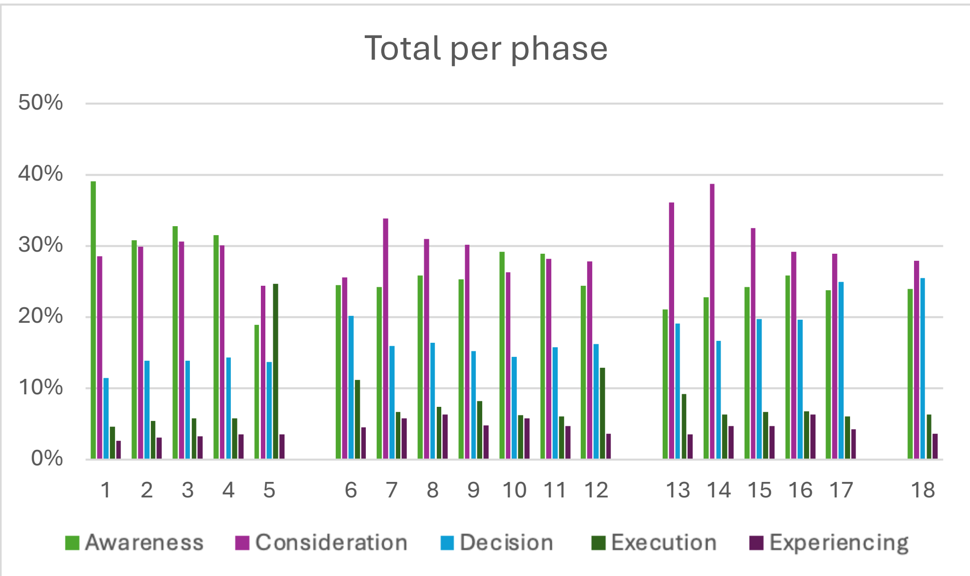


*Figure 20: Barriers per phase overview (author)*

Figure 20 summarizes the total distribution of all barriers mentions across the five decision-making phases. It shows indeed that barriers are most frequently reported in the Awareness and Consideration phases, with items like lack of information, lack of awareness, and high initial cost mostly mentioned. The Decision phase shows moderate barrier levels, particularly for financial and legal concerns (future uncertainty, costs). Barriers in Execution and Experiencing are much less frequent, suggesting that most resistance arises before commitment. Figure 21 shows the top 3 barriers per phase.

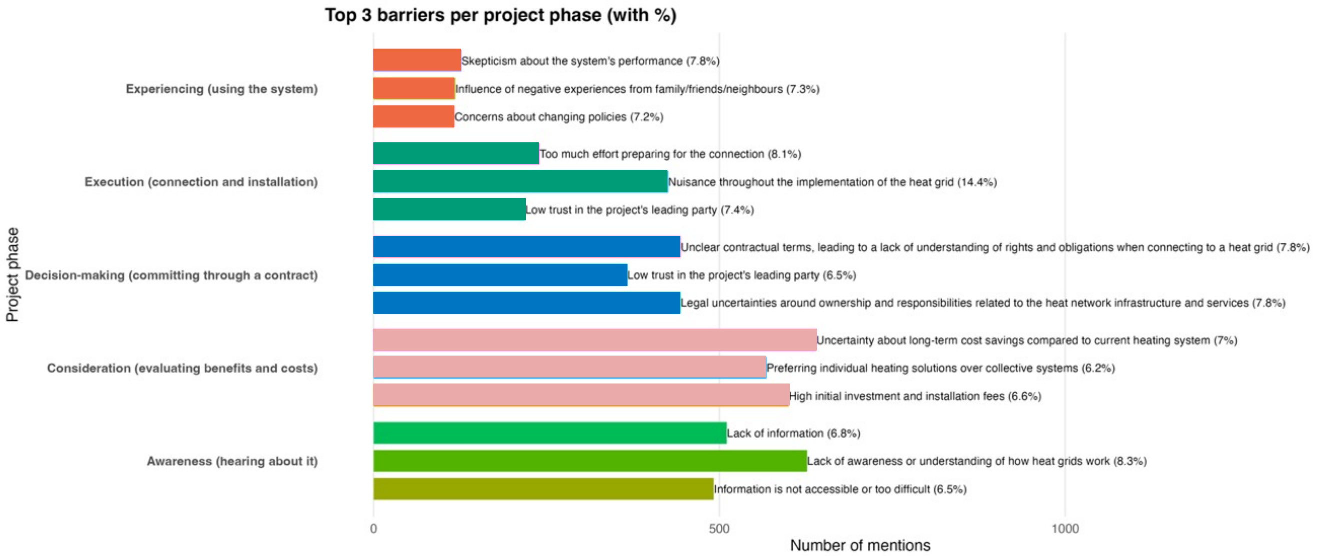



*Figure 21: Top 3 barriers per phase (author)*

Table 20 below shows an overview of all the barriers and the phase wherein they occur. A distinction has been made between the willingness groups. The barriers already validated by the case study results are marked with a *.

*Table 20: Overview barries (author)*

| Category | Barriers | Against | Neutral | Willing |
|---|---|---|---|---|
| Informational & Organizational | 1. Lack of information | X | | |
| | 2. Accessibility of information | X | | |
| | 3. Information overload | X | | |
| | 4. Lack of awareness* | X | X | |
| | 5. Nuisance | | X | |
| Behavioral & Social | 6.Lack of trust in leading party* | X | X | |
| | 7.Preferring individual heating solutions over collective systems | X | | |
| | 8.Skepticism about system performance | | | |
| | 9.Resistance to change from existing heating system | | X | |
| | 10.Influence of negative experiences from peers | | | |
| | 11.No renewable energy source | X | | |
| | 12.Too much effort preparing for the connection* | X | X | |
| Economic & Financial | 13.High initial cost* | X | X | |
| | 14.Uncertainty about long-term cost savings compared to current heating system | | X | |
| | 15. Perceived risk of monopolistic pricing | X | | |
| | 16. Future cost* | X | X | |
| | 17.Costs of alternatives | X | | |
| Legal & Technical | 18.Changing policies | | X | |

#### 6.6.1.2 Drivers

In addition to understanding which barriers hold people back, it is equally important to explore what motivates end-users to consider connecting to a heat grid. This section presents the drivers based on survey responses, in which participants indicated their level of agreement with the list of 14 potential motivators (Section 6.4.2.).

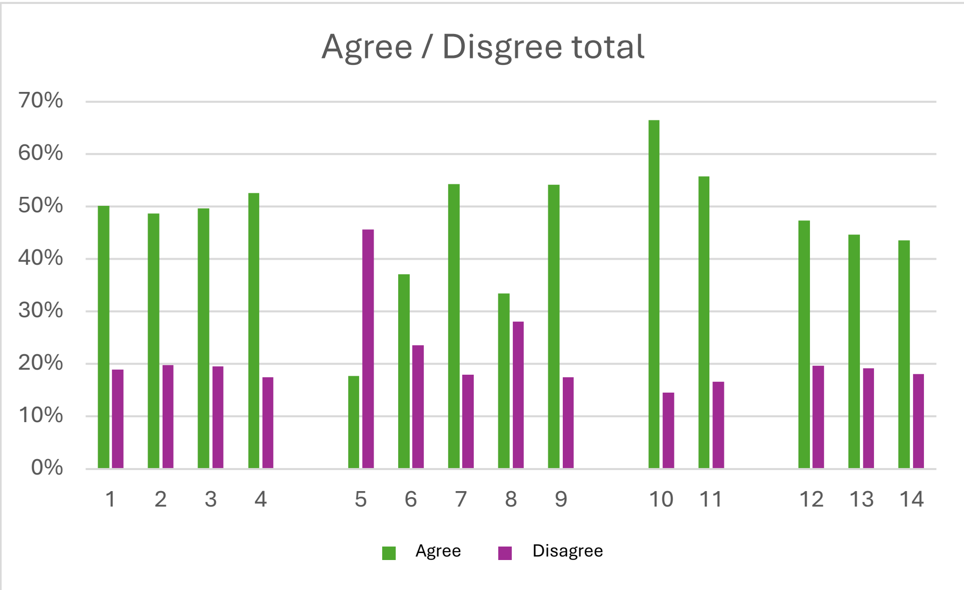



*Figure 22: Drivers agree vs disagree overview (author)*

The results highlight which factors most often encourage willingness to connect and serve as a foundation for engagement strategies.
Figure 22 presents the ranked overview of all drivers, based on the number of respondents who agreed or disagreed with each statement.
The data show that the majority of drivers received substantially more agreement than disagreement, highlighting broad recognition of these motivators across the respondent base. Lower energy bills (driver 10) stands out as the most widely agreed-upon motivator, with nearly 65% agreement and very low disagreement, emphasizing the central role of financial incentives in influencing willingness to connect. Other highly rated drivers include increased level of comfort at home (driver 9), accessible and understandable information (driver 2), and transparency about the process (driver 3), all with agreement levels above 50% and relatively low disagreement. This reflects the importance of clear communication and tangible benefits in building user confidence.

Additionally, social norm campaigns (driver 5) show the highest level of disagreement and the lowest agreement (just under 20%), indicating that peer pressure or fear of being left behind is not an effective motivator for most participants. Similarly, positive word-of-mouth (driver 6) and contributing to sustainability goals (driver 8) received relatively mixed responses, with agreement and disagreement bars more balanced, suggesting these are less persuasive on their own.

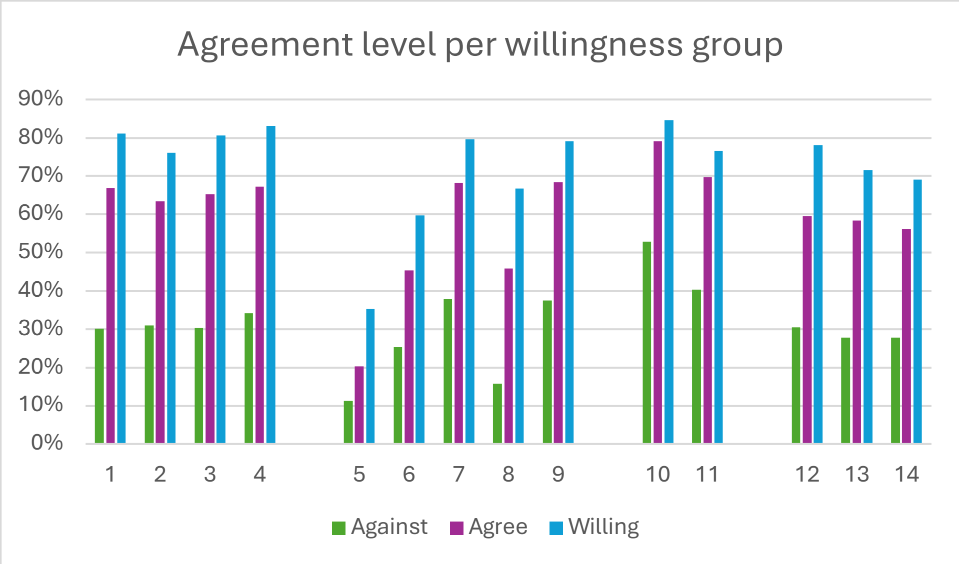


*Figure 23: Drivers total overview per willingness group (author)*

Figure 23 presents the level of agreement with each of the 14 drivers by willingness group. The chart clearly illustrates a consistent gradient across all drivers, with the Willing group showing the highest agreement rates, followed by the Neutral group, and the Against group displaying the lowest levels of agreement throughout.

The willing group reports agreement rates above 70–80% for most drivers, particularly for Informational & Organizational and Finanancial & Economical motivators such as clear overview of benefits (driver 1), availability of user-friendly support (driver 4), increased comfort (driver 9), and lower energy bills (driver 10). This group also shows relatively high response of more Behavioral & Social drivers such as trust in the leading party (driver 7) and contributing to sustainability goals (driver 8).

The neutral group consistently falls in the middle, typically rshowing agreement rates between 45–70%. For many drivers, especially those in the category Informational & Organizational (drivers 1–4) and Financial & Economical (drivers 10–11), their agreement approaches or even slightly exceeds that of the Willing group in relative numbers, suggesting that these factors play a key role in shifting neutral respondents toward willingness.

The against group is marked by low agreement across nearly all drivers, with most bars below 40% and some, such as social norm campaigns (driver 5) and contributing to sustainability (driver 8), falling even below 20%. Notably, the only driver that gained more than 50% agreement from this group is lower energy bills (driver 10), emphasizing that financial savings are the only broadly agreed to driver among the opposed group

So greater willingness correlates with broader and stronger agreement on drivers, especially in relation to informational clarity, financial benefits, and perceived trustworthiness. The neutral group emerges as particularly responsive to these practical drivers.
Figure 24, 25 and 26 display the distribution of agreement and disagreement levels for all 14 drivers, separated by willingness group. Each subplot presents a direct

comparison between the percentage of respondents within the group who agreed or strongly agreed versus those who disagreed or strongly disagreed with each motivator.

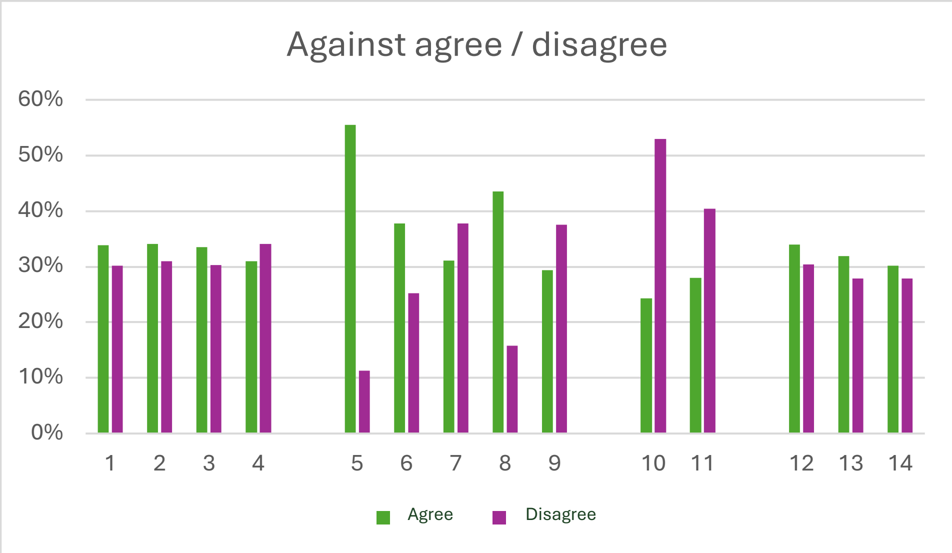



*Figure 24: Drivers agreement level against group (author)*

In the against group, disagreement dominates across most drivers. Particularly notable is the response to social norm campaigns (driver 5), where disagreement reaches its peak at over 50%, and agreement is under 15%. Similarly, low agreement and relatively high disagreement are seen for sustainability goals (driver 8), trust in the leading party (driver 7), and word-of-mouth recommendations (driver 6), suggesting that social and behavioral motivators are not persuasive for this group. The only driver with higher agreement than disagreement is lower energy bills (driver 10), indicating that cost savings is the only widely accepted incentive among this group.

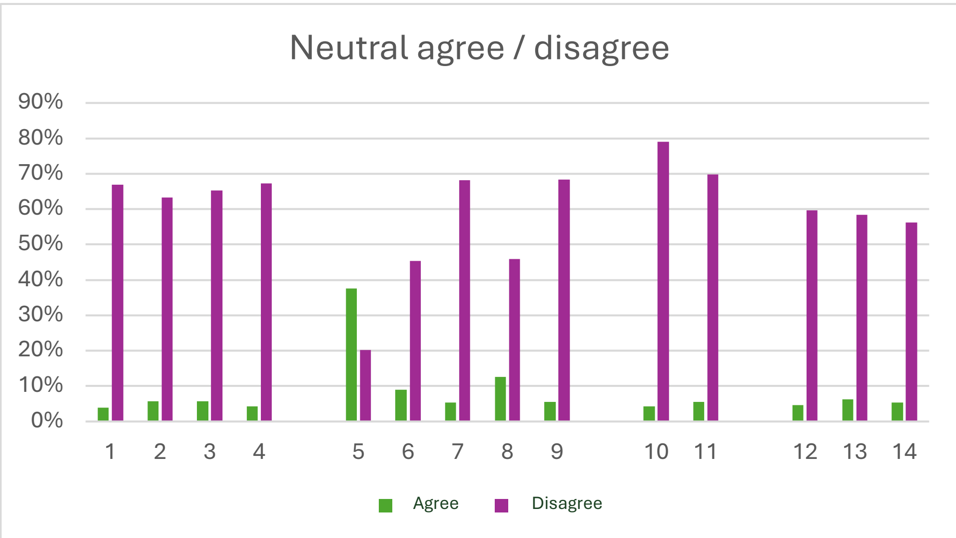



*Figure 25: Drivers agreement level neutral group (author)*

In contrast, the neutral group shows a clear reversal: agreement dominates for all drivers. For most items, agreement rates exceed 60–70%, while disagreement remains below 10%. This pattern demonstrates that neutral respondents are open to nearly all motivators, especially Financial & Economical ones (driver 10 and 11), Informational &

Organizational (drivers 1–4), and Technical (drivers 13–14). Notably, also drivers like trust and comfort are supported by a majority in this group, which shows that they are highly persuadable with the right messaging and support.

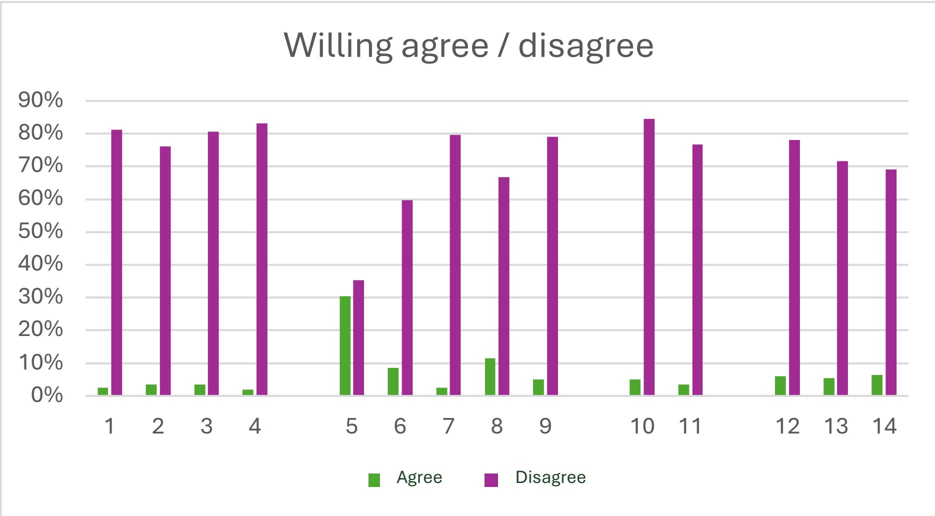


*Figure 26: Drivers agreement level willing group (author)*

Among the willing group, the same overall pattern arises, although with slightly lower levels of disagreement compared to the neutral group. Agreement is strong across all drivers, especially for *lower energy bills*, *clear process information*, and *availability of support*. Interestingly, *social norm campaigns* (driver 5) still show substantial disagreement (nearly 50%), even among the willing, suggesting that peer pressure is not an effective motivator even for those already supportive.

Together, these figures reinforce the earlier findings: willingness correlates strongly with higher agreement on most drivers, particularly those related to clarity, support, trust, comfort, and cost. Meanwhile, disagreement is concentrated among the against group and centers on social, ideological, and trust-based drivers, with cost savings as the sole broadly accepted driver. This shows the importance of tailoring engagement strategies by audience, neutral respondents are open to many forms of persuasion, while against individuals are largely resistant, except when financial benefits are clear.
Table 21, on the next page, shows an overview off all the drivers and highlighted are the ones that appear to be mostly agreed upon. The * means this driver was already marked by case study outcomes.

*Table 21: Drivers per willingness group overview in numbers (author)*

| Category | Drivers | Against | Neutral | Willing |
|---|---|---|---|---|
| Informational & Organizational | 1.Clear overview of the benefits for their household | 30% | 67% | 81% |
| | 2.Accessible and understandable information about the system* | 31% | 63% | 76% |
| | 3.Transparency about project timeline and connection process | 30% | 65% | 81% |
| | 4.Availability of user-friendly support before, during and after connection* | 34% | 67% | 83% |
| | *Total times mentioned category* | *920* | *1340* | *645* |
| Behavioral & Social | 5.Social norm campaigns, people don't want to be left behind from their peers | 11% | 20% | 35% |
| | 6.Positive word-of-mouth recommendations from friends/family/neighbors | 25% | 45% | 60% |
| | 7.Trust in leading party* | 38% | 68% | 80% |
| | 8.The feeling of contributing to sustainability goals | 16% | 46% | 67% |
| | 9. Increased level of comfort in my house | 38% | 68% | 79% |
| | *Total times mentioned category* | *936* | *1265* | *644* |
| Economic & Financial | 10.Lower energy bills* | 53% | 79% | 85% |
| | 11.Increased property value | 40% | 70% | 77% |
| | *Total times mentioned category* | *684* | *759* | *324* |
| Legal & Technical | 12.Energy independence (less reliance on fossil fuels) | 30% | 60% | 78% |
| | 13.Compatibility of heat network with existing (heating) systems | 28% | 58% | 72% |
| | 14.Flexibility to combine heat network connection with other measures (energy efficiency measures like insulation or window replacement / aesthetic measures like new kitchen or bathroom) | 28% | 55% | 69% |
| | *Total times mentioned category* | *631* | *889* | *440* |

### 6.6.1.3 Support

In addition to understanding which barriers hold people back, it is equally important to explore what support measures can help people overcome the experienced barriers. The survey asked respondents to indicate which forms of support they would find most helpful at each project phase. The results were grouped into the same four support categories as the Barriers.

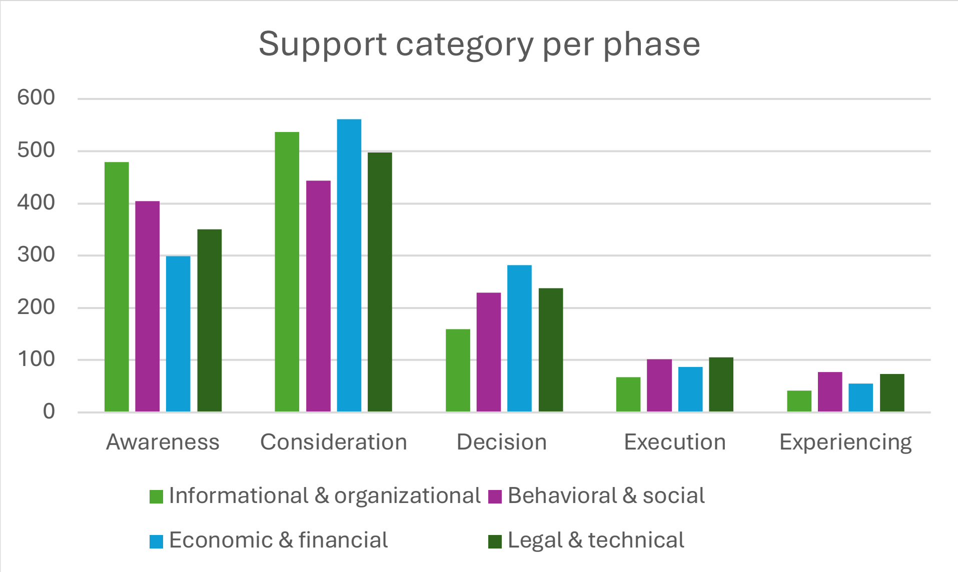



*Figure 27: Support categories per phase (author)*

As shown in Figure 27, support needs are highest in the Awareness and Consideration phases, reflecting that early-stage guidance is crucial for end-user engagement. In the Awareness phase, Informational & Organizational support is most frequently mentioned (nearly 500 mentions), followed by Behavioral & Social and Legal & Technical support. This indicates that respondents need accessible, clear information and early trust-building efforts to become open to the idea of a heat grid.

In the Consideration phase, all four support categories peak, with Economic & Financial support ranking highest (over 550 mentions), followed closely by Informational & Organizational. This shows that during evaluation, users demand clarity about potential costs, savings, and technical feasibility, as well as financial incentives and personalized guidance.

Support needs decline in the Decision phase, but Economic & Financial and Legal & Technical supports remain prominent. These include requests for contractual transparency, guarantees, and cost certainty, underlining the importance of risk mitigation and security at the point of commitment.

In the Execution and Experiencing phases, support needs are lower overall, yet still present. Respondents highlight the need for continued Informational, technical and social support during and after implementation, such as user assistance, reliable service, and peer encouragement, to ensure long-term acceptance and satisfaction.

Overall, the data demonstrate that different types of support are needed at different stages, with the early phases requiring the most intensive support and engagement.

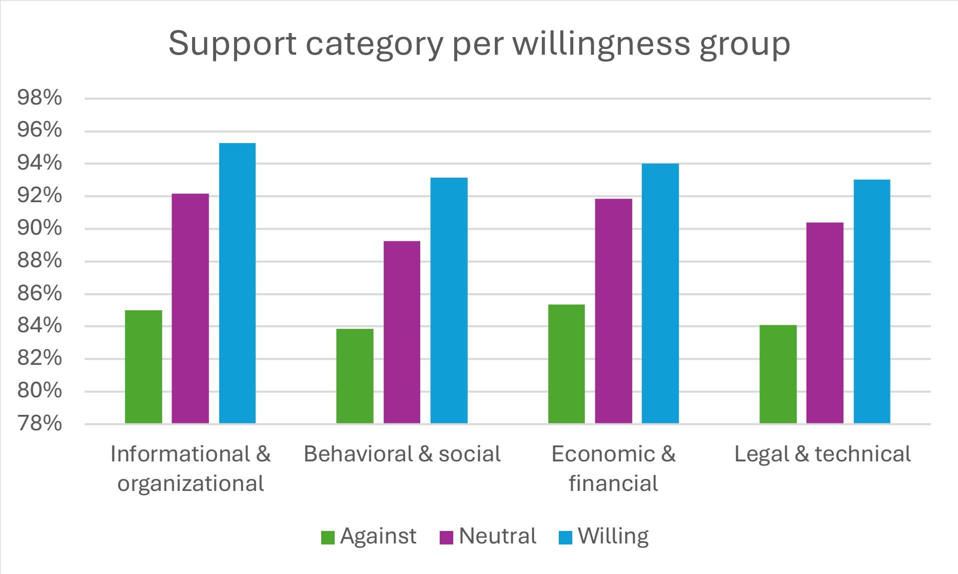



*Figure 28: Support categories per willingness group (author)*

Figure 28 illustrates the percentage of respondents in each willingness group who indicated a need for support across four categories. The data show a clear pattern: Willing respondents report the highest support needs in all categories (93–96%), followed by Neutral respondents (89–92%), and Against respondents (83–85%). This suggests that those most open to connection are also most aware of the support they need to move forward, especially in the categories of Informational & Organizational and Economic & Financial support. Meanwhile, the Against group, while still acknowledging support needs, shows lower levels across all categories, reflecting a more disengaged stance or lower perceived value of support.

These findings emphasize the importance of targeted support delivery, especially for the Neutral group, whose needs are substantial and who may still be persuaded with the right interventions.

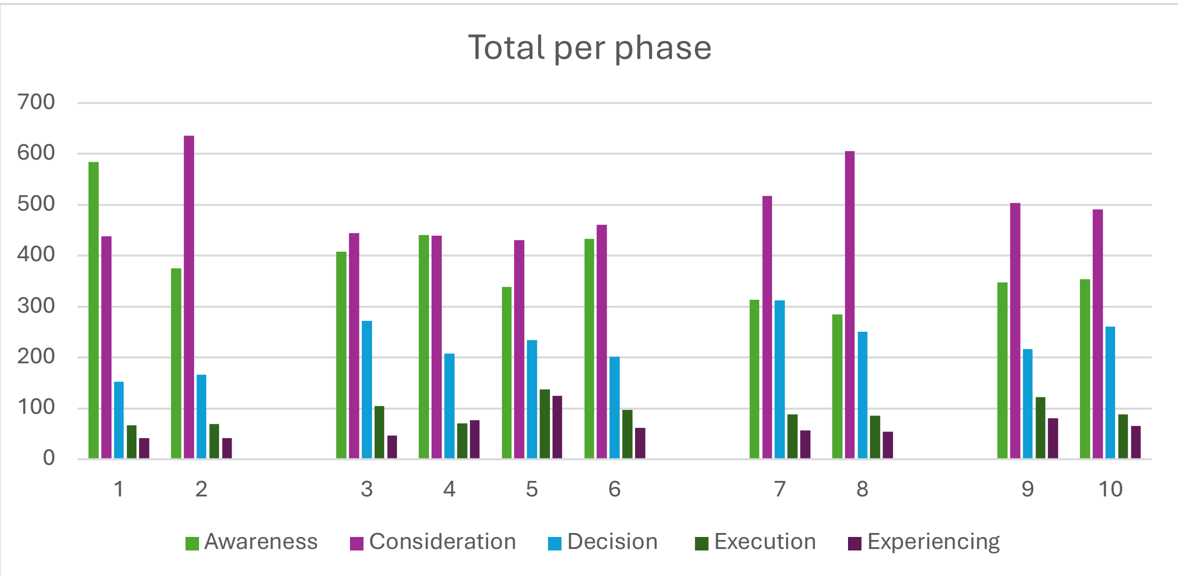



*Figure 29: Support per phase overview (author)*

Figure 29 shows which specific types of support were mentioned most frequently per phase. The data confirm that support needs peak in the Consideration phase, where items like more financial incentives (item 8), usage price clarity (item 7), and more insights about the actual investment (item 2) are mentioned most often.
In the Awareness phase, respondents emphasize clear initial information and education about benefits (item 1) and trust-building (item 3), highlighting the need for accessible, early-stage communication. During Decision, support around financial options and contractual clarity remains key. Support needs drop but still exist in Execution and Experiencing, especially for customer support (item 5) and participation opportunities (item 6).

Overall, the data suggest that support should be phase- tailored, with a strong focus on financial, informational, and relational elements in early to middle stages.

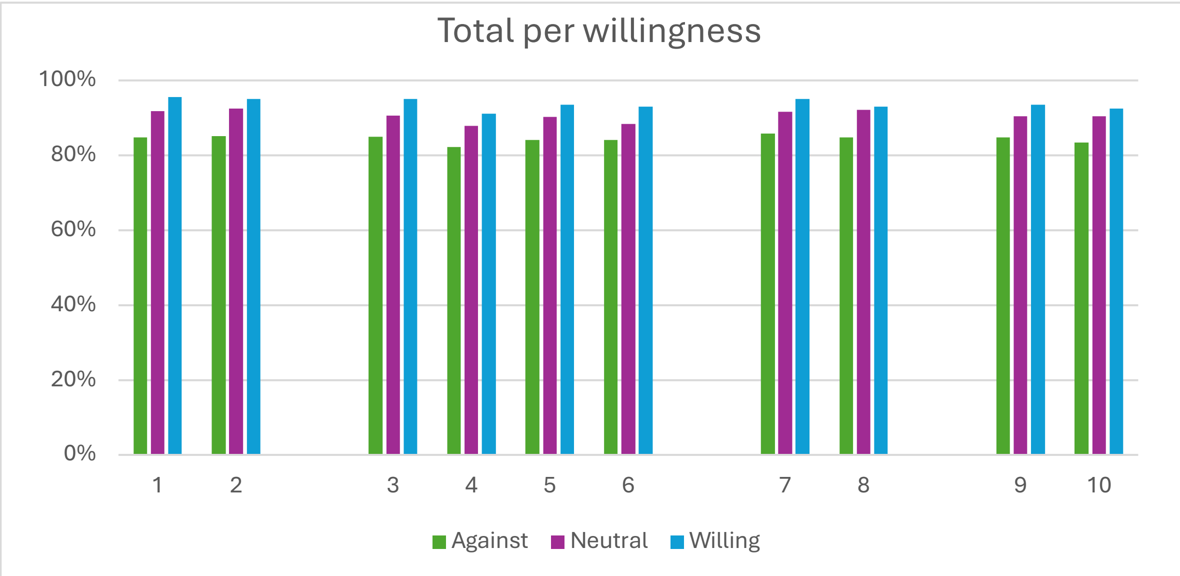


*Figure 30: Total support per willingness group (author)*

Figure 30 shows, as seen before, that all three willingness groups express high support needs across all ten items, with percentages generally above 80%. The Willing group consistently reports the highest support needs, particularly for clear information (item 1), financial incentives (item 8), and trust in the leading party (item 3).
The Neutral group also shows strong demand for support, especially around price stability (item 7), system insights (item 2), and participation opportunities (item 6), indicating a high potential for engagement if these needs are met.
The Against group reports slightly lower values across the board but still identifies clear information, price stability, and support as relevant. This suggests that even skeptical users recognize the value of strong and transparent support systems.

In summary, support needs are universally high, especially among those already willing or undecided. Tailoring support to these demands could potentially increase the willingness rates among those groups.

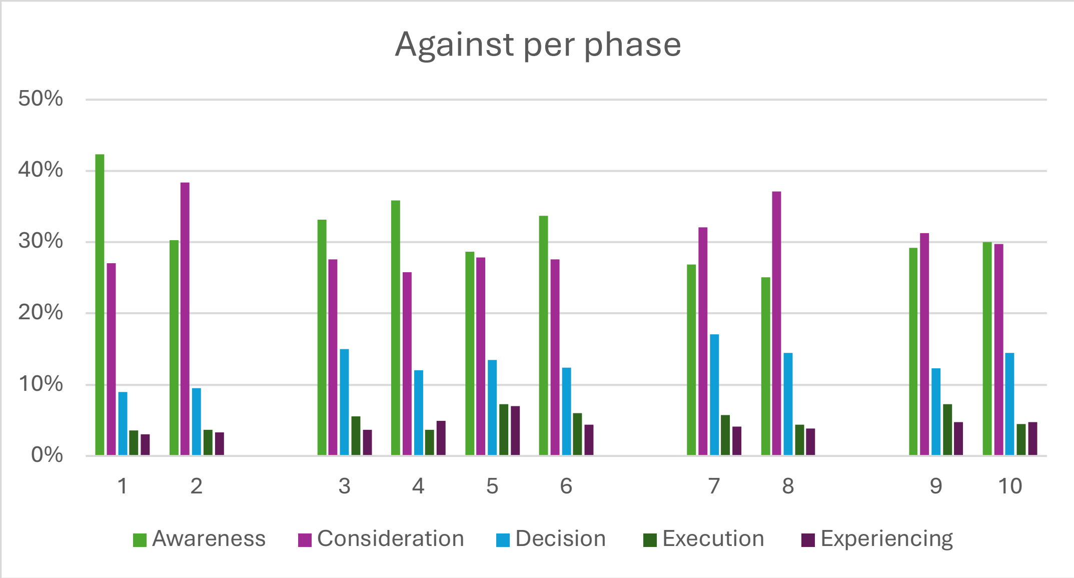


*Figure 31: Support per phase Against group (author)*

Figure 31 shows that Against respondents express the strongest need for support during the Awareness and Consideration phases. Key priorities include clear information (item 1), trust in the leading party (item 3), and financial incentives (item 8), with over 30–40% indicating a need for support in these areas early on.
In the Decision phase, support needs decline but remain notable for price stability and legal clarity. Support needs in later phases (Execution and Experiencing) is minimal.

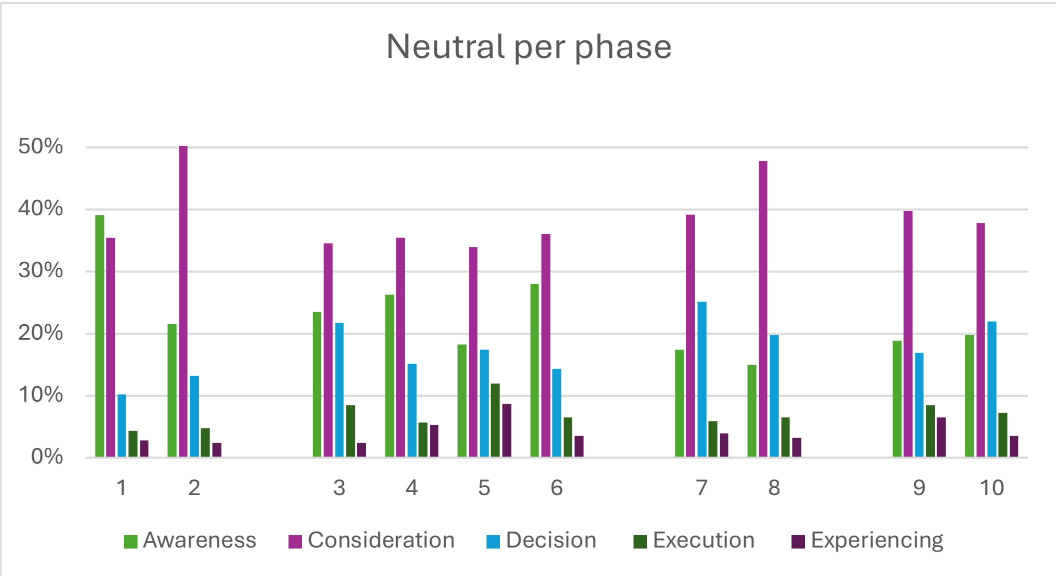


*Figure 32: Support per phase Neutral group (author)*

Figure 32 reveals that Neutral respondents most frequently request support in the Consideration phase, with several support types peaking above 30–40%. Key needs include more insights about the system's benefits (item 2), financial incentives (item 8), and usage price clarity (item 7), reflecting a desire for deeper understanding and cost certainty during evaluation.
Support in the Awareness phase is also substantial, especially for clear information (item 1) and trust-building (item 3). Needs decline again in later phases but remain notable in Decision, particularly for legal clarity and participation options. This suggests

that well-timed, detailed support during consideration is critical for moving this group toward a decision.

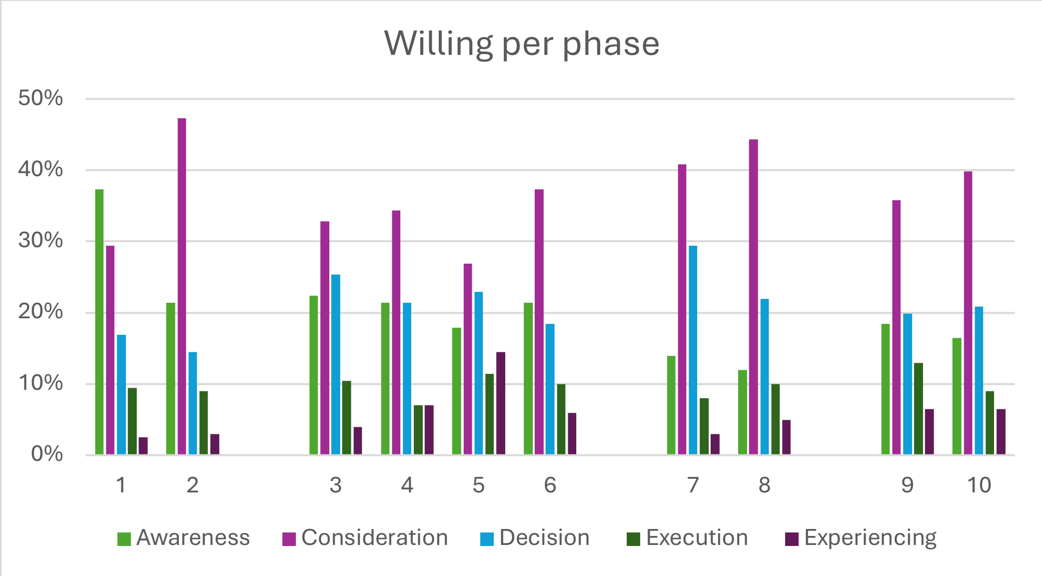



*Figure 33: Support per phase Willing group (author)*

Figure 33 shows that also the Willing respondents identify substantial support needs, particularly in the Consideration phase, where items like financial incentives (item 8), more insights into benefits (item 2), and participation opportunities (item 6) peak around 35–45%. Support in the Awareness and Decision phases is present again, mainly about clear information (item 1), trust in the leading party (item 3), and price stability (item 7). Although this group is already positive, the data suggest that continued financial clarity, transparency, and involvement options are key to remain the willingness and convert it into action.

The overall top 3 support measures per phase are shown in figure 34 below.

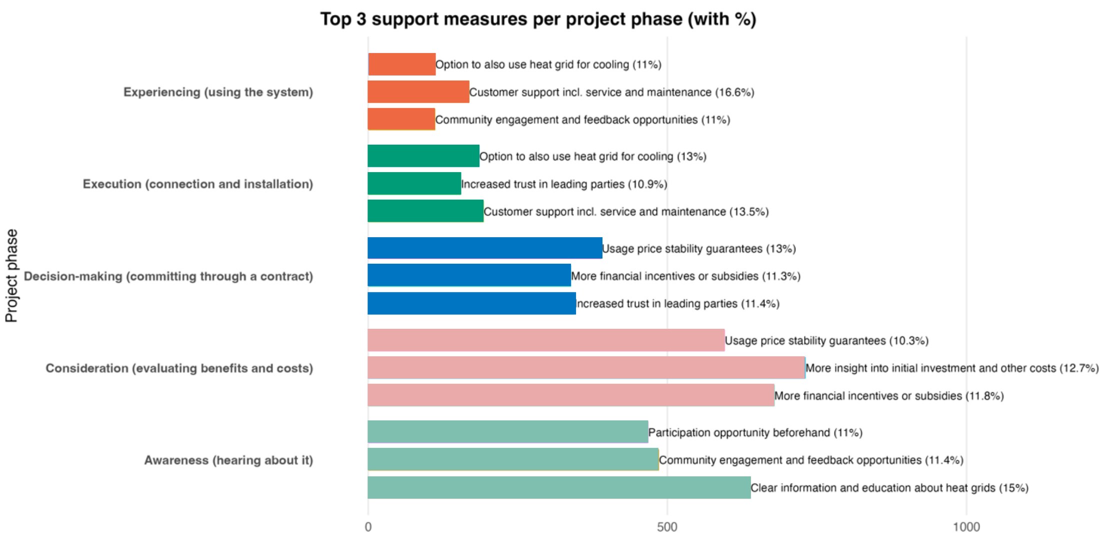



*Figure 34: Top 3 support measures per phase (author)*

*Table 22: Overview support measures (author)*

| Support measures | A | B | C | D | E |
|---|---|---|---|---|---|
| 1.Clear information and education about the benefits and operation of heat grid | X | X | | | |
| 2.More insights about the actual initial investment and other cost | | X | | | |
| 3. Increased trust in leading parties | X | | X | X | |
| 4. Community engagement with feedback opportunities | X | | | | X |
| 5. Customer support incl. service and maintenance | | | | X | X |
| 6. Participation opportunity about the connection process beforehand | | X | | | |
| 7. Usage price stability guarantees | | X | X | | |
| 8. More financial incentives or subsidies | | X | X | X | |
| 9.Option to use heat network for cooling | | | | | X |
| 10.Additional legislation that makes a heat grid connection more attractive | | X | X | X | |

### 6.6.2 Approach & process

This section dives into the interaction between the approach variables across different respondent groups and the levels of willingness to connect to a heat grid. The goal is to discover whether there is a mismatch between how people have been approached and how they prefer to be approached. Then this can help defining personas and strategies.

#### 6.6.2.1 Approached group

Among the total sample (N=1754), only 9.4% had ever been personally approached with information. Yet this group reported different patterns compared to those who had not been approached

***Method***

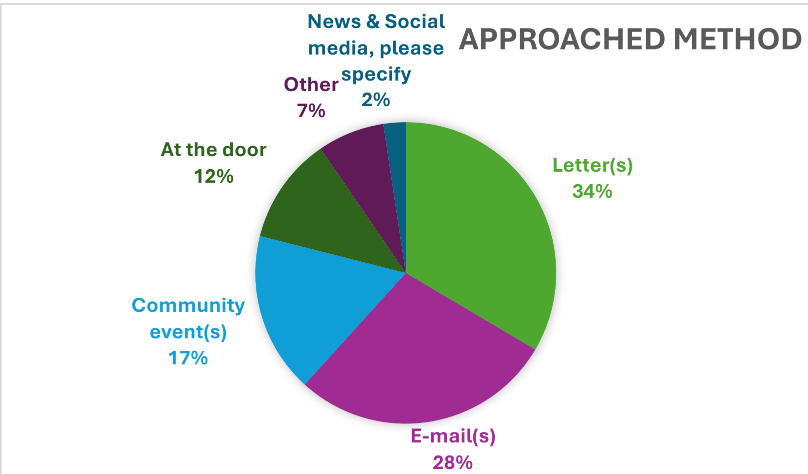



*Figure 35: Approached group method (author)*

Figure 35 shows how respondents who were approached for connection experienced different communication methods. The most common method was letter(s), used for 34% of the contacted individuals, followed closely by email(s) at 28%. These two formal and individualized methods together account for over 60% of all approaches, suggesting a strong reliance on direct written communication.

Community events were the third most common method (17%), followed by door-to-door contact at 12%, reflecting some level of in-person engagement. Less common were “Other” methods (7%) and news/social media (2%), indicating limited use of broad or informal outreach strategies.
Overall, the data suggest that municipalities and project initiators primarily use direct, written, and one-directional communication methods, with relatively less emphasis on interactive or community-based engagement. This may influence how well end-users feel informed and involved, a topic explored further in subsequent sections.

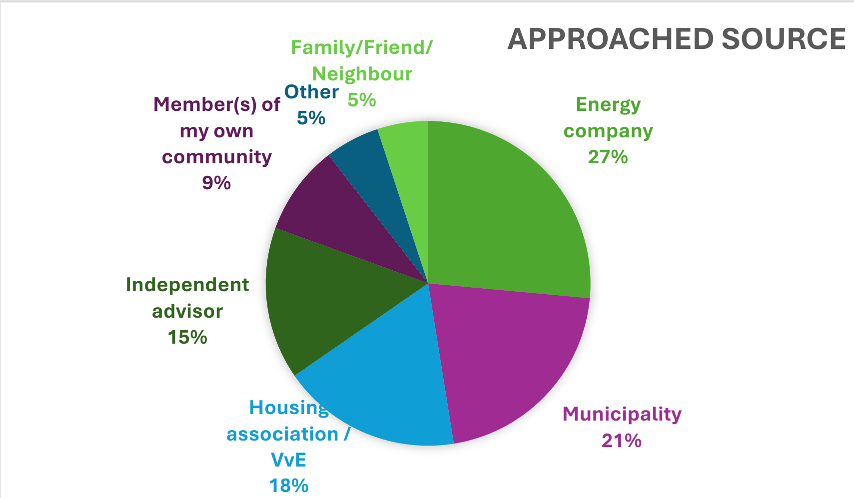



*Figure 36: Approached group source (author)*

Figure 36 shows the sources through which respondents were approached about connecting to a heat grid. The most frequently mentioned source was the energy company (27%), followed by the municipality (21%) and housing association or VvE (18%). Together, these institutional actors account for over 65% of all outreach, highlighting a strong reliance on formal, top-down sources.
Independent advisors were responsible for 15% of the approaches, indicating a moderate role for neutral or expert intermediaries. Less frequently mentioned were community members (9%), family, friends, or neighbors (5%), and other sources (5%).
Overall, the data suggest that while formal organizations dominate outreach efforts, peer-based or informal communication channels remain underutilized. This may affect the perceived trustworthiness or relatability of the message, especially for more hesitant or community-oriented end-users.

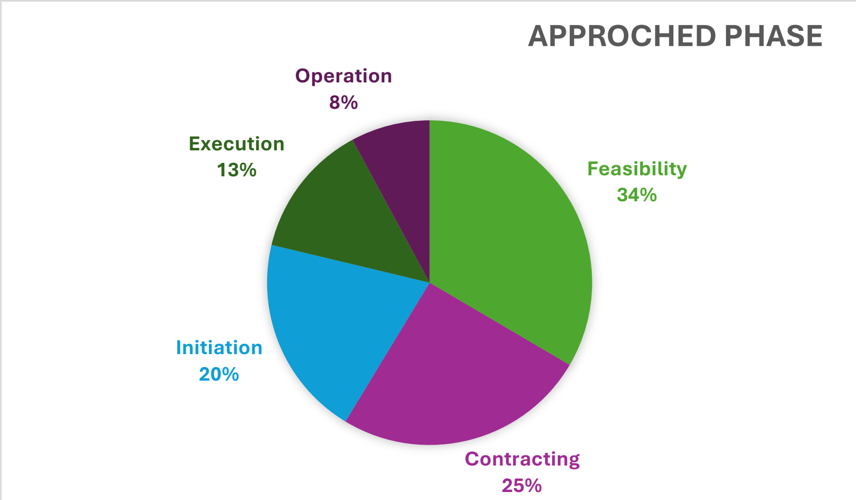



*Figure 37: Approached group phase (author)*

Figure 37 illustrates at which project phase respondents were approached regarding heat grid connection. The majority were contacted during the Feasibility phase (34%), followed by the Contracting phase (25%) and Initiation (20%). This suggests that outreach often occurs once projects are already technically and financially explored, but before actual implementation.
Only 13% were approached during Execution, and a mere 8% during Operation. While early- to mid-phase outreach dominates, the relatively low percentage in the Initiation phase suggests that some opportunities for early engagement and co-creation may be missed. This timing can influence how much influence residents feel they have and how informed they are throughout the process.

### *Experience*

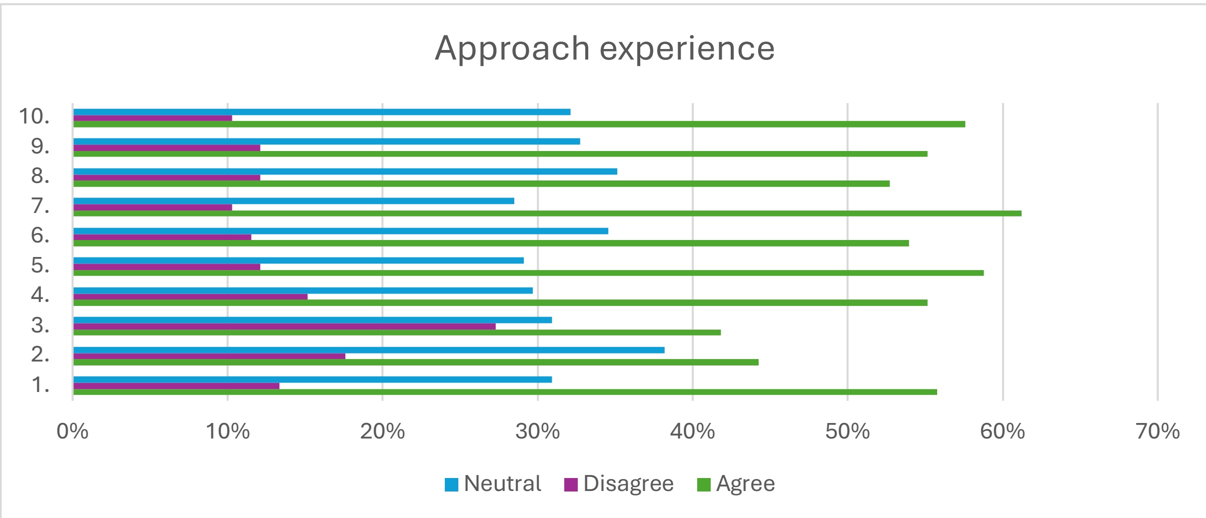



*Figure 38: Approach experience (author)*

*Statements:*
*1. The information provided was clear and understandable*
*2. There was an information overload*
*3. There was a lack of information about the potential benefits and drawbacks of connection to a heat grid*
*4. The steps required for connecting to the heat grid were easy to follow*
*5. The information was easily accessible (via website or information point)*

*6. The information was sufficient for making a decision or not*
*7. My questions and concerns were heard and addressed*
*8. The communication about costs was transparent*
*9. I was kept well-informed throughout the whole process*
*10. There was one central communication point / person*

Figure 38 shows how respondents evaluated their experience with the communication approach during the connection process, across ten key statements. While most statements received moderate to high levels of agreement, the results reveal clear room for improvement.

The most positively evaluated aspects of the approach were:

- Statement 7 ("My questions and concerns were heard and addressed")
- Statement 5 ("The information was easily accessible")
- Statement 10 ("There was one central communication point/person")

all with over 55% agreement and relatively low levels of disagreement. This suggests that personal responsiveness, clear points of contact, and accessible information were strong points in the communication strategy.

Statements 1 and 9 (clarity of information and being kept well-informed) also received over 50% agreement, but with slightly more neutral or mixed responses.

In contrast, the most critical feedback came from:

- Statement 3 ("There was a lack of information about potential benefits and drawbacks")
- Statement 8 ("The communication about costs was transparent")

which had the highest disagreement levels. This indicates that cost communication and balanced information provision were perceived as weak or insufficient by a significant share of respondents.

Neutral responses were relatively high for Statements 2, 4, and 6, relating to information overload, clarity of steps, and sufficiency of information for decision-making. This may show uncertainty or inconsistency in the experience.

Overall, the results indicate that while structural elements of the communication process were well received (like clarity, central contact), many respondents still felt unheard or underinformed, particularly regarding cost and engagement. This suggests a need for more dialogue-based and transparent communication strategies. Addressing these gaps could strengthen trust and help users move from awareness to commitment with greater confidence.

#### 6.6.2.2 Not approached group

While previous sections focused on respondents who had already been approached regarding connection to a heat grid, this subchapter turns to the group that had not been approached yet. Understanding their expectations and preferences is crucial for designing engagement strategies that resonate with different levels of willingness. The analysis explores which methods of communication are considered most acceptable or desirable by these end-users.

### *Preferred method*

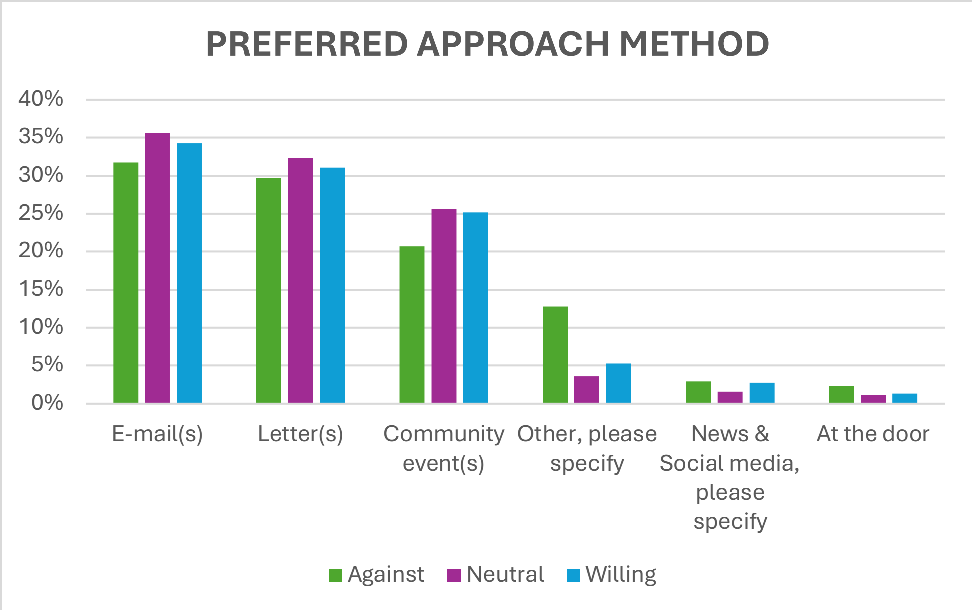



*Figure 39: Preferred approach method per willingness group (author)*

Figure 39 displays the preferred communication methods among respondents who had not been approached per willingness group. Across all groups, emails and letters are the two most preferred methods, with 35% of Neutral respondents selecting email, followed closely by the Willing and Against groups. Letters rank almost equally high, especially among Neutral and Willing respondents, suggesting that formal, direct written communication is generally favored across the board.
Community events are the third most preferred method (22–27%), showing that interactive formats also have appeal, particularly among the Neutral and Willing groups. In contrast, door-to-door contact and social media were the least preferred, with support levels below 5% for all groups.
Interestingly, the 'Other' category, including user-specified options, is noticeably more preferred by the Against group (12%) than the others. This may signal a preference for more tailored or less conventional forms of approach among more skeptical individuals.

In sum, the figure shows that while neutral and willing individuals are receptive to a variety of direct and community-based methods, even the Against group signals openness to some approach methods. This can create an opportunity for project initiators to align their engagement methods with end-user preferences early in the process.

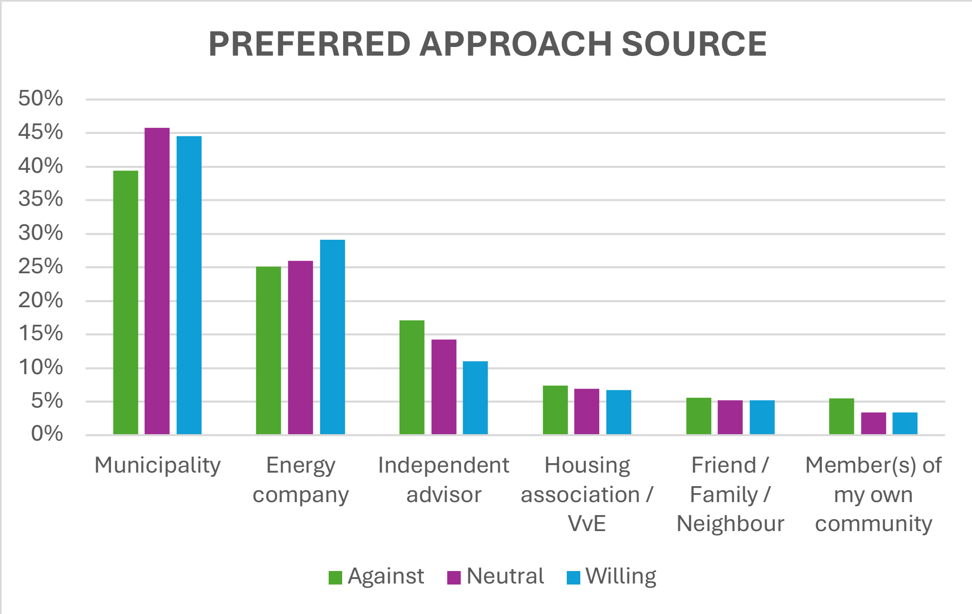



*Figure 40: Preferred approach source (author)*

Figure 40 shows which sources the not approached respondents would prefer to hear from regarding heat grid connection. The municipality is the most preferred source across all groups, with approximately 45% of Neutral and Willing respondents, and about 38% of the Against group selecting it. This suggests that local governments are widely viewed as legitimate and trustworthy communicators, particularly for undecided and receptive individuals.

The energy company follows as the second most preferred source, selected by just under 30% of Willing respondents and around 25% of the Against and neutral group. This indicates moderate but consistent trust in utility providers across the spectrum.

Independent advisors rank third overall, with roughly 10–18% preference across all groups. Interestingly, the Against group shows slightly more preference for independent advisors than the Willing group, perhaps reflecting a desire for non-commercial, neutral information among more hesitant respondents.

Other sources such as housing associations, friends/family/neighbours, and community members are much less preferred across all groups (all below 10%), suggesting that peer-based or informal communication holds little appeal, even for those willing to connect.

Interestingly, the Against group shows slightly higher interest for approach via a member of their own community.

In short, the data reveal a clear preference for being approached by professional, institutional actors, especially the municipality. This highlights the importance of visible and credible leadership from public authorities when initiating conversations about heat grid participation

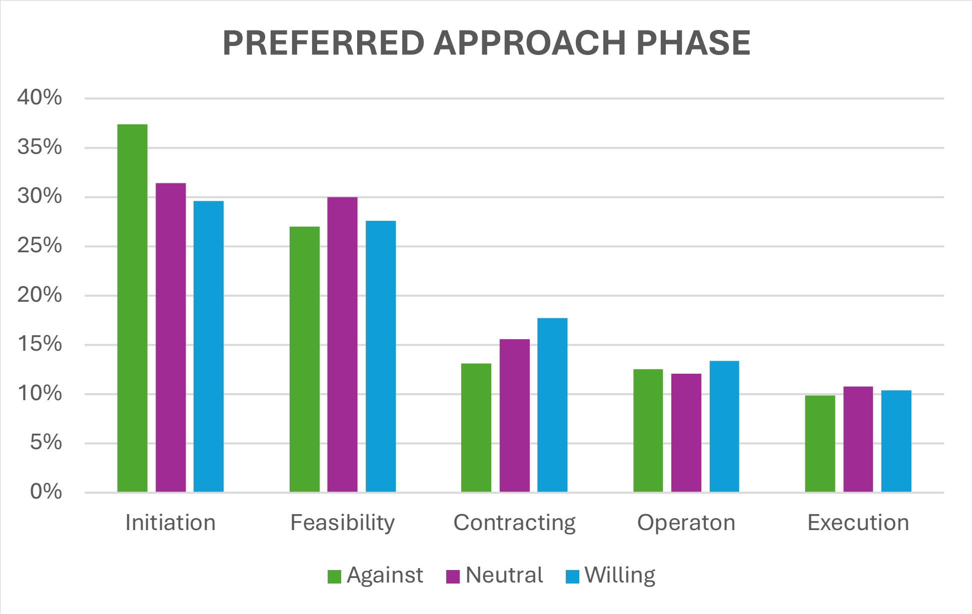


*Figure 41: Preferred approach phase (author)*

Figure 41 shows in which project phase respondents would prefer to be approached about connecting to a heat grid. Across all willingness groups, the Initiation phase is most preferred, especially by the Against group (37%), followed by Neutral (32%) and Willing (30%). This highlights a strong desire for early involvement, even among those currently not in favor of connection.

The Feasibility phase is the second most chosen moment, particularly among Neutral respondents (30%), indicating that many want to be informed once the idea is being explored but before decisions are made.

Preferences drop significantly in later stages. Contracting is only selected by about 12–18% of respondents, and Execution and Operation are the least preferred across all groups, with percentages around or below 12%.

These results confirm that most respondents, regardless of willingness, want to be approached before key decisions are finalized. Early-phase communication allows for more transparency, influence, and trust-building, essential elements in securing public support according to the literature review.

### *Preferred experience and information*

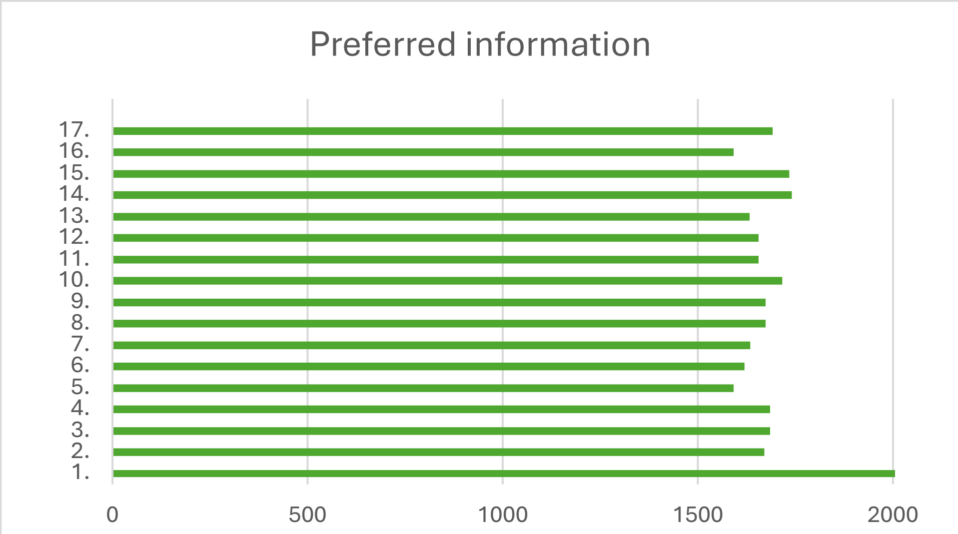



*Figure 42: Preferred information not approached group (author)*

*Information:*
*1. The initial investment and connection fees*
*2. Explanations about potential benefits*
*3. Explanations about potential disadvantages*
*4. Estimation of potential cost savings on my energy bill*
*5. Information about the impact on my property value*
*6. Information about funding opportunities like loans and subsidies*
*7. Information about which party will lead the project*
*8. Indication about the project duration and timeline*
*9. The works that need to be done in the area prior to the connection*
*10. The work and efforts needed to prepare my house for the connection*
*11. Information about potential nuisance during installation*
*12. Information about technical working of heat grid*
*13. The heat source that will be used*
*14. Information about heat usage cost*
*15. Information about maintenance and support after connection*
*16. Information about why a heat transition would be needed in the first place*
*17. Personalized cost-benefit analysis*

Figure 42 presents the types of information that respondents who had not yet been approached would like to receive before deciding on a heat grid connection.
The most requested item is “The initial investment and connection fees” (1), receiving the highest count overall. This reflects the strong need for upfront cost transparency.
Closely following are:

- Personalized cost-benefit analysis (17),
- Information about maintenance and support after connection (15),
- Information about heat usage cost (14).

These high rankings highlight that respondents want a clear picture of both short- and long-term financial implications before deciding.

In addition, items like:

- Potential disadvantages (3),
- Funding opportunities (6),

- Work required to prepare the house (10),
  also score high, indicating that respondents are not only interested in benefits, but also in realistic expectations and logistical impact.

Lower ranking, though still well-represented, are more technical topics such as:
- The heat source that will be used (13), and
- Technical working of the heat grid (12).

The data show that unapproached individuals want to be well-informed with concrete, personalized, and practical information, especially about costs, required actions, and long-term implications, before engaging further with a heat transition project.

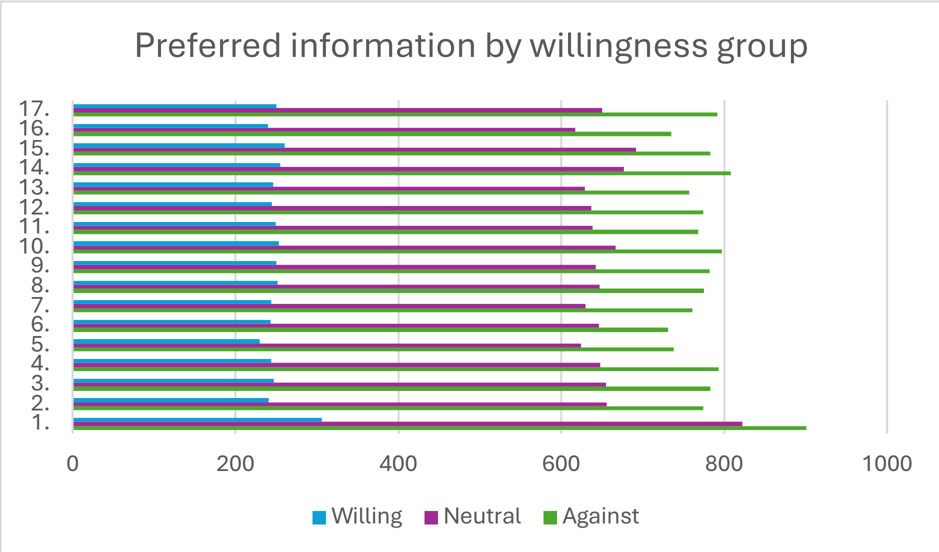



*Figure 43: Preferred information by willingness group (author)*

Figure 43 shows the types of information that not yet approached respondents consider most important by willingness groups. The charts reveal notable differences in, especially intensity and to some extend content preferences between the three groups.

*Against group*

The Against group shows the highest overall information demand. The top priority is clearly:
- The initial investment and connection fees, with the longest bar overall (1)

This is followed closely by:
- Information about heat usage cost (14),
- Personalized cost-benefit analysis (17), and
- Information about maintenance and support after connection (15)

This group also places considerable value on:
- Potential disadvantages (3),
- Effort needed to prepare the house (10), and
- Nuisance during installation (11)

This pattern highlights a strong focus on financial risk, disruption, and personal behavior burden. The broad spread of high scores indicates that these respondents want detailed, concrete, and critical information before reconsidering their position.

*Neutral group*
The Neutral group shows slightly lower overall scores, but with a similar ranking. Their top three are:
- Initial investment and connection fees (1),
- Maintenance and post-connection support (15), and
- Heat usage cost (14)

Also ranked highly are:
- Personalized cost-benefit analysis (17),
- Why a heat transition is needed (16), and
- Information about funding opportunities (6)

Compared to the Against group, Neutrals place slightly more emphasis on contextual and solution-oriented information, suggesting they are open to persuasion if their uncertainties are addressed with clear and future-focused messaging.

*Willing group*
The Willing group shows much lower information demand across all items, with the bars being considerably shorter. Still, their top priorities match the others:
- Initial investment (1),
- Usage cost (14), and
- Maintenance and support (15)

This suggests that although these respondents are already positively inclined, they still expect financial clarity and reliability in service delivery.

All groups prioritize financial transparency, but the Against group demands the broadest and most critical set of information, while Neutrals focus on reassurance and broader context. Willing respondents are less information-sensitive but still require confirmation on practical and financial aspects. Tailored communication strategies should reflect these differences in both tone and content.

# 7.
# DISCUSSION AND VALIDATION

This chapter synthesizes the research findings and validates them against the literature and case insights, discussing how household, building, and behavioral characteristics relate to willingness to connect. It then examines the key barriers, support needs, and drivers identified through the survey and interviews, linking these empirical results to earlier literature. The role of communication approaches in shaping end-user experiences is analyzed, followed by a critical reflection on the research methodology and its limitations.

## 7.1 HOUSEHOLD, BUILDING AND BEHAVIORAL CHARACTERISTICS INFLUENCING WILLINGNESS TO CONNECT

**Household characteristics**

The survey results reveal clear demographic patterns in willingness to connect. **Age** is a significant indicator. Older homeowners (55+ years) show substantially more reluctance to connect, comprising the largest share of the "against" group (68,9% of against respondents). In contrast, younger adults are underrepresented in the sample but slightly more open to sustainable innovations, respondents under 35 made up only 7,4% of the sample yet 7,5% of the willing group.

**Household composition** also plays a role. Couples without children, who formed 41,4% of the sample, are disproportionately present among those willing to connect (50,8%). This suggests that two-adult households (often with dual incomes or fewer family constraints) may face fewer barriers in decision-making and finances, making them more open to heat grid adoption. By contrast, single-parent households, who form a small portion of respondents (4%), are overrepresented in the against group (8,5%). This likely reflects the greater financial vulnerability and time constraints of single parents, which hinder engagement with new heating solutions. **Education** and employment status further differentiate willingness. The sample was relatively highly educated (62,4% with higher education), and interestingly this group was more critical: 72,7% of higher-educated respondents fall in the against group. This may indicate that more educated homeowners apply a critical or lens to new technologies and institutional promises, aligning with literature that suggests knowledge can increase skepticism and criticism. Those with mid-level education were somewhat more prominent in the willing group (40,8% of willing respondents), perhaps this reflects a more pragmatic focus on concrete benefits and incentives. In terms of **employment,** retired individuals (26,1% of the sample) showed a greater chance to be against. Retirees may have more time to consider such projects and possibly more stake in home comfort, despite fixed incomes. However, they are often happy with their current heating system and don't see the need to change. Meanwhile, full-time employed people are strongly represented among those against connecting (48,3% of the against group). Those working full-time might have less time or energy to engage with complex transition plans and may default to the status quo, or they could be mid-career homeowners wary of disruptions to their routines. Financial situation is a crucial underlying factor. Although most respondents are not in immediate financial distress, many lack a large financial buffer for a major investment like a heat grid connection. About 45% have less than 30% of their income freely disposable each month, and this group is disproportionately found in the against camp (they make up 50,7% of against respondents). Clearly, households with tighter finances are more reluctant, upfront cost and affordability fears weigh on their willingness. Conversely, those indicating a high level of financial flexibility (over 60% free disposable income) are relatively few (13,5% overall) but appear more often neutral or willing to connect. Notably, a significant minority of respondents preferred not to disclose their income or savings; intriguingly, this group constitutes a higher share of the willing segment (13% of willing respondents preferred not to share their income). This research speculates this could point to hidden wealth or a mindset prioritizing sustainability over financial disclosure. In any case, **financial capacity** correlates with willingness: those with less economic freedom and means show greater resistance, underlining affordability as a key concern.

Furthermore, the interviews and case studies revealed personal problems as another factor that influences one's willingness to connect. This ranges from having a disease or psychological problems to financial problems. These people don't have the headspace to deal with change and are mainly focused on "surviving".

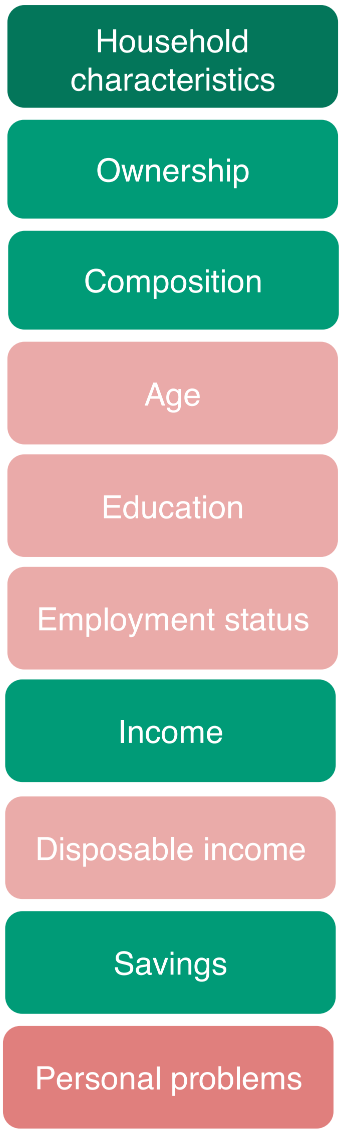



*Figure 44: Validated household characteristics willingness to connect (author)*

**Building characteristics**

The physical and tenure attributes of homes also influence willingness to connect. Many respondents live in homes built between 1971 and 2000 (nearly half the sample) meaning a large share reside in mid- to late-20th-century housing that may not be very energy-efficient by today's standards. Willingness is relatively higher among those in newer, better-insulated houses: owners of homes built from 2011 onward are more common in the willing group (up to 8,2%) than in the against group. People in older homes (pre-1945) or those from the 1945–1970 era tend to be more against connecting. Older houses may pose technical or financial hurdles, like the need for internal retrofits or uncertainty about compatibility that deter their owners from connecting to a heat grid. This pattern suggests that **dwelling age** and quality matter. Residents of newer, well-insulated homes feel more "ready" and thus open to connection, whereas those in older homes perceive more challenges or fewer benefits. Residential stability plays a decisive role: homeowners who intend to stay long-term are far more inclined to invest in a heat grid connection.

**Past and future energy renovations** appear to influence willingness in distinct ways. Respondents who carried out EERs recently (2023–2024) are overrepresented in the against group, suggesting that recent investments in alternatives may reduce perceived need for a heat grid. In contrast, those who implemented EERs more than five years ago appear more open to connection, possibly due to outdated measures.

Regarding future plans, respondents without plans for EERs are more often willing, implying that a heat grid connection might be seen as a substitute for individual action. Meanwhile, those currently exploring options or considering action depending on subsidies tend to be more against or neutral, showing how uncertainty hampers engagement. A significant portion of homeowners are in a wait-and-see mode: 23% said they might act depending on new subsidies or regulations, and this stance is most common among the neutral group (30,2% of neutrals).These findings highlight the importance of strategic messaging: linking heat grid connection to either enhancing existing investments or avoiding future costs can help address differing motivations across user groups.

Other building-related factors show more subtle trends. Dwelling size in the sample is typically medium-to-large (most commonly 100–149 $m^2$), and size alone does not vary drastically with willingness. However, owners of the largest homes (150 $m^2$ and above) appear somewhat more often in the willing group, whereas very small dwelling owners (<75 $m^2$) skew slightly toward the against group. Larger homes may have higher heating demands, so owners might see more absolute benefit from a cheaper heat supply or could indicate higher-income owners who can afford the transition. Small-home owners, often with lower consumption, might be less convinced that connecting is worthwhile. Likewise, housing type influences attitudes: while the majority of respondents live in ground-bound houses (terraced, semi-detached, detached), those in apartments showed a somewhat higher willingness ratio than their share of the sample. Apartments constituted 18,7% of all respondents but 21,4% of the willing group. This is notable because connecting an apartment often depends on collective decisions, via a homeowners' association, **VvE** or a housing corporation. It may be that in cases where an entire building's heating is collectively addressed, individual residents feel more confident or see inevitability in the transition, thus expressing willingness. Still, overall VvE membership was associated with more hesitation, only 18,1% of willing respondents were part of a VvE, whereas 25,7% of the total sample were in a VvE. Many VvE members fell into neutral or against camps, reflecting the complexity of coordinating multiple owners and the delays this causes. In summary, homeowners who decision autonomy and those in housing that is technically favorable (newer, larger) have higher willingness rates, whereas those who need collective agreement or who foresee technical hurdles lean resistant. This underlines how the feasibility of connection in physical and organizational terms intersects with personal willingness.


*Figure 45: Validated building characteristics for willingness to connect (author)*

**Behavioral characteristics**

Beyond static traits, the research examined behavioral aspects, like awareness and attitudes, that shed light on willingness. A striking finding is the general low **awareness** and experience with heat grids in the population. Over 82% of surveyed homeowners are neither connected to a heat network currently nor in any process of getting a connection. This means most are still in very early stages of the adoption curve. For example, only learning or forming opinions about the concept. Indeed, 44,7% of respondents admitted they were not familiar at all with heat grids before. Such lack of awareness is itself a barrier (see Section 6.4), but also an opportunity: it implies many are neutral simply due to unfamiliarity rather than firm opposition. Among those who had heard of heat grids, the primary information channels were passive, though news/media (24,5% of respondents) and personal interest searching (13,5%). Very few learned through active outreach: only 7,9% cited a municipal campaign and 5.8% heard

via friends/family, while a mere 3,6% learned of heat grids from an energy company. Furthermore, only 9,4% have ever been personally approached about connecting to a heat network. These figures reveal that proactive engagement efforts have been lacking, a significant insight for project initiators. The neutral group in particular, had the highest share of uninformed respondents, over half of neutrals were not familiar with heat grids. This correlates with their indecision; it suggests that many homeowners are sitting on the fence largely due to an information vacuum. Despite the low outreach, there is evidence that when information is provided, it can shift attitudes.
Most respondents currently use a natural gas boiler (81,1%), with relatively even distribution across the three willingness groups. Users of alternative systems, such as (hybrid) heat pumps, are slightly overrepresented in the against group, likely due to prior investments in individual sustainable solutions. This suggests a preference for autonomy and a lower perceived need to connect to a collective system. Those with blokverwarming also show more resistance, possibly due to negative prior experience. Overall, the **existing system** shapes perceptions of necessity, flexibility, and added value. Among willing respondents, 61,5% do not plan to move from their current home, a much higher proportion than in the neutral or against groups. In contrast, a significant share of those against connecting are people planning to move out within five years, 38,3% of the against group have short-term **moving plans**. This indicates that if individuals don't see themselves enjoying the long-term payoff, because they might sell the house soon, they are much less willing to support a major heating infrastructure change. These findings demonstrate a rational calculation: a heat grid connection is a long-term investment, so only those expecting to remain in their homes are eager to consider it. Those anticipating relocation understandably hesitate to bear the cost or hassle when the benefits would serve largely to future owners
An interesting aspect of the **survey design** was that it itself served as an informative exercise for respondents. After completing the questionnaire, which included facts and considerations about heat grids, 25,8% of respondents reported feeling more positive about connecting than before, whereas only 8,2% felt more negative. The majority (66%) said the survey did not change their view. The positive swing was especially visible among those who initially were opposed, over half of the "against" group indicated that the survey's information made them more positive to the idea afterwards. This outcome shows the importance of knowledge and communication: even a relatively brief exposure to structured information led a significant subset of skeptics to soften their stance. On the other hand, a notable finding is that 13,2% of the initially willing group felt more negative post-survey. It is likely that the survey also made these enthusiastic respondents aware of challenges or complexities they hadn't considered like potential costs, technical difficulties, and thereby slightly tempering their optimism. This shows that information cuts both ways, it can allay unfounded fears, but it can also introduce new concerns. Overall, however, the net effect was an informational benefit: a large undecided group exists, and with the right input, many leaned more towards willingness.

Looking forward, the survey asked about future plans to improve energy efficiency, and responses again reflect varying mindsets as just discussed in the building characteristic section. Many undecided homeowners could be nudged by external policy incentives like subsidies, they are neither embracing nor rejecting change, but looking for signals or support from authorities. Another 22,8% are actively exploring options (more prevalent in the against group, interestingly). The fact that nearly one-quarter of "against" respondents are currently exploring their options for energy measures suggests their opposition may not be to any change, but perhaps specifically to the heat grid solution, they might be investigating individual alternatives like heat pumps. Indeed, interviewees noted that many hesitant homeowners still intend to decarbonize but prefer individual solutions (see Section 6.4). This finding highlights that decision autonomy and speed can enable higher willingness, collective action problems remain a hurdle in multi-owner contexts. The case studies and interviews revealed that **trust** in the leading party and preferred communication approaches play a crucial role in shaping willingness. A lack of transparency or inconsistent communication undermines trust, especially in areas where previous engagement efforts fell short. Respondents expressed clear preferences for timely, personal, and reliable communication, ideally from familiar or independent sources. These preferences underline the need for a trustworthy and well-aligned **approach** strategy throughout the implementation process.

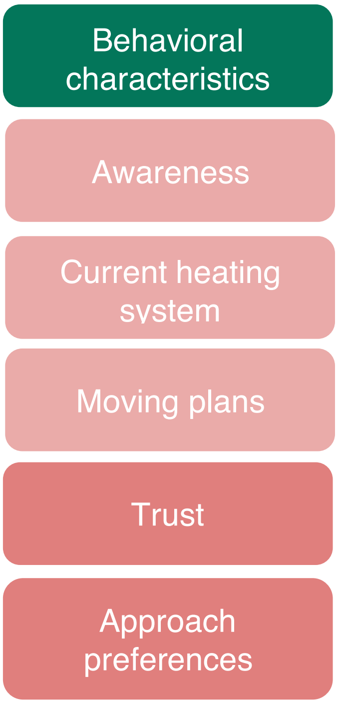



*Figure 46: Validate behavioral characteristics for willingness to connect (author)*

In summary, the household, building, and behavioral profile of those willing versus not willing to connect reveals important insights. Younger, dual-income or childless households with some financial flexibility and prior sustainability engagement lean more willing, while older, financially constrained or risk-averse owners, especially those satisfied with their current system, lean against. Physical context matters too: long-term residents of newer, larger homes who can decide independently see fewer barriers, whereas people in older or collectively-owned homes and those planning to move see more obstacles. Most importantly, a lack of awareness and outreach keeps a large middle group undecided, a group that could be swayed with the right approach. These nuances underscore that willingness to connect is not a uniform trait but the product of many interrelated factors.
These findings show the importance of a multi-layered approach that does not treat end-users as a homogeneous group but rather targets intervention strategies according

to their demographic and psychological profile. The implications of these insights are translated in the persona typology and strategy in order to propose actionable recommendations for increasing user willingness and accelerating the adoption of heat networks among homeowners. The next sections describe the Against, Neutral and Willing group more detailed and delves into how these factors influence the experience of specific barriers or drivers, and how strategic support and communication can tip the balance for undecided homeowners.

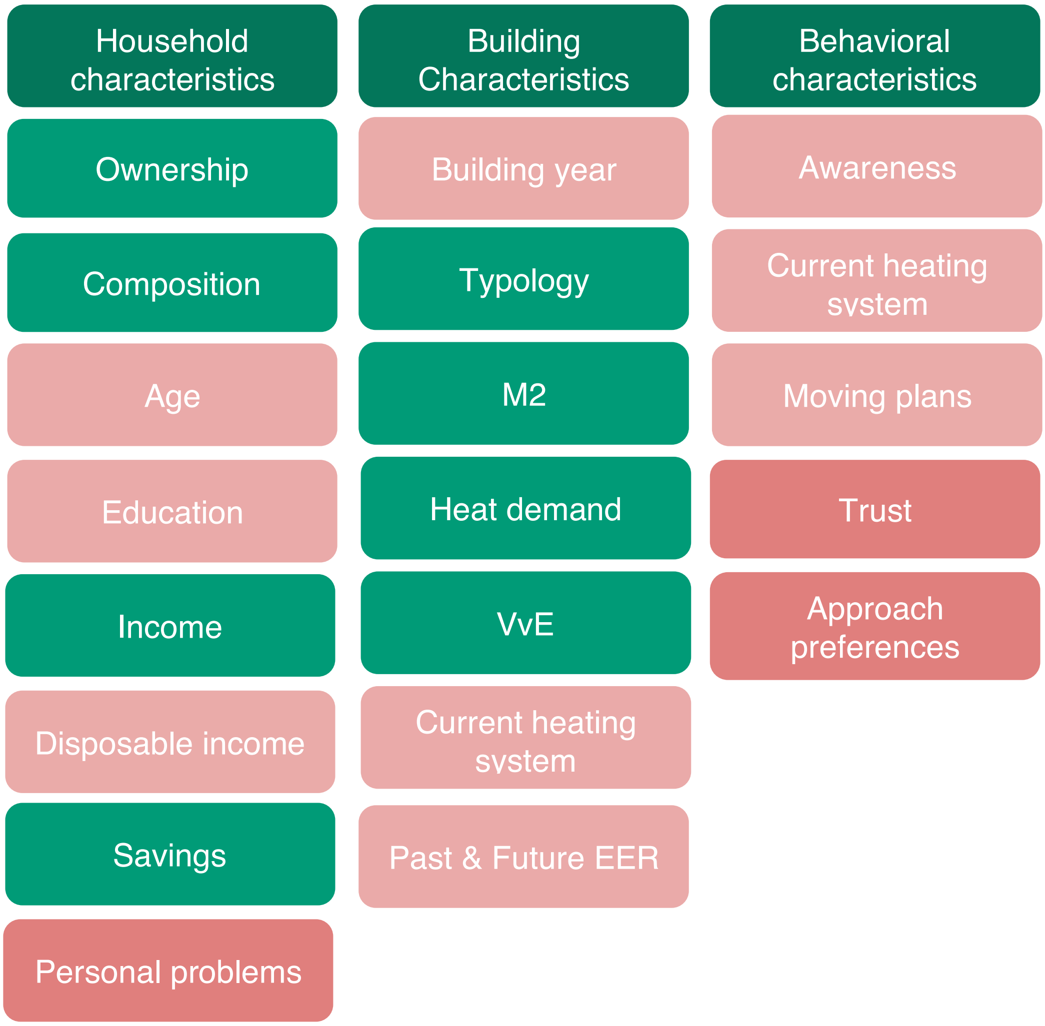



*Figure 47: Validated characteristics (author)*

## 7.2 PERSONA'S BASED ON AGAINST, NEUTRAL AND WILLING GROUPS

The identified characteristics offer a valuable foundation for anticipating which willingness group a homeowner is likely to belong to. Patterns in socio-demographic, building-related, and behavioral traits, appear to correlate meaningfully with the willingness to connect. These characteristics can therefore serve as a strategic **starting point** in assessing end-user profiles early in the engagement process, enabling initiators to tailor communication and support strategies accordingly.
To translate the findings into practical insight, three archetypal end-user personas were developed. Each persona – one willing, one neutral, and one against – synthesizes key

characteristics found in the data, case studies and interviews. These are fictional, yet data driven profiles.

**The Resistant Traditionalist (Against)**
Jan is a 70-year-old retired homeowner living in an older detached (or row) house built in the 1960s. His home has minimal insulation and still uses a conventional gas boiler, and he lives on a fixed pension, circumstances typical of the “against” group. Jan prefers the status quo: he feels his existing heating works well, so he sees no need to change. He expects that switching to a heat grid would not save money and might even increase his bills). This skepticism is fed by low trust in authorities and fear of hidden costs. Jan has not engaged with any project information, he has never attended a meeting or been approached, so his opinions are shaped mainly by word-of-mouth and negative media stories. In short, Jan is comfortable and change-averse; only a very strong incentive or necessity, for example, a large subsidy or a failed boiler, might make him reconsider.

**The Cautious Considerer (Neutral)**
Sophie is a 55-year-old homeowner who lives with her spouse in an 1980s townhouse with only moderate insulation. Her household has a middle-range income with limited disposable budget, reflecting the typical neutral group in the survey. Sophie values stability and is satisfied with her current gas heating system. She is open but hesitant: curious about new solutions yet not convinced without evidence. Her hesitancy stems from uncertainty over high upfront costs and unclear long-term savings, and she has heard mixed reliability messages about heat networks. Sophie also harbors some distrust of the project leaders, so she needs credible reassurance before committing. To date she has only seen occasional news about heat grids and has not been personally approached by any project representatives. In Sophie’s case, clear, trusted information and peer examples would be needed to move her from neutral to willing.

**The Enthusiastic Adopter (Willing)**
Mark is a 45-year-old homeowner living with his family in a well-insulated semi-detached house built in the 1990s. He earns a stable, above-average income and has considerable savings, and he is highly educated, traits that align with the survey’s “willing” group profile. Mark is environmentally conscious and first learned about heat grids through news media and his own research. He trusts the project initiators and the technology behind the heat grid. Motivated by potential benefits (lower energy bills, a future-proof home, climate contribution), he actively engages in the process, for example, he attends local information meetings and reviews detailed cost comparisons to support his decision. Mark’s confident, proactive stance reflects the enthusiastic adopter profile described from the analysis.

## 7.3 BARRIERS, SUPPORT & DRIVERS VALIDATED PER PERSONA AND PHASE

This study identified a range of barriers that somehow effect end-users’ willingness to connect to a heat grid, as well as drivers and support needs that can enable or encourage that willingness. By comparing survey data, interview insights, and the earlier literature review, we validate which challenges are most critical and how they align with known patterns. Overall, the findings strongly reinforce many of the barriers highlighted in prior studies, while also revealing their phase-specific nature and the opportunities to mitigate them through targeted support.

**Key barriers to willingness**

The empirical results confirm that end-users face multifaceted barriers, Informational & Organizational, Behavioral & Social, Economic & Financial, and Technical & Legal throughout the decision-making process. These barriers are not evenly distributed across time: they tend to cluster in the early stages of awareness and consideration, then evolve into more concrete financial or legal concerns in later stages. This phased pattern became evident when survey respondents indicated at which project phase (from initial awareness to post-connection) they experienced each barrier.

*In the Awareness phase*, lack of information and related organizational issues dominated. Many respondents indicated that they simply did not know enough about the project, the technology, or the stakeholders when first introduced to the idea of a heat grid, a classic informational barrier. This aligns with existing literature, which emphasizes information deficits as an early barrier. Simultaneously, behavioral and social barriers also emerged prominently at this stage, particularly lack of trust and general skepticism. Interviews revealed that initial outreach was often met with distrust towards the initiator or doubts about whether the project was genuinely in residents' interest. Survey data confirmed that "lack of trust in the leading party" was one of the strongest barriers, especially for the group against connection.

*During the Consideration phase,* when homeowners begin to weigh the pros and cons, economic and financial barriers come to the forefront. The most frequently cited concern across all groups was financial feasibility. "High initial cost" was a major barrier, especially in this phase, as respondents expressed concern over connection fees and required home modifications. In addition, many were uncertain about long-term cost savings and did not receive credible projections to support the assumption that heat grids would reduce their monthly expenses. This uncertainty also extended to pricing structures: people feared being dependent on a single heat provider that might raise prices in the future. These price-related fears were especially prevalent during the consideration to decision transition.
Behavioral & social barriers continued during this phase as well. Many homeowners preferred individual heating solutions, like heat pumps, over collective systems like heat grids. This preference was linked to autonomy and trust: owning one's own system was associated with a greater sense of control. Furthermore, over half of the unwilling respondents stated they were simply satisfied with their current heating setup. This resistance to change, often rooted in comfort with the status quo and fear of the unknown, presented a significant hurdle even when alternative systems could be objectively better. Additional barriers included concerns about reliability; some respondents doubted whether a heat grid could deliver the same level of comfort and consistency as their current gas boiler.

*In the Decision phase*, legal and technical concerns became more prominent. Respondents expressed unease about unclear contract terms, division of responsibilities like ownership and maintenance of technical components, and the fear of being locked into long-term commitments without clear exit strategies and fear of monopolistic pricing. Additionally, some questioned whether the system would be truly sustainable or if fossil sources would still be used. While fewer respondents reached this phase, those who did often required strong reassurances on legal clarity, technical feasibility, and environmental guarantees.

Crucially, the data revealed that nearly all respondents, including those who were willing to connect, experienced multiple barriers throughout the process. Even the willing group reported high rates of informational and financial concerns, indicating that willingness does not equate to a barrier-free journey. The neutral group reported the highest frequency of barriers, suggesting that indecision is often the result of experiencing a wide range of unresolved issues. The unwilling group, by contrast, tended to latch onto one or two decisive barriers, such as distrust or cost.

**Effective Drivers and Support measures**

To overcome these barriers, the study identified several drivers and corresponding support needs that can motivate willingness and reduce resistance. These drivers are most effective when they are tailored to the specific phase of the implementation process and to the user group in question.

*In the Awareness phase*, the dominant needs are informational and organizational. Respondents across all groups emphasized the importance of clear, accessible information about what a heat grid is, what benefits it provides, and who is involved in its delivery. Behavioral support, such as trust-building efforts and communication from credible sources (like municipalities or independent advisors), also plays a crucial role in addressing early skepticism. When effectively implemented, these measures transform early barriers into potential drivers by increasing understanding and building confidence.

*In the Consideration phase*, support needs peak. Economic & Financial concerns become central, and so do the measures required to address them. Respondents expressed a need for financial incentives, such as subsidies, transparent information about expected costs and savings, and clear communication about what kind of investment is required. Many respondents suggested that personalized guidance, such as a household-specific cost-benefit analysis, would help them better evaluate their options. Price stability and usage guarantees were also requested, especially by neutral and skeptical groups. When these are provided, they can turn doubt into willingness by reducing financial uncertainty and building perceived value.

Support in the *Decision and Execution phases* becomes more legal and technical in nature. Respondents at this stage wanted clear contracts, understandable terms, and protections against long-term risk. Others indicated the importance of continued customer service and engagement even after the installation phase. If early adopters have a positive experience during execution like minimal nuisance and quick installation, they are more likely to speak positively about the heat grid, thus influencing others through word-of-mouth, which is a powerful behavioral driver itself

Across all phases, the consistent pattern is that barriers can be mitigated and, in many cases, converted into drivers if the right support measures are offered at the right time. The key themes that come to light are Awareness & Lack of information, Trust & Engagement, Financial Support and Technical & Financial support.

**Personas and phase-specific strategies**

The study identified three end-user personas based on levels of willingness and associated behavioral profiles: the Resistant Traditionalist, the Cautious Considerer, and the Enthusiastic Adopter. Each persona experiences barriers differently, responds to different drivers, and requires tailored engagement across phases.

The Resistant Traditionalist (Jan) is change-averse. He prefers his existing gas boiler, sees little need to switch, and distrusts authorities. His main barriers arise early: informational deficits and a lack of trust dominate the Awareness phase. The only driver that resonates with him is the potential for clear and significant financial savings. Support strategies must focus on the basics: simple cost comparisons, clear communication, and strong financial incentives. In the Consideration phase, his focus shifts to the anticipated effort and disruption of switching systems. While most traditionalists opt out before Decision, those who remain need legal clarity and long-term price guarantees. Overall, Jan's journey is defined by skepticism and cost sensitivity, which must be addressed through heavy outreach and basic assurances early in the process.

The Cautious Considerer (Sophie) is curious but unconvinced. She enters the Awareness phase with limited information and no personal engagement. Her initial need is trustworthy information and clarity about the benefits. As she progresses to Consideration, her doubts intensify. Cost, reliability, and long-term savings become central concerns. However, unlike Jan, Sophie is open to persuasion. She responds positively to personalized advice, transparent data, and visible community involvement. Tailored support, especially during Consideration, is essential. Sophie needs clear cost projections, simple contracts, and opportunities for feedback. If these are delivered, she can transition from uncertainty to commitment; if not, indecision will persist.

The Enthusiastic Adopter (Mark) is proactive and optimistic. He tends to seek information independently, trusts project initiators, and expects to benefit from connection. In the Awareness phase, his barriers are limited. However, he still appreciates clear information and visible transparency. During Consideration, he seeks confirmation: financial incentives, detailed technical information, and opportunities for involvement help remain his support. By Decision, Mark's concerns are largely addressed, though he still appreciates legal clarity and pricing stability. His experience during Execution is often positive, and he may even act as a peer promoter of the project. Mark's journey is driven by intrinsic motivation and positive expectations and the role of support measures is to reinforce these and ensure no barriers arise that could erode his enthusiasm.

In conclusion, this study confirms that barriers to willingness are not only multidimensional but phase- and persona-dependent. The same barrier (for example, cost uncertainty) may require very different support strategies depending on whether the homeowner is skeptical, cautious, or enthusiastic (see table 23). By aligning engagement efforts with both the timeline of the project and the psychological profile of the user, initiators can maximize the effectiveness of their outreach. For Resistant Traditionalists, early trust-building and financial clarity are key; for Cautious Considerers, support must peak during the consideration phase with detailed

*Table 23: Overview of Barriers, Support & Drivers per persona and phase (author, see Appendix A for clear version)*

| Category | Phase | Awareness | Consideration | Decision | Excecution | Experiencing | Awareness | Consideration | Decision | Excecution | Experiencing | Awareness | Consideration | Decision | Excecution | Experiencing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | **Barriers** | | | | | | | | | | | | | | | |
| Informational & Organizational | 1. Lack of information | 41% | 27% | 10% | 3% | 3% | 38% | 32% | 13% | 6% | 2% | 34% | 27% | 15% | 6% | 2% |
| | 2. Accessibility of information | 34% | 26% | 12% | 5% | 4% | 30% | 35% | 15% | 4% | 3% | 21% | 32% | 15% | 10% | 2% |
| | 3. Information overload | 36% | 27% | 11% | 5% | 3% | 31% | 35% | 17% | 5% | 3% | 26% | 34% | 16% | 9% | 2% |
| | 4. Lack of awareness* | 35% | 26% | 12% | 6% | 3% | 31% | 34% | 16% | 5% | 3% | 22% | 34% | 16% | 7% | 5% |
| | 5. Nuisance | 24% | 22% | 11% | 22% | 3% | 15% | 28% | 15% | 27% | 4% | 9% | 25% | 20% | 28% | 3% |
| Behavioral & Social | 6.Lack of trust in leading party* | 30% | 24% | 17% | 10% | 4% | 21% | 28% | 22% | 12% | 5% | 13% | 25% | 29% | 11% | 5% |
| | 7.Preferring individual heating solutions over collective systems | 29% | 29% | 14% | 6% | 7% | 20% | 40% | 18% | 6% | 4% | 16% | 34% | 19% | 9% | 5% |
| | 8.Skepticism about system performance | 32% | 27% | 14% | 7% | 7% | 22% | 36% | 19% | 7% | 5% | 13% | 30% | 19% | 11% | 8% |
| | 9.Resistance to change from existing heating system | 30% | 27% | 13% | 8% | 5% | 22% | 35% | 17% | 8% | 4% | 17% | 30% | 17% | 9% | 4% |
| | 10.Influence of negative experiences from peers | 34% | 23% | 13% | 5% | 6% | 24% | 31% | 16% | 6% | 5% | 24% | 24% | 14% | 9% | 6% |
| | 11.No renewable energy source | 35% | 25% | 13% | 5% | 5% | 24% | 33% | 19% | 6% | 4% | 22% | 29% | 17% | 9% | 5% |
| | 12.Too much effort preparing for the connection* | 30% | 26% | 13% | 12% | 4% | 21% | 31% | 19% | 14% | 3% | 13% | 26% | 22% | 15% | 4% |
| Economic & Financial | 13.High initial cost* | 27% | 32% | 15% | 10% | 4% | 17% | 42% | 21% | 9% | 3% | 11% | 38% | 28% | 9% | 3% |
| | 14.Uncertainty about long-term cost savings compared to current heating system | 28% | 34% | 14% | 6% | 6% | 19% | 43% | 20% | 7% | 3% | 13% | 43% | 20% | 7% | 5% |
| | 15. Perceived risk of monopolistic pricing | 31% | 28% | 16% | 6% | 6% | 19% | 39% | 23% | 6% | 4% | 13% | 32% | 25% | 12% | 4% |
| | 16. Future cost* | 31% | 27% | 17% | 6% | 6% | 23% | 34% | 22% | 5% | 5% | 14% | 26% | 22% | 14% | 8% |
| | 17.Costs of alternatives | 28% | 29% | 20% | 5% | 5% | 21% | 29% | 30% | 6% | 4% | 14% | 29% | 29% | 9% | 5% |
| Legal & Technical | 18.Changing policies | 29% | 25% | 21% | 6% | 4% | 20% | 31% | 30% | 6% | 2% | 14% | 30% | 29% | 7% | 5% |
| | **Support measures** | | | | | | | | | | | | | | | |
| | 1.Clear information and education about the benefits and operation of heat grid | 42% | 27% | 9% | 4% | 3% | 39% | 35% | 10% | 4% | 3% | 37% | 29% | 17% | 9% | 2% |
| | 2.More insights about the actual initial investment and other cost | 30% | 38% | 10% | 4% | 3% | 22% | 51% | 13% | 5% | 2% | 21% | 47% | 14% | 9% | 3% |
| | 3. Increased trust in leading parties | 33% | 28% | 15% | 6% | 4% | 24% | 35% | 22% | 8% | 2% | 22% | 33% | 25% | 10% | 4% |
| | 4. Community engagement with feedback opportunities | 36% | 26% | 12% | 4% | 5% | 26% | 35% | 15% | 6% | 5% | 21% | 34% | 21% | 7% | 7% |
| | 5. Customer support incl. service and maintenance | 29% | 28% | 14% | 7% | 7% | 18% | 34% | 17% | 12% | 9% | 18% | 27% | 23% | 11% | 14% |
| | 6. Participation opportunity about the connection process beforehand | 34% | 28% | 12% | 6% | 4% | 28% | 36% | 14% | 6% | 4% | 21% | 37% | 18% | 10% | 6% |
| | 7. Usage price stability guarantees | 27% | 32% | 17% | 6% | 4% | 17% | 39% | 25% | 6% | 4% | 14% | 41% | 29% | 8% | 3% |
| | 8. More financial incentives or subsidies | 25% | 37% | 14% | 4% | 4% | 15% | 48% | 20% | 6% | 3% | 12% | 44% | 22% | 10% | 5% |
| | 9.Option to use heat network for cooling | 29% | 31% | 12% | 7% | 5% | 19% | 40% | 17% | 8% | 6% | 18% | 36% | 20% | 13% | 6% |
| | 10.Additional legislation that makes a heat grid connection more attractive | 30% | 30% | 14% | 5% | 5% | 20% | 38% | 22% | 7% | 4% | 16% | 40% | 21% | 9% | 6% |
| | **Drivers** | | | | | | | | | | | | | | | |
| Informational & Organizational | 1.Clear overview of the benefits for their household | X | X | | | | X | | | | | X | X | X | | |
| | 2.Accessible and understandable information about the system* | | | | | | | | | | | | | | | |
| | 3.Transparency about project timeline and connection process | | | | | | | | | | | | X | X | x | |
| | 4.Availability of user-friendly support before, during and after connection* | | X | X | X | X | | | | | | | | X | X | X |
| Behavioral & Social | 5.Social norm campaigns, people don't want to be left behind from their peers | | | | | | | | | | | | | | | |
| | 6.Positive word-of-mouth recommendations from friends/family/neighbors | | | | | | | | | | | | | | | |
| | 7.Trust in leading party* | X | X | | | | | X | X | X | X | | | X | X | x |
| | 8.The feeling of contributing to sustainability goals | | | | | | | | | | | | | | | |
| | 9. Increased level of comfort in my house | | X | | X | X | X | X | X | | X | | | | | |
| Economic & Financial | 10.Lower energy bills* | X | X | X | | X | X | X | X | | X | X | X | | | X |
| | 11.Increased property value | X | | | | X | X | | | | X | | | | | |
| Legal & Technical | 12.Energy independence (less reliance on fossil fuels) | | | | | | | | | | | | | | | |
| | 13.Compatibility of heat network with existing (heating) systems | | | | | | | | | | | | | | | |
| | 14.Flexibility to combine heat network connection with other measures (energy efficiency measures like insulation or window replacement / aesthetic measures like new kitchen or bathroom) | | | | | | | | | | | | | | | |

| | |
|---|---|
| (grey) | most important |
| (green) | *validated by case studies |
| X | Suitable moment |

information and personal advice; and for Enthusiastic Adopters, reinforcement of expected benefits and transparent implementation help maintain their willingness. Understanding these differences allows for phase-specific, persona-based strategies that can effectively convert reluctance into willingness – and willingness into action. These strategies will be presented in Section 7.4.

## 7.4 APPROACH PREFERENCES VALIDATED PER PERSONAL AND PHASE

In the survey, only a relatively small share of respondents reported having been approached about a possible connection to a heat grid. This limited sample size prevents drawing generalizable conclusions about the effectiveness of existing outreach practices. Moreover, among those who were approached, several mismatches came to light. Respondents often reported being contacted too late, by actors they did not trust, or via impersonal channels. These mismatches highlight the need for more strategic outreach design.
Therefore, this section focuses on the non-approached group, whose preferences offer a valuable base for designing future communication strategies. Since these individuals have not been influenced by previous contact, their responses provide a clearer picture of ideal approach looks like.

The preferences were analyzed across the three persona groups identified earlier and mapped onto each phase of the heat grid development process. This alignment allows for phase-specific and persona-sensitive engagement strategies that anticipate informational, behavioral, and contextual needs.

The non-approached respondents consistently indicated the following

- Preferred initiator (who): The municipality was most preferred, followed by energy companies and independent advisors.
- Preferred method (how): Emails and letters were most preferred, while community events and info sessions were positively evaluated, especially by neutral and willing personas.
- Preferred content (what): Respondents wanted concrete information about initial investments, potential cost savings, and technical modifications required.
- Preferred timing (when): A strong preference existed for contact during the early project phases, particularly Initiation and Feasibility, corresponding with the Awareness phase in user decision-making.

These insights were then broken down per persona.

**<u>Approach Preferences per Persona and Phase</u>**

*Resistant Traditionalist (Against)*
The Resistant Traditionalist values institutional credibility and minimal interference. He prefers one-directional communication through letters or emails and trusts the municipality above other actors. Because this persona is most skeptical early in the process, it is critical to reach him in the Initiation phase, before fixed negative attitudes

solidify. His main interest lies in financial clarity, especially fixed connection costs and long-term price guarantees. In later phases, if still involved, he needs straightforward legal terms and clear responsibility arrangements.

*Cautious Considerer (Neutral)*
This persona is receptive but cautious. She requires trust-building, well-timed contact, and clear content during the Feasibility and Planning phases. Her preferred initiators are municipalities and independent advisors, and she values detailed and interactive communication, such as Q&A sessions, webinars, and info evenings. Her decisions depend on comparisons of financial and technical alternatives, long-term reliability, and transparency in contracts and pricing. Continued support through the Execution and Operation phases reassure her and build long-term confidence.

*Enthusiastic Adopter (Willing)*
The Enthusiastic Adopter is proactive and motivated. He welcomes early engagement in the Initiation phase and seeks involvement throughout all subsequent stages. He is open to contact by municipalities or energy companies and enjoys community events, digital platforms, and opportunities for co-creation. While less sensitive to trust issues or cost concerns, he still expects clarity and consistency. In the later project phases, he values regular updates, technical performance information, and access to user platforms for monitoring and feedback.

This integrated analysis confirms that effective engagement requires alignment between user type, decision-making phase, and project phase. Communication that is too generic or poorly timed risks reinforcing resistance or missing key moments of openness. Instead, municipalities and heat network providers should tailor their strategies to reflect both who they are addressing and where that person is in the process.

By incorporating these preferences into outreach and planning, project initiators can maximize participation, reduce opt-outs and build long-term user confidence. Each persona requires a different pathway to connection, and when properly supported through the appropriate phase and method, even initially hesitant groups can be persuaded to take part in the transition. The strategies are presented in the next section

## 7.5 TAILORED STRATEGIES

The analysis integrates both decision-making phases and corresponding project phases. This dual perspective reveals when and how communication should take place to maximize user engagement across different types of homeowners.

The first step towards tailoring strategies is to have an overview of who the potential end-users are, what barriers they face and how supporting them can reveal drivers. Section 6.5.1-6.5.3 revealed how household, building and behavioral characteristics influence the willingness to connect. It's argued that these characteristics can give an insight and prediction in which willingness group an individual falls and based on the mean, typical aspects in each group the 3 persona's (Section 7.2) were created to tailor the strategies to.

The strategies can be formed by carefully considering the most common barriers for each persona, to then look what support measures can be used to mitigate these barriers into drivers. At the same time, looking at for example the main drivers for the willing group, lessons can be taken, and these drivers could be used to activate hesitant homeowners.
The crucial aspect within the strategies are the approach source, method, timing and information provided. Sometimes only information is not enough, and people need to be engaged through more active and interactive approach methods.
The final set of key actions shows how following a step by step phased approach, while still targeting and addressing different needs and preferences can be used as a strategy to start building trust early on and move towards taking action and increasing willingness to connect.

Five core principles underpin the engagement strategy:

- Timing is critical: Decisions are shaped early. The majority of key barriers manifest in the Awareness and Consideration phases. Delayed outreach drastically reduces chances of conversion.
- One size does not fit all: User groups differ in their motivations, concerns, and informational needs. Tailored communication by persona is more effective than generalized messaging.
- Trust is key: Especially among skeptical or resistant groups, building trust in the initiating party is essential before benefits or financials will be considered.
- Reduce friction: Informational and financial complexities act as bottlenecks. Minimizing cognitive and procedural burdens enables homeowners to move from intention to action.
- Engagement is continuous: Willingness must be maintained. Even committed homeowners can disengage if later phases are not handled well. Therefore, engagement strategies should extend beyond the decision to connect and also address the long-term experiencing phase.

*Table 24: Strategies per persona and phase (author, see Appendix B for clear version)*

| End-User Group | Phase | Strategy/Key Action | Approach Method/information | Overcome Barriers | Used Support/Drivers | Address in Project Phase | Responsible Stakeholder |
|---|---|---|---|---|---|---|---|
| The Resistant Traditionalist | Awareness | - Build trust through presence<br>- Raise awareness and educate on why the energy transition is needed<br>- Use examples<br>- hear people's (other) concerns | - One-way outreach (letters/emails) led by the municipality<br>- Slowly convince this person through trusted figure<br>- Being present at local event | Lack of information<br>Lack of trust in leading party | - Clear information<br>- Trust in leading party<br>- Lower energy bills | Initiation | Municipality/ trusted person |
| | Consideration | - Provide simple cost comparisons with current system<br>- Highlight financial benefits | - Clear presentations<br>- Demonstrations in example dwelling | High initial cost, uncertainty about savings, effort of preparation | - Clear information<br>- Financial support,<br>- Price guarantees and insights about actual cost | Feasibility / Contracting | Municipality / Energy company |
| | Decision | - Emphasize minimal disruption of switching<br>- highlight (future) cost clarity<br>-make use of subsidies or provide financial support | - Clear presentations<br>- Demonstrations<br>- One-on-one talks (with trusted community member) | Contract complexity, pricing trust issues | - Transparent contracts<br>- Usage price stability guarantees<br>- Increased trust | Contracting | Municipality / Energy provider |
| | Execution | - Ensure low-nuisance installation with user-friendly support<br>- One-stop-shop for all the works that need to be done | - Dedicated, low-threshold contact person for questions during installation | Nuisance and lack of clarity about process, efforts preparing their house | - Customer service<br>- Increased comfort guarantee | Realization | Energy company/ Installation contractor |
| | Experiencing | - Provide maintenance and support and show actual system performance | - Follow up survey about experience<br>- Emails/app with up-to-date system performance numbers | Uncertainty about long-term performance | - Positive word-of-mouth<br>- Increased comfort<br>- Lower energy bills | Operation | Energy company / Customer service |
| The Cautious Considerer | Awareness | - Build trust and awareness through presence<br>- Provide trustworthy, transparent information highlighting benefits<br>-Let people participate in decision for heat grid | - Interactive outreach (Q&A sessions, info evenings)<br>- Additional information through email/newsletters<br>- Digital platforms | Lack of awareness,<br>initial trust issues | - Detailed cost comparisons<br>- peer recommendations<br>- increased trust<br>- participation opportunity | Feasibility / Initiation | Municipality / Independent advisors |
| | Consideration | - Offer personalized advice via home-specific cost-benefit analyses<br>- Make use of subsidies or one-time-offers | - Workshops and presentations<br>- Info evenings | Financial and reliability concerns individualism | - Subsidies<br>- usage guarantees<br>- peer examples | Feasibility / Contracting | Municipality / Independent advisors |
| | Decision | - Ensure clear pricing and simple contracts<br>- Show comparison with other alternatives | - one-on-one counselling<br>- Demonstations In example dwelling | Contract complexity, unclear(future) costs<br>High initial cost | - Transparent contracts<br>- Usage price stability guarantees<br>- Increased trust | Contracting | Municipality / Energy company |
| | Execution | - Ensure low-nuisance installation with user-friendly support<br>- One-stop-shop for all the works that need to be done<br>- Insights about actual costs | - Dedicated liaison<br>- Regular updates through email about timeline | lack of clarity about process, efforts preparing their house | - Customer service<br>- Insights about actual costs | Realization | Installation contractor |
| | Experiencing | - Follow up and highlight comfort and savings achieved<br>- show actual system performance | - Surveys via email or at follow up event<br>- feedback opportunities | Uncertainty about long-term performance | - Increased comfort<br>- Lower energy bills | Operation | Energy company / Customer service |
| The Enthusiastic Adopter | Awareness | - Engage early with transparent information and sustainability framing<br>- Let people participate in decision for heat grid | - Community events<br>- Digital platforms<br>- Interactive outreach (Q&A sessions, info evenings) | Information overload | - Cost comparisons<br>- Sustainability motivation<br>- Increased trust | Initiation | Municipality / Energy Company |
| | Consideration | - Provide technical and financial details and use incentives | - site visits<br>- FAQs<br>- Demonstrations in example dwelling | Future cost | - Participation opportunity<br>- Transparency | Feasibility / Contracting | Municipality / Energy Company |
| | Decision | - Provide simple contracts and price guarantees<br>- Avoid backsliding trust | - Workshops and online contract platforms | Legal/financial unclarity | - Usage price stability guarantees | Contracting | Municipality / Energy Company |
| | Execution | - Smooth connection and involve as ambassador | - Updates through emails and feedback moments | Nuisance | - Customer service | Realization | Energy company/ Installation contractor |
| | Experiencing | - Show actual system performance<br>- Keep involved as community promoter | - User forums and shared stories<br>- Surveys at follow-up event or via email | Changing policies | - Increased comfort<br>- Lower energy bills | Operation | Energy company / Customer service |

The recommended actions (Table 24) directly respond to each persona's profile as characterized in Section 7.2.

<u>*Resistant Traditionalists*</u> who are most likely preferring the status quo and distrustful of authorities) need very basic, credible outreach in the Awareness phase. Therefore simple, municipality-led mailings or flyers that compare their current boiler costs to the heat grid's costs are suggested. This addresses barriers like "Lack of information" and "Lack of trust in leading party" by delivering "Clear information and education about heat grid benefits" (support 1). Emphasizing "lower energy bills" (driver 10) converts their cost sensitivity into motivation.
In the Consideration phase, Traditionalists fixate on price and effort. Thus, the strategy is personalized cost projections and strong guarantees. Home-visit consultations with the energy provider or independent advisor can explain actual connection fees and potential subsidies, tackling "High initial cost" and "Uncertainty about long-term savings". We use support measures like "More insights about actual initial investment" (support 2) and "usage price stability guarantees" (support 7) to overcome financial barriers. Also by addressing "lower bills" and "increased comfort" (drivers 10 and 9) as tangible benefits that Traditionalists value.

At Decision, the focus for Traditionalists shifts to contract clarity. Therefore, simplifying legal terms and lock in pricing, countering barriers of "unclear contracts" and "monopolistic pricing concerns." Engaging them via one-on-one meetings allows explanation of fixed pricing and exit options (using the driver of trust again). This is justified by the thesis's finding that remaining Traditionalists need "straightforward legal terms and price guarantees."
During Execution, Traditionalists must see installation go smoothly with minimal fuss. Providing dedicated support staff and flexible scheduling reduces the "nuisance" and "too much effort" barriers. Using the support measure "Customer support incl. service and maintenance" (support 5) and prior "participation opportunity" (support 6) eases their concerns. Successful installation and post-installation help create positive word-of-mouth (driver 6), which later reinforces confidence in the system.
Finally, in Experiencing, satisfaction should be solidified. For Traditionalists, who may have been the hardest to convince, ensuring reliable performance and responsive and professional service addresses any distrust that is left. Sharing up-to-date system performance data to confirm the driver of "increased comfort" and the social proof from early adopters. Each phase's strategy aligns with the outcomes that "for Resistant Traditionalists, early trust-building and financial clarity are key."

*Cautious Considerers* start curious but uncertain. In Awareness, they need credible, clear messaging. We therefore propose interactive education (like info evenings or webinars) led by municipalities or independent advisors, given the finding that Sophie (the Considerer) has "limited information and no personal engagement" initially. This approach overcomes the "lack of awareness/information" barrier by providing "accessible and understandable information" (driver 2) about heat grids and builds trust via community engagement (support 4) and peer examples (drivers 5–6).
In Consideration, Cautious Considerers' doubts center on costs, reliability, and long-term savings. So, a personalized cost–benefit analyses based on her situation and a demonstration dwelling of a peer can make abstract savings concrete. This tackles "high initial cost" and "uncertainty about savings." Supports like "More insights about initial investment" (support 2) and "participation opportunity" (support 6) are used so they can give feedback. Furthermore, financial incentives (support 8) and reminding them of "energy independence" and "property value" improvements (drivers 12 and 11) address their concerns about alternative solutions and long-term benefits. T
During the Decision phase, the table suggests emphasizing transparency and continued trust-building. Cautious Considerers benefit from detailed Q&A on contracts and pricing by personal meetings or 1 dedicated liaison. This overcomes "unclear contracts" and "monopolistic pricing" fears by using driver 3 ("transparency about timeline") and support 7 ("price stability guarantees"). As the thesis results note that Sophie values simple contracts and transparency in pricing.
In Execution, installation should proceed with close homeowner collaboration and minimal disruption. Providing clear preparation checklists and flexible scheduling addresses the "too much effort" barrier. Again, use support 5 (customer service) and involving residents in planning the process.
Finally, in Experiencing, highlighting the positive outcomes of a connection by collecting and sharing user satisfaction (like showing actual cost savings or comfort improvements), the driver of "positive word-of-mouth" (driver 6) is used to improve trust.

*The Enthusiastic Adopter* is already motivated. In Awareness, the strategy is to engage him with clear, transparent information and emphasize values he cares about. The recommendation is using multi-channel communication (community events, social media, detailed newsletters) as the research finds Mark "already trusts the project initiators and the technology somewhat" and values clear information even if barriers are few. The approach uses support 1 (clear education) and driver 8 (sustainability).
During Consideration, the Adopter seeks confirmation and involvement. Thus, detailed technical details should be offered, access to project data, and incentives (like option to use the grid for cooling or small subsidies), using support 9 (cooling option) and 8 (financial incentives). These measures appeal to his drivers of "intrinsic motivation" and "savings."
At Decision, commitment is streamlined, like easy and fast contract possibilities and price guarantees, as even early adopters appreciate such clarity. During Execution, efficiency must be ensured as well as expert installation with little disruption. Then, if everything goes smoothly and he is satisfied, invite Mark to act as a peer advocate. This reflects that the literature expects Enthusiastic Adopters to be "peer promoters" if satisfied.
Finally, in Experiencing, Mark is kept engaged via regular updates and feedback platforms, maintaining and confirming his positive expectations with tangible results (driver 10, "lower bills", and 8, "sustainability"). In all cases, the recommended tactics explicitly draw on the listed barriers, support measures, and drivers (like mentioning "Lack of trust," "High initial cost," "Clear information," "price guarantees,").

**Awareness & Lack of information**

- Launch coordinated public info campaigns (local media, peer sessions, coaches)
- Use visual and simple language to explain heat grid concepts
- Tailor information to different literacy levels and demographics
- Create 1 access point for FAQs, helpdesk, or guided explanations

**Trust & Engagement**

- Involve local community members and homeowner associations
- Use independent experts to validate technical and financial plans
- Co-create and maintain two-way dialogue
- Publish updates on budget, pricing, and decision-making transparently
- Be present and visible for people to address concerns and have someone to talk to

**Financial Support**

- Offer upfront subsidies and collective discounts
- Partner with involved stakeholders to provide transparency and best price
- Guarantee fixed or predictable pricing to reduce uncertainty
- Provide personalized cost-saving estimates and property value insights

**Technical & Practical Support**

- Provide a one-stop-shop model for home prep and upgrades
- Offer personal assessments and clear installation timelines
- Reduce nuisance: coordinate works, offer temporary solutions
- Ensure smooth handover and ongoing support after connection

*Figure 48: Actionable strategies by themes (author)*

By matching strategy to both the decision phase and the persona, these actions maximize relevance and address the specific barriers that each group faces.

The other way to structure strategies, is to look at the key barrier themes. Each of these themes can be overcome by a set of actionable strategies as shown in figure 48.

## 7.6 RESEARCH METHODOLOGY REFLECTION & LIMITATIONS

It is essential to critically reflect on the research design and acknowledge the limitations that influence how the findings should be interpreted. This study employed a mixed-methods approach, combining a nationwide survey with in-depth case studies and interviews. This allowed for both broad insights and contextual depth into end-user perspectives on heat grid implementation. However, several limitations emerged throughout the process.

Sampling Bias and Representativeness

Although the survey had a relatively large sample size, it was not fully representative of the Dutch homeowner population. The sample skewed toward older and more highly educated individuals. While this partly reflects the actual distribution of homeownership in the Netherlands, the degree of overrepresentation suggests a bias toward more engaged or sustainability-conscious respondents. The recruitment strategy, likely based on online distribution channels, may have attracted individuals already interested in the topic. Consequently, the results may underrepresent perspectives of less-engaged or lower-educated homeowners. Moreover, younger homeowners were underrepresented, which limits the generalizability of findings across age groups. The survey also excluded tenants, except indirectly via case studies. While some insights into tenant perspectives were gathered qualitatively, a systematic quantitative analysis of this group is lacking. Geographically, the survey was distributed nationally, but the geographical spread of responses was not explicitly analyzed. If many responses came from municipalities already involved in heat grid planning, this could have inflated awareness or willingness figures. Conversely, if respondents were mostly from areas without active projects, awareness might be lower than average. The inability to correlate responses to local contexts is a limitation, although case studies provided some place-based insights.

Self-reported data

The survey captures a snapshot in time and relies on self-reported intentions. Respondents' willingness to connect may change rapidly due to policy updates, personal circumstances, or exposure to new information. Furthermore, stated intentions are not the same as actual behavior. Some respondents may overstate their willingness due to social desirability, while others may be more cautious in their answers. Since the research did not track actual sign-up behavior, the gap between intention and action remains unexplored.

Uneven group sizes and statistical power

The analysis of willingness levels was complicated by the unequal size of response groups. The "willing" group was significantly smaller than the "neutral" or "against" groups, which limits the robustness of some comparisons. While descriptive statistics were used to mitigate this, the small sample size in some subgroups reduces confidence in generalizations. Moreover, statistical significance testing was not applied, making it difficult to confirm whether observed differences between groups are meaningful.

Phase-related challenges
A distinctive element of the survey was asking participants to associate perceived barriers and support needs with different implementation phases (awareness, consideration, decision, execution, and experiencing). This required respondents to understand and interpret a hypothetical project timeline. Given that most participants had not experienced a heat grid project directly, their answers regarding later phases were speculative. The resulting data are thus based on imagined future scenarios rather than lived experience. This may have introduced inconsistencies or noise in the phase-specific findings. While the overall trends remain credible, detailed interpretations of when certain barriers or support measures arise should be approached with caution.

Case study generalizability
The case studies added valuable depth and allowed for triangulation of survey findings. However, they represent only a small number of urban contexts and cannot fully capture the diversity of heat grid projects across the country. For instance, rural areas or projects facing community resistance may present different challenges and dynamics. The selected cases were relatively successful or active, and thus may not reveal the full spectrum of issues, including failure points. Additionally, both cases were situated in areas with proactive municipalities and engaged local stakeholders, which may not be the norm.

Interview and response bias
The interviews with municipal officials, project managers, and other stakeholders provided important implementation perspectives. However, most interviewees were professionals or intermediaries. While some resident perspectives were included, the number of direct interviews with end-users was limited. Moreover, professionals may portray their projects in a favorable light or focus on issues relevant to their roles. As such, the qualitative data are illustrative rather than comprehensive.

Timing constraints
The study was conducted in a dynamic policy landscape. Heat grid policies, funding schemes, and public opinion on energy transition are evolving rapidly. It is likely that developments since the data collection period, such as rising energy prices, new subsidies, or major media coverage, have influenced public sentiment. The findings therefore reflect a specific moment in time and may need to be re-evaluated as the policy context changes.

Analysis limitations
This research relied primarily on descriptive and comparative analyses. While this is suitable for an exploratory study, it limits the ability to determine which factors most strongly and significantly influence willingness to connect. No multivariable statistical methods, like regression, were applied to isolate effects of individual variables while

controlling for others. Therefore, some observed relationships may be confounded or coincidental. Future studies could expand the analytical depth to test specific hypotheses and enhance explanatory power.

Survey
An additional consideration is that the survey itself may have influenced respondents. Because it included background information on project phases and technical aspects, it may have functioned partly as an informative intervention. While this helped ensure that participants could respond meaningfully to the questions, it also means that the survey may have shaped attitudes during completion. This is particularly relevant when interpreting findings on awareness or willingness levels.

Ethical and practical constraints
The survey was anonymous and participation was voluntary. While this supports ethical research practices, it also limited opportunities for follow-up or longitudinal tracking. Furthermore, the sample was self-selecting: those most disengaged with the topic may not have participated at all. Ironically, these are the individuals that real-world engagement strategies need to reach most urgently.

Overall Reflections
Despite these limitations, the study's mixed-methods approach allowed for triangulation across data sources, enhancing validity. Many of the patterns observed in the survey were echoed in the interviews and confirmed in the case study narratives. For example, concerns about cost and transparency emerged consistently across methods. While the cases used were not representative of all possible scenarios, they provided grounded insights that support the broader conclusions.

In sum, this research offers meaningful insights into the willingness of end-users to connect to heat networks, but these findings must be interpreted considering the methodological boundaries described above. They provide a foundation for further research, which can refine and deepen the insights through longitudinal studies, more representative sampling, and advanced statistical analysis.

## 7.7 VALIDATION

To ensure the reliability of the findings and recommendations, a validation step was incorporated through iterative expert interviews and cross-referencing with literature insights. Furthermore, validation took place primarily through the case study interviews. All interviewees were directly involved in the two selected neighborhoods. Some were interviewed twice, once during the initial exploration and again in a follow-up to reflect on the results and the theoretical expectations derived from literature. These second-round discussions helped verify whether the findings matched local realities, and whether any relevant factors had been overlooked or misrepresented in the survey design or theoretical framework. In general, their feedback confirmed key observations, although it was pointed out that in practical, the phases are not as black and white as described academically. There are overlaps and it's hard to measure where one phase ends and the other starts. On top of that, the interviews with the (potential) end-users in

the cases, resonated with the main findings from the survey, such as concerns about insufficient information and cost uncertainties and provided anecdotes and confirmation of barriers like trust and perceived inconvenience.
By triangulating quantitative and qualitative insights throughout the research process, the proposed strategies and interpretations are grounded in both data and real-world perspectives.

# 8. CONCLUSION

This chapter discusses the sub-questions of the research to finally answer the main research question:

**"How can different end-user groups be effectively engaged in the heat grid implementation process to optimize their willingness to connect?"**

## 8.1 SQ1: Who are the different end-user groups within suitable areas for heat grids, and what are their specific characteristics and needs?

Within the scope of this study, homeowners have been segmented into three personas based on their behavioral tendencies and survey responses: the Resistant Traditionalist, the Cautious Considerer, and the Enthusiastic Adopter. These personas reflect varying degrees of openness to heat grid connection and differing motivational drivers and barriers.

Resistant Traditionalists are characterized by a strong preference for the status quo, high sensitivity to costs, and low levels of trust in public authorities or unknown technologies. Cautious Considerers are open to sustainable alternatives but demand clarity, transparency, and credible information before committing. They are often guided by financial rationality and seek assurance. Enthusiastic Adopters, though the smallest group, are sustainability-minded and willing to connect, often citing environmental motivation and a desire to contribute to the energy transition. These differences underscore the importance of tailoring engagement to user profiles, as the same information or incentive may be received differently by each group.

### 8.2.1 SQ2a: What barriers hinder different end-user groups in their willingness to connect to heat grids and their decision-making process?

The survey results and case study insights reveal that financial, informational, and behavioral barriers most strongly affect homeowners' willingness to connect. Across all groups, “High initial investment” was the most frequently cited barrier, followed closely by “Uncertainty about cost savings” and “Lack of clear information.” Among the Resistant Traditionalists, trust-based concerns such as “Distrust in leading party” and “Lack of control” were particularly prominent. For Cautious Considerers, financial concerns combined with practical and procedural uncertainties played a major role, especially in the Consideration phase.

Interestingly, even among the Enthusiastic Adopters, who expressed willingness, around 25% still reported concern about financial feasibility and lack of technical clarity. This indicates that willingness does not imply unconditional readiness, but rather a need for continuous reassurance and information. These findings confirm that barriers are both attitudinal and situational, and often cumulative, particularly in early decision phases.

### 8.2.2 SQ2b: How do these barriers vary across user groups and phases of the implementation process?

Barriers are not static; they shift in relevance and intensity across both user groups and project phases. The Awareness phase is dominated by information-related barriers, especially for the Resistant Traditionalist and Neutral groups. In the Consideration phase, financial concerns, particularly high upfront costs and uncertain payback periods, become more pronounced. For many homeowners, the Decision phase introduces anxiety about contractual complexity and loss of autonomy.

Survey segmentation shows that 60% of Resistant Traditionalists reported the highest concentration of barriers in the Awareness and Consideration phases. Cautious Considerers experienced a barrier peak in the Consideration phase, with financial and procedural concerns most prominent. Enthusiastic Adopters showed fewer barriers overall, but still experienced concerns related to technical feasibility and user-friendliness, particularly in later stages such as Execution.

These findings underscore the need for timely and phased intervention strategies: trust-building and awareness in early phases, financial transparency and contractual clarity in the middle, and supportive services during Execution and Experiencing.

### 8.2.3 SQ3: How can project initiators use different strategies to effectively engage different end-user groups and optimize their willingness to connect throughout the heat grid implementation process?

Based on the empirical findings from the survey and case studies, this thesis proposes a phase-based engagement strategy matrix. This framework aligns homeowner personas with the key decision-making and project phases, allowing initiators to target communication and support more effectively.

For example, the Resistant Traditionalist benefits from early-stage interventions such as municipal-led letters explaining cost comparisons and subsidies, whereas the Cautious Considerer responds better to interactive sessions and transparent, personalized contract offers. The Enthusiastic Adopter should be engaged early in the Initiation phase, offered detailed technical briefings, and activated as an ambassador in later phases.

The survey confirmed that drivers such as “Trust in leading party”, “Clear overview of household benefits,” and “Positive word-of-mouth” were consistently important, but varied in impact depending on the persona and phase. Execution of these strategies should involve clearly defined responsibilities: municipalities as the trusted initiators, energy providers as transparent financial communicators, and technical actors as providers of responsive, high-quality service.

In summary, engaging homeowners in the heat grid transition requires a well-orchestrated mix of communication, financial support, and trust-building, tailored to the specific needs and concerns of each group across the entire process timeline.

### 8.2.4 MQ: How can different end-user groups be effectively engaged in the heat grid implementation process to optimize their willingness to connect?

This research demonstrates that effective engagement of homeowners in heat grid implementation depends on a targeted, trust-oriented, and phase-based approach, tailored to the characteristics and decision-making behavior of different end-user groups. Two overarching principles guide the development of engagement strategies:
1. Strategies can be structured based on personas, or
2. Based on the barriers most likely to occur.
In both cases, the foundation lies in understanding who the potential end-users are and what defines them.

The first step is to identify potential end-users based on their household, building, and behavioral characteristics, such as income, ownership type, energy performance of the dwelling, and trust in institutions. From this understanding, residents can be placed into a persona group they most likely resonate with; the Resistant Traditionalist, Cautious Considerer, or Enthusiastic Adopter. Each persona predicts a distinct set of barriers, drivers, and support needs, enabling initiators to proactively design strategies that reduce resistance, build trust, and ultimately increase willingness.

Survey results confirm the relevance of this tailored approach. Among homeowners surveyed, only 22% were clearly willing to connect, while 42% were undecided and 36% were resistant. The main barriers cited, particularly by the neutral and resistant groups, included lack of information, high upfront costs, distrust in the leading party, and perceived loss of control. These vary across decision-making phases: information and trust barriers dominate early on, while cost and contract concerns surface later. Conversely, key drivers of willingness include clear financial benefits, transparent communication, trust in the leading party, and a sense of contributing to sustainability goals.

In response, this thesis proposes a strategy framework grounded in four core engagement principles:

1. Identify: Classify potential end-users using observable characteristics (ownership type, building type, income level, etc.).

2. Predict: Map these user profiles to one of the three personas to understand likely barriers and drivers.

3. Engage Early: Build trust and awareness in the Initiation and Consideration phases using appropriate channels (like municipality-led outreach, personalized home visits, peer ambassadors).

4. Tailor: Customize the approach method and information based on the persona's needs, ranging from low-effort, fact-based communication to participatory co-creation.
   OR Customize the approach method and strategy based on the key barriers that need to be addressed in the specific project context

The persona-based strategy matrix ensures that engagement efforts are not generic but phased, specific, and anticipatory. For example, the Resistant Traditionalist is best approached through simple cost comparisons and municipality-backed credibility in the Awareness phase, while the Cautious Considerer benefits from detailed information and individual consultations during the Decision phase. The Enthusiastic Adopter, on the other hand, thrives when engaged early and asked to take an active role in the planning and promotion of the project.

In conclusion, optimizing homeowners' willingness to connect requires more than just incentives, it requires an integrated, informed strategy that matches communication, support, and timing to the needs and expectations of each homeowner profile.

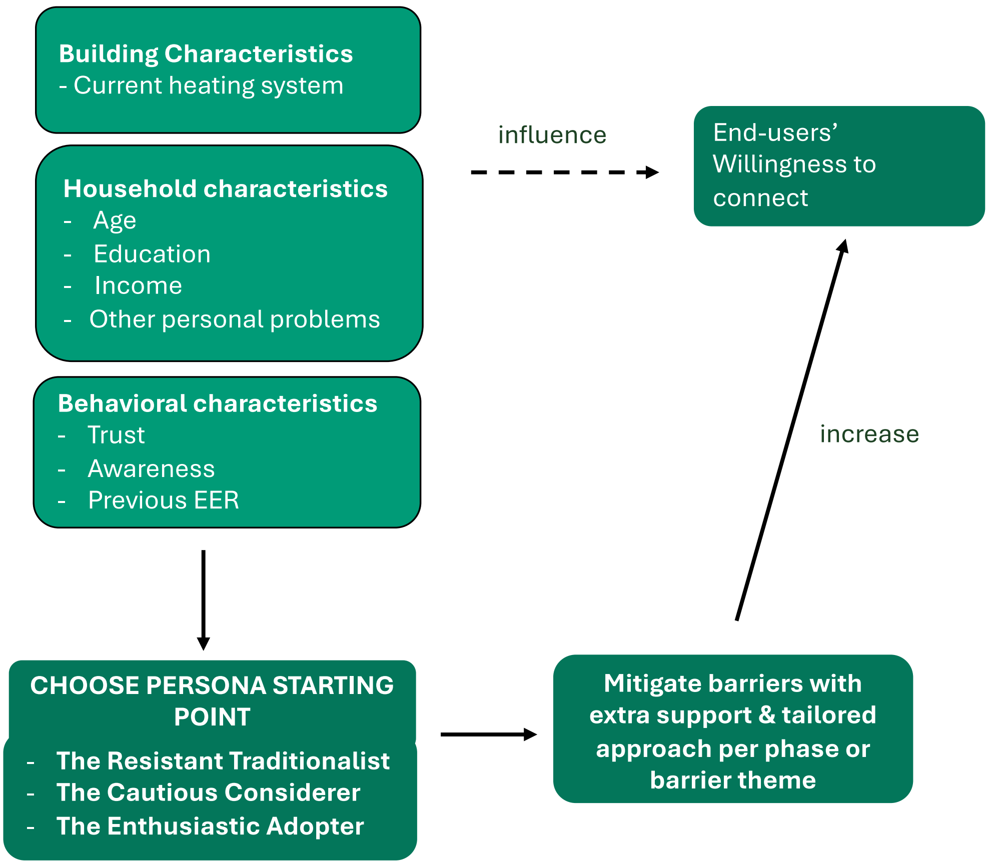



*Figure 49: Strategy (author)*

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# APPENDIX

## APPENDIX A – Barriers, Support & Drivers per persona and phase

| | End-user group | Against | | | | | Neutral | | | | | Willing | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Phase | Awareness | Consideration | Decision | Excecution | Experiencing | Awareness | Consideration | Decision | Excecution | Experiencing | Awareness | Consideration | Decision | Excecution | Experiencing |
| Category | Barriers | | | | | | | | | | | | | | | |
| Informational & Organizational | 1. Lack of information | 41% | 27% | 10% | 3% | 3% | 38% | 32% | 13% | 6% | 2% | 34% | 27% | 15% | 6% | 2% |
| | 2. Accessibility of information | 34% | 26% | 12% | 5% | 4% | 30% | 35% | 15% | 4% | 3% | 21% | 32% | 15% | 10% | 2% |
| | 3. Information overload | 36% | 27% | 11% | 5% | 3% | 31% | 35% | 17% | 5% | 3% | 26% | 34% | 16% | 9% | 2% |
| | 4. Lack of awareness* | 35% | 26% | 12% | 6% | 3% | 31% | 34% | 16% | 5% | 3% | 22% | 34% | 16% | 7% | 5% |
| | 5. Nuisance | 24% | 22% | 11% | 22% | 3% | 15% | 28% | 15% | 27% | 4% | 9% | 25% | 20% | 28% | 3% |
| Behavioral & Social | 6.Lack of trust in leading party* | 30% | 24% | 17% | 10% | 4% | 21% | 28% | 22% | 12% | 5% | 13% | 25% | 29% | 11% | 5% |
| | 7.Preferring individual heating solutions over collective systems | 29% | 29% | 14% | 6% | 7% | 20% | 40% | 18% | 6% | 4% | 16% | 34% | 19% | 9% | 5% |
| | 8.Skepticism about system performance | 32% | 27% | 14% | 7% | 7% | 22% | 36% | 19% | 7% | 5% | 13% | 30% | 19% | 11% | 8% |
| | 9.Resistance to change from existing heating system | 30% | 27% | 13% | 8% | 5% | 22% | 35% | 17% | 8% | 4% | 17% | 30% | 17% | 9% | 4% |
| | 10.Influence of negative experiences from peers | 34% | 23% | 13% | 5% | 6% | 24% | 31% | 16% | 6% | 5% | 24% | 24% | 14% | 9% | 6% |
| | 11.No renewable energy source | 35% | 25% | 13% | 5% | 5% | 24% | 33% | 19% | 6% | 4% | 22% | 29% | 17% | 9% | 5% |
| | 12.Too much effort preparing for the connection* | 30% | 26% | 13% | 12% | 4% | 21% | 31% | 19% | 14% | 3% | 13% | 26% | 22% | 15% | 4% |
| Economic & Financial | 13.High initial cost* | 27% | 32% | 15% | 10% | 4% | 17% | 42% | 21% | 9% | 3% | 11% | 38% | 28% | 9% | 3% |
| | 14.Uncertainty about long-term cost savings compared to current heating system | 28% | 34% | 14% | 6% | 6% | 19% | 43% | 20% | 7% | 3% | 13% | 43% | 20% | 7% | 5% |
| | 15. Perceived risk of monopolistic pricing | 31% | 28% | 16% | 6% | 6% | 19% | 39% | 23% | 6% | 4% | 13% | 32% | 25% | 12% | 4% |
| | 16. Future cost* | 31% | 27% | 17% | 6% | 6% | 23% | 34% | 22% | 5% | 5% | 14% | 26% | 22% | 14% | 8% |
| | 17.Costs of alternatives | 28% | 29% | 20% | 5% | 5% | 21% | 29% | 30% | 6% | 4% | 14% | 29% | 29% | 9% | 5% |
| Legal & Technical | 18.Changing policies | 29% | 25% | 21% | 6% | 4% | 20% | 31% | 30% | 6% | 2% | 14% | 30% | 29% | 7% | 5% |
| | Support measures | | | | | | | | | | | | | | | |
| | 1.Clear information and education about the benefits and operation of heat grid | 42% | 27% | 9% | 4% | 3% | 39% | 35% | 10% | 4% | 3% | 37% | 29% | 17% | 9% | 2% |
| | 2.More insights about the actual initial investment and other cost | 30% | 38% | 10% | 4% | 3% | 22% | 51% | 13% | 5% | 2% | 21% | 47% | 14% | 9% | 3% |
| | 3. Increased trust in leading parties | 33% | 28% | 15% | 6% | 4% | 24% | 35% | 22% | 8% | 2% | 22% | 33% | 25% | 10% | 4% |
| | 4. Community engagement with feedback opportunities | 36% | 26% | 12% | 4% | 5% | 26% | 35% | 15% | 6% | 5% | 21% | 34% | 21% | 7% | 7% |
| | 5. Customer support incl. service and maintenance | 29% | 28% | 14% | 7% | 7% | 18% | 34% | 17% | 12% | 9% | 18% | 27% | 23% | 11% | 14% |
| | 6. Participation opportunity about the connection process beforehand | 34% | 28% | 12% | 6% | 4% | 28% | 36% | 14% | 6% | 4% | 21% | 37% | 18% | 10% | 6% |
| | 7. Usage price stability guarantees | 27% | 32% | 17% | 6% | 4% | 17% | 39% | 25% | 6% | 4% | 14% | 41% | 29% | 8% | 3% |
| | 8. More financial incentives or subsidies | 25% | 37% | 14% | 4% | 4% | 15% | 48% | 20% | 6% | 3% | 12% | 44% | 22% | 10% | 5% |
| | 9.Option to use heat network for cooling | 29% | 31% | 12% | 7% | 5% | 19% | 40% | 17% | 8% | 6% | 18% | 36% | 20% | 13% | 6% |
| | 10.Additional legislation that makes a heat grid connection more attractive | 30% | 30% | 14% | 5% | 5% | 20% | 38% | 22% | 7% | 4% | 16% | 40% | 21% | 9% | 6% |
| | Drivers | | | | | | | | | | | | | | | |
| Informational & Organizational | 1.Clear overview of the benefits for their household | X | X | | | | X | | | | | X | X | X | | |
| | 2.Accessible and understandable information about the system* | | | | | | | | | | | | | | | |
| | 3.Transparency about project timeline and connection process | | | | | | | | | | | | X | X | x | |
| | 4.Availability of user-friendly support before, during and after connection* | | X | X | X | X | | | | | | | | X | X | X |
| Behavioral & Social | 5.Social norm campaigns, people don't want to be left behind from their peers | | | | | | | | | | | | | | | |
| | 6.Positive word-of-mouth recommendations from friends/family/neighbors | | | | | | | | | | | | | | | |
| | 7.Trust in leading party* | X | X | | | | | X | X | X | X | | | X | X | x |
| | 8.The feeling of contributing to sustainability goals | | | | | | | | | | | | | | | |
| | 9. Increased level of comfort in my house | | X | | X | X | X | X | X | | X | | | | | |
| Economic & Financial | 10.Lower energy bills* | X | X | X | | X | X | X | X | | X | X | X | | | X |
| | 11.Increased property value | X | | | | X | X | | | | X | | | | | |
| Legal & Technical | 12.Energy independence (less reliance on fossil fuels) | | | | | | | | | | | | | | | |
| | 13.Compatibility of heat network with existing (heating) systems | | | | | | | | | | | | | | | |
| | 14.Flexibility to combine heat network connection with other measures (energy efficiency measures like insulation or window replacement / aesthetic measures like new kitchen or bathroom) | | | | | | | | | | | | | | | |

| | |
|---|---|
| (grey) | most important |
| (green) | *validated by case studies |
| X | Suitable moment |

## APPENDIX B – Strategies per persona and phase

| End-User Group | Phase | Strategy/Key Action | Approach Method | Overcome Barriers | Used Support/Drivers | Address in Project Phase | Responsible Stakeholder |
|---|---|---|---|---|---|---|---|
| The Resistant Traditionalist | Awareness | - Build trust through presence.<br>- Raise awareness and educate on why the energy transition is needed | - One-way outreach (letters/emails) led by the municipality<br>- Being present at local event<br>-one on one talks (with trusted community member) | - Lack of information<br>- Lack of trust in leading party | - Clear information<br>- Trust in leading party<br>- Lower energy bills | Initiation | Municipality/ Trusted community member |
| | Consideration | Provide simple cost comparisons and clear communication emphasizing financial benefits | Clear presentations or demonstrations on installation | High initial cost, uncertainty about savings, effort of preparation | Financial support, price guarantees, clear info | Feasibility / Contracting | Municipality / Energy provider |
| | Decision | Emphasize minimal disruption of switching and highlight cost clarity | Direct one-on-one consultation | Contract complexity, pricing trust issues | Transparent contracts, fixed-price offers | Contracting | Municipality / Energy provider |
| | Execution | Ensure low-nuisance installation with user-friendly support | Dedicated contact person for installation updates & questions | Nuisance and lack of clarity about process | Customer service, comfort guarantee | Realization | Installation contractor |
| | Experiencing | Provide maintenance and support and show actual system performance | - Follow-up survey about experience<br>-Emails/app with up-to-date system performance numbers communication and guidance | Uncertainty about long-term performance | Positive word-of-mouth, comfort improvement | Operation | Customer service / Energy company |
| The Cautious Considerer | Awareness | Provide trustworthy, transparent information highlighting benefits | Interactive outreach (Q&A sessions, info evenings) | Lack of awareness, initial trust issues | Detailed cost comparisons, peer recommendations | Feasibility / Initiation | Municipality / Independent advisors |
| | Consideration | Offer personalized advice via home-specific cost-benefit analyses | Workshops and expert consultations | Financial and reliability concerns | Subsidies, usage guarantees, peer examples | Feasibility / Contracting | Municipality / Independent advisors |
| | Decision | Ensure clear pricing and simple contracts | Written quotes and one-on-one counseling | Contract complexity, unclear costs | Fixed-price schemes, transparent terms | Contracting | Municipality / Legal advisors |
| | Execution | Provide hands-on support during installation | Dedicated liaison and regular updates | Preparation concerns, need for involvement | Customer service and problem resolution | Realization | Installation contractor |
| | Experiencing | Follow up and highlight comfort and savings achieved | Surveys and feedback loops | Performance validation | Satisfaction guarantees and testimonials | Operation | Customer service/ Energy Company |
| The Enthusiastic Adopter | Awareness | Engage early with transparent information and sustainability framing | Community events, digital platforms | Minor info clarification | Sustainability motivation, technical trust | Initiation | Municipality / Energy provider |
| | Consideration | Provide technical details and reinforce incentives | Briefings, site visits, technical FAQs | Future cost or tech doubt | Incentives, advanced data, community engagement | Feasibility / Contracting | Municipality / Energy provider |
| | Decision | Provide simple contracts and price guarantees | Workshops and online contract platforms | Legal/financial closure | Stable pricing, contract clarity | Contracting | Municipality / Energy provider |
| | Execution | Smooth connection and involve as ambassador | Updates and feedback moments | Nuisance risk | Fast install, technical responsiveness | Realization | Municipality / Energy provider |
| | Experiencing | Keep involved as community promoter | User forums and shared stories | Avoid backsliding in trust | Word-of-mouth, sustainability recognition | Operation | Customer service/ Energy Company |

## APPENDIX C - Interview protocol

**Main Questions for the Interview (1 hour)**

**A. Background & Project (5 min)**

**1. Can you briefly introduce yourself and describe your role in heat network projects?**

o How long have you been involved in heat network projects?
o Which projects have you previously worked on?
o What is your specific role and responsibility within this project?

---

**B. Collaboration & Decision-Making (15 min)**

**2. Can you describe how this project emerged and how the process developed from initiation to implementation?**

o What was the reason for starting this project?
o Who took the initiative?
o Other involved parties/stakeholders and collaboration.
o The process and roles of involved parties—from initiation to execution?
o What were the key milestones?
o What were the biggest challenges? And how were they solved?

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**C. End-User Involvement (15-20 min)**

**3. How and at what point in the process were end-users involved in the project?**

o In what ways and by whom were end-users informed (information sessions, surveys, workshops, letters, door-to-door visits, other channels)?
o What information did they receive to make a decision?
o How was their willingness to connect measured? (e.g., surveys, intention statements, contracts)
o How was it determined which end-users needed to be involved, and was a distinction made between different types of end-users (tenants, homeowners, homeowners' associations, or based on other criteria)? If so, how was this managed?
o Was there a distinction between tenants, homeowners, and homeowners' associations?
o What worked well in communication with end-users? What could have been improved?
o Do you think the current engagement strategies by leading parties are effective in ensuring user participation? Why or why not?

---

**D. Barriers and Success Factors (15 min)**

**4. What were the main concerns of end-users regarding connection to the heat network?**

o What were the biggest obstacles to involving end-users in the first place?
o What were the most common objections from homeowners (and tenants)?
o How was distrust or resistance towards the heat network handled?

**5. What do you consider the key success factors in increasing end-users' willingness to connect?**

o What were the most effective methods to convince people?
o Specific (financial) incentives or communication strategies that worked best?
o Were financial or other incentives used to encourage participation?
o How did willingness to connect differ between different target groups?

---

**E. Conclusion (5-10 min)**

**6. Are there lessons from this project that you would approach differently in the future?**

o What would you do differently in a future project?
o Are policy or process adjustments needed?
o Other relevant insights from this project?

**7. Are there other people or parties I should speak to for more insights?**

o Colleagues
o End-users

# APPENDIX D – Informed consent letter

*Informed consent letter*

You are invited to participate in a research study conducted by Negin Heshmati, Master student Management in the Built Environment at the TU Delft faculty of Architecture.
The title of the research is: “Towards scaling up heat grid implementation in the Netherlands by understanding the willingness to connect of different end-user groups: barriers, drivers and engagement strategies”

The purpose of this study is to gather insights into the involvement of end-users in district heating projects, particularly homeowners. Focusing on the decision-making process, communication strategies, and stakeholder roles, the aim is to come up with tailored strategies for different end-user groups to increase willingness to connect to a heat grid among homeowners. Your responses will contribute to academic research for my Master thesis at TU Delft.

All information provided during the interview will be treated confidentially.
Your identity will remain anonymous in all reports, publications, or presentations resulting from this research.
Data will be anonymized during the transcription process, and personal identifiers will be removed.

With your consent, the interview will be audio-recorded to ensure accuracy during transcription. The recordings will be securely stored and only accessible to the researcher. After transcription and anonymization, the recordings will be permanently deleted.

The anonymized data will be used solely for academic purposes related to this research and may be included in reports, academic papers, or presentations.

Your participation is voluntary. You may refuse to answer any questions or withdraw from the interview at any time without any consequences.

Sincerely,
Negin Heshmati

| PLEASE TICK THE APPROPRIATE BOXES | Yes | No |
|---|---|---|
| **A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION** | | |
| 1. Ik heb de informatie over het onderzoek gedateerd [*DD/MM/YYYY*] gelezen en begrepen, of deze is aan mij voorgelezen. Ik heb de mogelijkheid gehad om vragen te stellen over het onderzoek en mijn vragen zijn naar tevredenheid beantwoord. | ☐ | ☐ |
| 2. Ik doe vrijwillig mee aan dit onderzoek, en ik begrijp dat ik kan weigeren vragen te beantwoorden en mij op elk moment kan terugtrekken uit de studie, zonder een reden op te hoeven geven. | ☐ | ☐ |
| 3. Ik begrijp dat mijn deelname aan het onderzoek de volgende punten betekent:<br>• Er wordt een audio opgenomen<br>• Er worden schriftelijke notities gemaakt | ☐ | ☐ |
| 4. Ik begrijp dat de studie uiterlijk in de zomer van 2025 eindigt. | ☐ | ☐ |
| **B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)** | | |
| 5. Ik begrijp dat mijn deelnamen geheel vrijwillig is en ik ervoor kan kiezen om geen antwoord te geven op bepaalde vragen | ☐ | ☐ |
| 6. Ik begrijp dat mijn deelname betekent dat er mogelijk persoonlijke identificeerbare informatie en onderzoeksdata worden verzameld, met het risico dat ik hieruit geïdentificeerd kan worden. Deze data zijn als volgt:<br>• Naam, telefoonnummer, werkgever, email adres<br>• Audio opname | ☐ | ☐ |
| 7. Ik begrijp dat de volgende stappen worden ondernomen om het risico van een databreuk te minimaliseren, en dat mijn identiteit op de volgende manieren wordt beschermd in het geval van een databreuk:<br>• De data zal op een beveiligde drive van de TU Delft worden opgeslagen gedurende het onderzoek<br>• Pseudo anonimiteit: Naam zal veranderd worden in een code. In dit onderzoek is het wel van belang om algemene rol en het project waar u aan werkt wel te delen.<br>• Audio opname zal worden verwijderd zodra het interview getranscribeerd is. | ☐ | ☐ |
| 8. Ik begrijp dat de persoonlijke informatie die over mij verzameld wordt en mij kan identificeren, zoals naam telefoonnummer en email adres, niet gedeeld worden buiten het onderzoeksteam. | ☐ | ☐ |
| 9. Ik begrijp dat de persoonlijke data die over mij verzameld wordt, permanent vernietigd wordt door het te verwijderen van de drive na afloop van het onderzoek (zomer 2025) | ☐ | ☐ |
| **C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION** | | |
| 10. Ik begrijp dat na het onderzoek de geanonimiseerde informatie gebruikt zal worden voor<br>• Master thesis report, gepubliceerd in de open-access TU Delft student repository<br>• Mogelijk verdere onderzoeken | ☐ | ☐ |
| 11. Ik geef toestemming om mijn antwoorden, ideeën of andere bijdrages anoniem te quoten in resulterende producten. | ☐ | ☐ |

**Signatures**

| | | |
|---|---|---|
| Name of participant | Signature | Date |

# Plan Overview

*A Data Management Plan created using DMPonline*

**Title:** Master thesis MBE: Users' perspective towards scaling up heat network implementation in the Netherlands

**Creator:**Negin Heshmati

**Affiliation:** Delft University of Technology

**Template:** TU Delft Data Management Plan template (2021)

**Project abstract:**

This research explores the challenges and opportunities in engaging households in the Netherlands to connect to heat networks as part of the energy transition. Heat networks, which use centralized (renewable) energy sources to distribute heat to multiple buildings, are critical for reducing reliance on fossil fuels and achieving national climate goals. Especially now net congestion is hindering electrification. However, household willingness to connect remains a significant challenge due to factors such as cost concerns, lack of awareness, and mistrust in involved parties.

The study aims to identify barriers and drivers influencing the willingness of households to connect to heat networks. Using a combination of survey and stakeholder analysis, the research evaluates where in the process these barriers occur and how they can be mitigated. Particular attention is given to how households prefer to be approached, the type of information they require in order to make a decision, and the timing of communication. Household characteristics will be used to categorize different groups and their preferences for a more tailored approach.

The outcomes of this study are expected to provide actionable recommendations for municipalities and energy providers to improve their strategies for engaging households. These insights will contribute to more effective implementation of heat networks, ensuring greater adoption while addressing the concerns of end-users. The findings will offer a roadmap for integrating user perspectives into sustainable energy initiatives.

**ID:** 166126

**Start date:** 16-12-2024

**End date:** 30-04-2025

**Last modified:** 06-02-2025

# Master thesis MBE: Users' perspective towards scaling up heat network implementation in the Netherlands

## 0. Administrative questions

**1. Name of data management support staff consulted during the preparation of this plan.**

*The data and DMP for this project has been discussed with my supervisor, Queena Qian on 7-12-2024*

*My faculty data steward, Janine Strandberg, has reviewed this DMP on 9-1-2025 (first round of feedback in DMP online) and on 20-1-2025 (second round of feedback via PDF)*
*On 6-2-2025 an additional advise meeting took place with her, to discuss the input from the Privacy team (Lieke Font Freide).*

*On 5-2-2025 the Privacy team (Lieke Font Freide) stated that an additional agreement between the TU Delft and Panel Inzicht about the survey is not required.*
*Regarding the anonymization of the survey she stated that the opening statement of the survey should explain that the participants' IP adres will be collected in the first place, but deleted before data-analysis and not stored or linked to the survey data.*

- 

**2. Date of consultation with support staff.**

2025-01-09

## I. Data description and collection or re-use of existing data

**3. Provide a general description of the type of data you will be working with, including any re-used data:**

| **Type of data** | **File format(s)** | **How will data be collected (for re-used data: source and terms of use)?** | **Purpose of processing** | **Storage location** | **Who will have access to the data** |
|---|---|---|---|---|---|
| Survey results (incl personal data like age, income, savings, Municipality, household composition, employment status, dwelling features + opinion on heat grid connection+ IP adresses (which will be deleted after data collection> anonymized after collection via Qualtrics | .cvs | Online survey. The survey will be distributed by a third party, Panel Inzicht. However, data will be collected through Qualtrics. | Collecting data to create persona's and analyse in order to understand end-users perspectives towards connecting to a heat grid | Qualtrics server (temporary storage) +Surfdrive (primary storage) | The project team: Primary researcher and thesis supervisors Queena Qian, Elham Maghsoudi Nia and Ladislav Krutisch |

Table 1: Experiment 1=Online survey among homeowners, distributed by Panel Inzicht as part of the university research Integrale Energietransitie Bestaande Bouw (IEBB).

| Type of data | File format(s) | How will data be collected (for re-used data: source and terms of use)? | Purpose of processing | Storage location | Who will have access to the data |
|---|---|---|---|---|---|
| Personally Identifiable Information (PII): participants' name, email, employer, possibly mobile number | .pdf | Contact information for participants, received from municipalities. And consent forms that will be signed before the interview that contain participants name. | For administrative purposes: obtaining informed consent and communicating with participants | Surfdrive (primary storage) | The project team: Primary researcher and thesis supervisors Queena Qian, Elham Maghsoudi Nia and Ladislav Krutisch |
| audio recordings of interviews | .mp3 | Interviews are conducted when visiting a "buurthuis" in the case study area. Audio-recordings are made on an external device, before being moved to Surfdrive. Recordings are deleted after transcription. | Capturing opinions on end user participation in heat grid projects and understanding the process | External recording device (temporary storage) + Surfdrive (primary storage) | The project team |
| Anonymous transcriptions of interviews | .txt. | Anonymous transcriptions created manually based on audio-recordings. | Making sure that the interview insights can be anonymized and used for analysis | Surfdrive (primary storage) | The project team |

Table 2: Experiment 2= Interviews with experts working on the case study projects i'm analyzing.

**4. How much data storage will you require during the project lifetime?**

- < 250 GB

probably even < 50GB

## II. Documentation and data quality

**5. What documentation will accompany data?**

- README file or other documentation explaining how data is organised
- Methodology of data collection
- Data will be deposited in a data repository at the end of the project (see section V) and data discoverability and re-usability will be ensured by adhering to the repository’s metadata standards

## III. Storage and backup during research process

**6. Where will the data (and code, if applicable) be stored and backed-up during the project lifetime?**

- SURFdrive
- Project Storage at TU Delft

***Experiment 1:***
*The survey will be created with Qualtrics and data will be collected via Panel Inzicht. However, Panel Inzicht will not have access to an extend to which they can export raw data files, since the results will only be accessible through my own Qualtrics account to which they don't have access. So the Qualtrics server will also be used for temporary storage of survey responses.*

*Panel Inzicht will in the first place collect the IP-adresses from the participants, but this will be deleted before data processing, so survey outcomes cannot be linked to individual participants.*

*And for ease of the project the data will also be temporarily stored on researchers SURFdrive account and shared with the project team (as mentioned in Q3).*

*Lastly the IEBB Project Data Storage at TU Delft will be the storage place for the research data.*

***Experiment 2:*** *Project data storage (primary research storage*
*+*
*researchers' SURFdrive account and shared with the project team (temporary storage)*

## IV. Legal and ethical requirements, codes of conduct

**7. Does your research involve human subjects or 3rd party datasets collected from human participants?**

- Yes

**8A. Will you work with personal data?  (information about an identified or identifiable natural person)**

***If you are not sure which option to select, first ask your [Faculty Data Steward] for advice. You can also check with the [privacy website] . If you would like to contact the privacy team: privacy-tud@tudelft.nl, please bring your DMP.***

- Yes

***Experiment 1:***
*The research will collect personal data like income and savings(not exact numbers, but in terms of income brackets). Furthermore the participants will be asked for their employment status, Municipality they live in, dwelling features and their opinion/experience about heat grid connection. Since these questions include financial/personal data, the data can involve sensitive data. To reduce potential risks, the option "I don't know" and "I prefer not to say" is included for sensitive questions to make sure participants have the choice to not share this sensitive data.*

*The research will, in the first place, collect IP addresses as well, since Panel Inzicht is distributing the survey among it's network, so the survey cannot be considered fully anonymous. However, the IP adreses will be deleted before analyzing any of the data. Furthermore all data collected will be anonymized directly and will be stored and processed according to the European General Data Protection Regulation.*

*After consultation with the Privacy Team, this is communicated in the opening statement of the survey to prevent confusion about anonymity*

***Experiment 2:***
*Some personal data will be processed for administrative reasons, namely to obtain informed consent and communicate with participants.*

**8B. Will you work with any other types of confidential or classified data or code as listed below? (tick all that apply)**

***If you are not sure which option to select, ask your [Faculty Data Steward] for advice.***

- No, I will not work with any confidential or classified data/code

**9. How will ownership of the data and intellectual property rights to the data be managed?**

***For projects involving commercially-sensitive research or research involving third parties, seek advice of your [Faculty Contract Manager] when answering this question. If this is not the case, you can use the example below.***

***Experiment 1:***
*The primary researcher is using the data for writing her master thesis at the TU Delft. However, the survey is funded by IEBB, it is part of a university research and the university will be the owner of the dataset derived from this research. The data will be available for other researchers within this project as well. During the active phase of research, the primary researcher from TU Delft will*

*manage the access rights to data and other outputs and the data will be accessible for future research since the data will be publicly released following the TU Delft Research Data Framework Policy.*

*An Intellectual Property Rights agreement will be established between researcher and supervisor to officially state this.*

***Experiment 2:***
*anonymized data will be publicly released following the TU Delft Research Data Framework Policy.*

**10. Which personal data will you process? Tick all that apply**

- Signed consent forms
- Email addresses and/or other addresses for digital communication
- IP addresses
- Other types of personal data - please explain below
- Gender, date of birth and/or age

**Experiment 1:**
The privacy team officer stated that an additional privacy agreement is not required for the collaboration between Panel Inzicht and TU Delft.

The survey will collect the following data:

- IP adresses: Since a third party is distributing the survey, IP addresses will be collected in the first place. They will be deleted and all data will be anonymized before analyzing it.
- *Personally Identifiable Research Data* PIRD/other types of *personal data*
  *Dwelling features: building year, energy consumption, m2, previous renovations, energy label*
  *Personal data: employment status, age, income, savings, household composition+type,*
  *Financial information: income and savings deposits*
  *Municipality of residence*
- *Personally Identifiable Research Data*

  ***Experiment 2:***
  - *Personally Identifiable Information (PII): interviewee name, employer, email address, and possibly mobile phone number are processed for administrative reasons, namely to obtain informed consent and communicate with participants*
  - *Personally Identifiable Research Data (PIRD): Audio recordings*

**11. Please list the categories of data subjects**

**Experiment 1:**
Variety of homeowners in the Netherlands.
**Experiment 2:**
Professionals working on heat grid projects and end-user representatives

**12. Will you be sharing personal data with individuals/organisations outside of the EEA (European Economic Area)?**

- No

**15. What is the legal ground for personal data processing?**

- Informed consent

Informed consent for both experiments

If the participant doesn't agree to the opening statement, then they will automatically be redirected to the end and cannot participate.

opening statement survey:

**Dear participant,**
**Thank you for your interest in participating in our research study!**
**Geachte deelnemer,**
**Hartelijk dank voor uw interesse in deelname aan ons onderzoek!**

This questionnaire was developed by researchers at Technische Universiteit Delft (TU Delft) as part of the research project Integrale Energietransitie Bestaande Bouw (IEBB).
Deze vragenlijst is ontwikkeld door onderzoekers van de Technische Universiteit Delft (TU Delft) als onderdeel van het onderzoeksproject Integrale Energietransitie Bestaande Bouw (IEBB).

Furthermore, this survey was developed as part of a Master thesis research at the Faculty of Architecture and the Built Environment.
Daarnaast is deze enquête ontwikkeld als onderdeel van een afstudeeronderzoek aan de faculteit Architectuur en Built Environment.

Our goal with this research is to understand Dutch homeowners' perspectives towards heat grid connection and the broader topic of the heat transition.
Ons doel met dit onderzoek is om inzicht te krijgen in de houding van Nederlandse huiseigenaren ten opzichte van warmtenetaansluiting en het bredere onderwerp van de warmtetransitie.

Your privacy is important to us.
Participation in this survey is voluntary, and your data will be used solely for research purposes, we will use all information anonymously. Note that because of your participation via Panel Inzicht, your IP-adres will be collected in the first place, however this will be deleted before starting the data analysis.
You can opt-out of the survey at any time.
Uw privacy is belangrijk voor ons.
Deelname aan dit onderzoek is vrijwillig, en uw gegevens worden uitsluitend gebruikt voor onderzoeksdoeleinden, wij gebruiken alle informatie anoniem. Vanwege uw deelname via Panel Inzicht, wordt uw IP-adres in eerste instantie wel verzameld, deze zal echter worden verwijderd voordat de data-analyse begint.
kunt te allen tijde afzien van deelname aan het onderzoek.

The survey will take you around 15-20 min.
Het onderzoek duurt ongeveer 15-20 minuten.

By clicking I agree below, you confirm that you have read and understood the information provided above.
Door hieronder op Ik ga akkoord te klikken, bevestigt u dat u de bovenstaande informatie hebt gelezen en begrepen.

**16. Please describe the informed consent procedure you will follow:**

***Experiment 1:***
*At the start of the survey, the description and introduction will state that the data will be processed anonymously, and they are voluntarily filling in the survey. And the data will be accessible for other research in the future as well. If they do not agree to this, they will not be able to fill out the questions. Furthermore, they can drop out of the survey at any time.*

***Experiment 2:***
*Before the interview and my recording starts, the participants will read the informed consent letter and sign this. If they do not agree with one or more points, then the interview will not be conducted. And ofcourse they can always choose to not answer a question or stop the interview.*

**17. Where will you store the signed consent forms?**

- Same storage solutions as explained in question 6

**18. Does the processing of the personal data result in a high risk to the data subjects?**

**If the processing of the personal data results in a high risk to the data subjects, it is required to perform a Data Protection Impact Assessment (DPIA). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data during your research (check all that apply).**

**If two or more of the options listed below apply, you will have to complete the DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to receive support with DPIA.**
**If only one of the options listed below applies, your project might need a DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to get advice as to whether DPIA is necessary.**

**If you have any additional comments, please add them in the box below.**

- Sensitive personal data

see Q10

**19. Did the privacy team advise you to perform a DPIA?**

- No

On 5-2-2025, Lieke Font Freide from the TU Delft Privacy Team stated that it is not needed.

**22. What will happen with personal research data after the end of the research project?**

- Anonymised or aggregated data will be shared with others
- Other - please explain below
- Personal research data will be destroyed after the end of the research project

***Experiment 1:***

- *Personal data: IP-adresses will be destroyed before even analyzing the data.*
- *Anonymized or aggregated data will be stored on the TU Delft storagefor 10 years and available for further research by other researchers*
- *See Q9 for further explanation*

***Experiment 2:***
*Anonymous data will be shared*

## V. Data sharing and long-term preservation

**27. Apart from personal data mentioned in question 22, will any other data be publicly shared?**

- I do not work with any data other than personal data

**29. How will you share research data (and code), including the one mentioned in question 22?**

- All anonymised or aggregated data, and/or all other non-personal data will be uploaded to 4TU.ResearchData with public access

*As indicated in Question 22, anonymised data will potentially be reused for scientific investigation in the future. For example researchers of this research project (IEBB) may conduct further exploratory analysis and researchers from another institute may reuse the anonymised data for meta analysis upon request. We will share the metadata of the whole research dataset in 4TU.ResearchData in accordance with the FAIR principles. Anonymized data may be shared with researchers who conduct further investigation.*

**30. How much of your data will be shared in a research data repository?**

- < 100 GB

**31. When will the data (or code) be shared?**

- Other - please explain

- As soon as corresponding results (papers, theses, reports) are published

During the research, the anonymized data can already be used by other researchers of the IEBB project, but the data will be shared in the repository no later than upon completion of this master thesis.

**32. Under what licence will be the data/code released?**

## VI. Data management responsibilities and resources

**33. Is TU Delft the lead institution for this project?**

- Yes, the only institution involved

**34. If you leave TU Delft (or are unavailable), who is going to be responsible for the data resulting from this project?**

*Thesis supervisor Queena Qian*
*k.qian@tudelft.nl*

**35. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?**

*4TU.ResearchData is able to archive 1TB of data per researcher per year free of charge for all TU Delft researchers. We do not expect to exceed this and therefore there are no additional costs of long term preservation.*

APPENDIX F - Survey

English (United Kingdom)

## Introduction

**Dear participant,**
**Thank you for your interest in participating in our research study!**
**Geachte deelnemer,**
**Hartelijk dank voor uw interesse in deelname aan ons onderzoek!**

This questionnaire was developed by researchers at Technische Universiteit Delft (TU Delft) as part of the research project Integrale Energietransitie Bestaande Bouw (IEBB).
Deze vragenlijst is ontwikkeld door onderzoekers van de Technische Universiteit Delft (TU Delft) als onderdeel van het onderzoeksproject Integrale Energietransitie Bestaande Bouw (IEBB).





Furthermore, this survey was developed as part of a Master thesis research at the Faculty of Architecture and the Built Environment.
Daarnaast is deze enquête ontwikkeld als onderdeel van een afstudeeronderzoek aan de faculteit Architectuur en Built Environment.

Our goal with this research is to understand Dutch homeowners' perspectives towards heat grid connection and the broader topic of the heat transition.
Ons doel met dit onderzoek is om inzicht te krijgen in de houding van Nederlandse huiseigenaren ten opzichte van warmtenetaansluiting en het bredere onderwerp van de warmtetransitie.

Your privacy is important to us.
Participation in this survey is voluntary, and your data will be used solely for research purposes, we will use all information anonymously. Note that because of your participation via Panel Inzicht, your IP-adres will be collected in the first place, however this will be deleted before starting the data analysis.
You can opt-out of the survey at any time.
Uw privacy is belangrijk voor ons.
Deelname aan dit onderzoek is vrijwillig, en uw gegevens worden uitsluitend gebruikt voor onderzoeksdoeleinden, wij gebruiken alle informatie anoniem. Vanwege uw deelname via Panel Inzicht, wordt uw IP-adres in eerste

instantie wel verzameld, deze zal echter worden verwijderd voordat de data-analyse begint.
kunt te allen tijde afzien van deelname aan het onderzoek.

The survey will take you around 10-15 min.
Het onderzoek duurt ongeveer 10-15 minuten.

By clicking *I agree* below, you confirm that you have read and understood the information provided above.
Door hieronder op *Ik ga akkoord* te klikken, bevestigt u dat u de bovenstaande informatie hebt gelezen en begrepen.

## Informed Consent

- **I agree with the conditions mentioned above**
- **I do not agree** (you will automatically leave this survey)

## What is your form of ownership?
Wat is jouw eigendomsvorm?

- **I own my home**
  Ik ben de eigenaar van mijn woning
- **I rent my home**
  Ik huur mijn huis





- ***Does not apply***
  *Is niet van toepassing*

## What best describes your household?
Wat beschrijft uw huishouden het best?

- **One-person household | 34 years and younger**
  Eenpersoonshuishouden | 34 jaar en jonger
- **One-person household | 35 - 64 years**
  Eenpersoonshuishouden | 35 - 64 jaar
- **One-person household | 65 years and older**
  Eenpersoonshuishouden | 65 jaar en ouder
- **Couple | 34 years and younger**
  Paar | 34 jaar en jonger
- **Couple | 35 - 64 years**
  Paar | 35 - 64 jaar
- **Couple | 65 years and older**
  Paar | 65 jaar en ouder
- **Couple with children**
  Paar met kinderen
- **Single-parent family**
  Eenoudergezin

## What best describes your household?
Wat beschrijft uw huishouden het best?

- **One-person household**
  Eenpersoonshuishouden

- **Couple without children**
  Paar zonder kinderen
- **Family**
  Gezin
- **Single-parent household**
  Eenoudergezin
- **Non-family household**
  Niet-gezinshuishouden

## What is your age?
Wat is uw leeftijd?

- **18 – 24 years** / jaar
- **25 – 29 years** / jaar
- **30 – 34 years** / jaar
- **35 – 39 years** / jaar
- **40 – 44 years** / jaar
- **45 – 49 years** / jaar
- **50 – 54 years** / jaar
- **55 – 59 years** / jaar
- **60 – 64 years** / jaar
- **65 – 69 years** / jaar
- **70 – 74 years** / jaar
- **75 years or older** of ouder

## Do you want to answer the rest of this survey in Dutch or in English?





## veranderd?

## Welke verbeteringen in de benadering en het communicatieproces voor een aansluiting op het warmtenet zou u voorstellen om huishoudens zoals dat van u beter te betrekken en informeren?

## 1_EN Socio-Demographic Factors

## What is your gender?

- **Male**
- **Female**
- **Other**
- *Prefer not to say*

## What is your highest level of education?

- **No diploma**
- **VMBO** or equivalent

- **HAVO/VWO** or equivalent
- **MBO** (Intermediate vocational education)
- **HBO** (Higher professional education)
- **University**
- **Other**, please specify:
- *Prefer not to say*

## What is your employment status?

- **Employed full-time**
- **Employed part-time**
- **Self-employed**
- **Unemployed**
- **Retired**
- **Unable to work**
- **Housewife / Houseman / full-time carer**
- **Other**, please specify:
- *Prefer not to say*

## What is your total gross household income per year?

- **less than €10.000**
- **€10.000 – €20.000**
- **€20.000 – €30.000**





- **€30.000 – €40.000**
- **€40.000 – €50.000**
- **€50.000 – €60.000**
- **€60.000 – €70.000**
- **€70.000 – €80.000**
- **€80.000 – €90.000**
- **€90.000 – €100.000**
- **€100.000 – €200.000**
- **€200.000 or more**
- *Prefer not to say*

## How much of your monthly household net income do you have at your free disposal?

- **0 – 10%**
- **10 – 20%**
- **20 – 30%**
- **30 – 40%**
- **40 – 50%**
- **50 – 60%**
- **60 – 70%**
- **70 – 80%**
- **over 80%**
- *Prefer not to say*

## What are your household's bank and savings deposits?

- **less than €10.000**
- **€10.000 – €20.000**
- **€20.000 – €30.000**
- **€30.000 – €40.000**
- **€40.000 – €50.000**
- **€50.000 – €60.000**
- **€60.000 – €70.000**
- **€70.000 – €80.000**
- **€80.000 – €90.000**
- **€90.000 – €100.000**
- **€100.000 – €200.000**
- **€200.000 or more**
- *Prefer not to say*

## What percentage of your household's bank and savings deposits would you be willing to spend on energy efficiency (energy saving measures)?

- **0 – 10%**
- **10 – 20%**
- **20 – 30%**
- **30 – 40%**
- **50 – 60%**
- **60 – 70%**
- **70 – 80%**





- **over 80%**
- *Prefer not to say*

## How many people does your household consist of?

- **1** person
- **2** persons
- **3** persons
- **4** persons
- **5 or more** persons

## What is the composition of your household?

- **Single-person household**
- **Household without child(ren)**
- **Household with child(ren) living at home**
- **Household with child(ren) out of the house**
- **Household with child(ren) and other family members living at home**
- **Household with child(ren) out of the house but other family members living at home**
- **Other**, please specify:

## 2_EN Dwelling Features

## In what type of building do you live in?

- I live in a **single-family building**
- I live in a **multi-family building** (with several individual apartments)
- I live in a **mixed-use building** (with several individual apartments but also containing for example offices & shops)

## Are you part of a VvE (Vereeniging van Eigenaars / Homeowner association)

- **Yes, I own my home as part of a VvE** (Vereeniging van Eigenaars / Homeowner association)
- **No**, I am not

## In which Municipality do you live?

## Please specify your building type:

- **Apartment**
- **Maisonette**
- **Terraced house**
- **Corner house**
- **Semi-detached house**





- **Detached house**
- **Other**, please specify:

## When was your house built?

- **before 1945**
- **1945 – 1970**
- **1971 – 1985**
- **1986 – 2000**
- **2001 – 2010**
- **2011 – 2020**
- **2020 or later**
- *I don't know*

## How many square meters is your house?

- **less than 30**$m^2$
- **30**$m^2$ **– 49**$m^2$
- **50**$m^2$ **– 74**$m^2$
- **75**$m^2$ **– 99**$m^2$
- **100**$m^2$ **– 149**$m^2$
- **150**$m^2$ **– 200**$m^2$
- **over 200**$m^2$
- *I don't know*

## For how long have you been living in your current house?

- less than 1 year
- 1 – 5 years
- 5 – 10 years
- 10 – 15 years
- 15 – 20 years
- over 20 years

## Are you planning to move?
**If so,** please indicate the time frame

- **I do not plan to move**, out of my current home
- **I plan to move** out of my current home, **within 1 year** (before 2026)
- **I plan to move** out of my current home, **within 2 years** (before 2027)
- **I plan to move** out of my current home, **within 3 years** (before 2028)
- **I plan to move** out of my current home, **within 4 years** (before 2029)
- **I plan to move** out of my current home, **within 5 years** (before 2030)
- **I plan to move** out of my current home, **in over 5 years** (after 2030)
- *I don't know*

## What is the current yearly energy demand of your household in kWh?
*You can find this on the yearly energy consumption overview of your energy provider.*





*[as a reference: a typical 2-person household in a terraced house uses 1800 kWh on average]*

- 0 – 1750 kWh
- 1751 – 2700 kWh
- 2701 – 3250 kWh
- 3251 – 3790 kWh
- 3791 – 4150 kWh
- 4151 – 6000 kWh
- 6001 – 8000 kWh
- above 8000 kWh
- *I don't know*

## What is your house's energy label?

- A+ or better
- A
- B
- C
- D
- E
- F
- G
- *I don't know*

## Have you ever taken any measures to make your house more energy efficient?

- ◯ **Yes, just recently** (2024 & 2025)
- ◯ **Yes, 2 years ago** (2023)
- ◯ **Yes, 3 years ago** (2022)
- ◯ **Yes, 4 years ago** (2021)
- ◯ **Yes, 5 years ago** (2020)
- ◯ **Yes, more than 5 years ago**
- ◯ **No, I never took any measures** for a more energy efficient house

## What measures have you taken?

*In case you took more than one measure, please select every measure you took*

[multiple choice possible]

- ☐ **Insulation of facade/walls, roof, floor**
- ☐ **Replaced windows and/or frames for HR++ or Triple glazing**
- ☐ **Installed or replaced solar panels (PV)**
- ☐ **Installed or replaced a solar heater or PVT**
- ☐ **Installed or replaced a (hybrid) heat pump**
- ☐ **Renewed/Upgraded natural gas boiler to a more efficient one**
- ☐ **Installed or replaced a ventilation/HVAC system**
- ☐ **I have been connected to a heat grid/network**
- ☐ [ ] **Other**, please specify:





## What was the main reason for taking these measures?

- ◯ **My house needed a renovation**
- ◯ **Financial benefits of a more energy efficient house** (lower energy bill)
- ◯ **It was recommended to me by family & friends** who already took measures
- ◯ **Environmental considerations** (e.g. CO2 reduction)
- ◯ **I could make use of subsidies**
- ◯ **I was motivated by a Municipality campaign**
- ◯ [ ] **Other**, please specify:

## What is your experience with these measures? Rate the following statements.

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| I have achieved a high level of energy efficiency in the form of reduced energy consumption | ◯ | ◯ | ◯ | ◯ | ◯ |
| I see a reduction on my energy bill | ◯ | ◯ | ◯ | ◯ | ◯ |
| I experience more thermal comfort in my house | ◯ | ◯ | ◯ | ◯ | ◯ |

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| I feel good about my contribution to the CO2 reduction, which is good for the environment | ○ | ○ | ○ | ○ | ○ |
| I experience an increase in the well-being and quality of life of my household | ○ | ○ | ○ | ○ | ○ |
| The value of my house has increased after taking these measures | ○ | ○ | ○ | ○ | ○ |
| I combined (or I would combine if I were to do it again) these measures with other necessary measures [e.g. maintenance, or renovations of kitchen/bathroom]. | ○ | ○ | ○ | ○ | ○ |

## Are you planning to take any (additional) measures to make your house more energy efficient in the upcoming 5 years?

- ○ **Yes, I am already working on it or have concrete plans**
- ○ **Yes, I am curenty exploring my options**
- ○ **Maybe, depending on subsidies or new regulations**
- ○ **No, I don't have any plans**





- ○ **I don't know / I have not thought about it yet**

## What (additional) measures would you consider?

*In case you would consider more than one measure, please select every measure would you consider*
[multiple choice possible]

- ☐ **Insulation of facade/walls, roof, floor**
- ☐ **Replacing windows and/or frames for HR++ or Triple glazing**
- ☐ **Installing or replacing solar panels (PV)**
- ☐ **Installing or replacing a solar heater or PVT**
- ☐ **Installing or replacing a (hybrid) heat pump**
- ☐ **Renewing/Upgrading natural gas boiler to a more efficient one**
- ☐ **Installing or replacing a ventilation/HVAC system**
- ☐ **Connecting to a heat grid/network**
- ☐ [ ] **Other**, please specify:

## Please explain why you are not considering any measures or haven't thought about it (yet)?

[ ]

# 3_EN Heat Network: Awareness & Willingness to Connect

## Are you familiar with the concept of heat grids and if yes, where did you learn about it?

- ○ **No, I am not familiar**
- ○ **Yes, out of own interest**
- ○ **Yes, municipality campaign**
- ○ **Yes, energy company advertisement**
- ○ **Yes, from news & media**
- ○ **Yes, from family / friends / neighbours**
- ○ [ ] **Yes, other**, please specify:

## Have you ever been approached personally to connect to a heat grid?

- ○ **Yes**
- ○ **No**

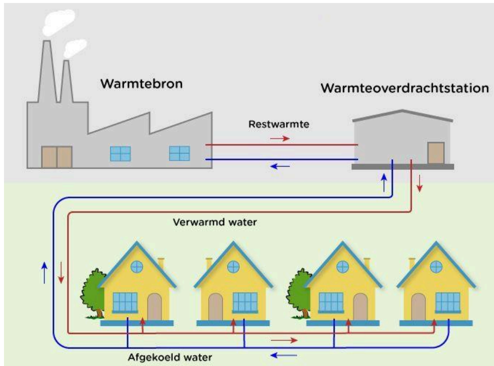
## *This is an attention check. Please check "Agree" to continue.*

| Strongly Agree | Agree | Disagree | Strongly Disagree |
|---|---|---|---|
| ○ | ○ | ○ | ○ |





## A heat network is a system of underground pipelines that distributes heat from a central source, like geothermal energy or industrial waste heat.
## The central source is used to heat multiple buildings.
## Each connected building uses a heat exchanger to transfer the heat for space heating and hot water.
## In order to connect, your house might need upgrades, such as improved insulation.




*source: www.energievergelijk.nl*

## Is your house connected to a heat grid?

- ○ **I am already connected** to a heat grid
- ○ **I am in the process of being connected** to a heat grid

- **I am not connected to a heat grid and not in the process** of getting a connection

## Please indicate your general willingness to connect to a heat grid:

- I am **very willing** to connect to a heat grid
- I am **willing** to connect to a heat grid
- I am **neither in favour nor against** being connected to a heat grid
- I am **against** being connected to a heat grid
- I am **totally against** being connected to a heat grid

## What was the price of your heat grid connection?
[please indicate in € EUR]

## Why are you (currently) not willing to connect to a heat grid?

- **I am satisfied with my current heating system**
- **I don't consider a heat grid to be reliable**
- **I don't expect a heat grid connection to lower my monthly energy bill**
- **I don't have the financial means for the initial investment**





- **I have already invested in an alternative heating system, namely:**
- **Other**, please specify:

## Please explain why you chose this specific alternative heating system over a heat grid connection

## What is your current heating system?

- **Natural gas boiler (CV ketel)**
- **(Hybrid) Heat pump**
- **Collective heating (blokverwarming)**
- **Solar Heater or PVT**
- **Other**, please specify

## At what price would you consider a heat grid connection to be ...

[please fill in all the open fields and indicate the price in € EUR]

| | |
|---|---|
| ... priced **so low that you** would **feel something is wrong** with the offer | |
| ... **a bargain** - a great value for the money | |
| ... **starting to get expensive**, so that getting a connection is not out of question but you would have to give some thought to buying it | |
| ... **so expensive that you would not** consider **buying** it | |

## 4_EN Heat Network: Barriers, Drivers, Support

**What would *drive* you to be willing to connect to a heat grid?**

The following aspect drives my willingness to connect to a heat grid:

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Clear overview of the benefits for my household | ○ | ○ | ○ | ○ | ○ |





| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Accessible and relevant information about the technical aspects of the system | ○ | ○ | ○ | ○ | ○ |
| Transparency about the timeline and the connection process | ○ | ○ | ○ | ○ | ○ |
| Having trust in leading party | ○ | ○ | ○ | ○ | ○ |
| Positive word-of-mouth recommendations from family / friends / neighbours | ○ | ○ | ○ | ○ | ○ |
| Availability of user friendly support before, during and after the connection | ○ | ○ | ○ | ○ | ○ |
| Increased level of comfort in my house | ○ | ○ | ○ | ○ | ○ |
| Lower energy bills | ○ | ○ | ○ | ○ | ○ |
| Increase of my property value | ○ | ○ | ○ | ○ | ○ |

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| **Flexibility to combine heat network connection with other measures** (energy efficiency measures like insulation or window replacement or aesthetic / small measures like new kitchen or bathroom) | ○ | ○ | ○ | ○ | ○ |
| **Social norm campaigns; I don't want to be left behind from my peers** | ○ | ○ | ○ | ○ | ○ |
| **The feeling of contributing to sustainability goals** | ○ | ○ | ○ | ○ | ○ |
| **Compatibility of heat network with existing (heating) systems in my house** | ○ | ○ | ○ | ○ | ○ |
| **Energy independence** (less reliance on fossil fuels) | ○ | ○ | ○ | ○ | ○ |

**Are there any other *drivers* for you that are not listed above?**





**What would be *barriers* that decrease your willingness to connect to a heat grid and when do you experience them?**
Cross all the phases that apply to you [multiple choice possible]

The user decision-making process is usually as follows:

**1. Awareness (hearing about it):**
This is the phase where you first hear or learn about the possibility of connecting your home to a heat network.
It may come from a letter, a meeting, a neighbour, or the municipality.
**2. Consideration (evaluating benefits & costs):**
In this phase, you begin to evaluate whether connecting makes sense for you.
You might look into costs, compare it to your current system, ask questions, or read about potential benefits or disadvantages.
**3. Decision (signing a contract):**
Here, you decide whether or not to formally agree to connect.
This might involve signing a contract, committing financially, or confirming your participation.

**4. Execution (connection & installation):**
In this phase, the technical work begins.
Your home may be connected toYou begin heating your home with the new system and gain experience with its performance, comfort, service, and costs.
the system, and installation work might be carried out.
You may also have to make adjustments to your home during this period.

**5. Experiencing (using the system):**
This phase starts once the system is installed and in use.

| | **Awareness** (hearing about it) | **Consideration** (evaluating benefits and costs) | **Decision-making** (committing through a contract) | **Execution** (connection and installation) | **Experiencin** (using the system) |
|---|---|---|---|---|---|
| **Lack of awareness or understanding of how heat grids work** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Too much information, leading to an overload** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Lack of information** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Information is not accessible or too difficult** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Nuisance throughout the implementation of the heat grid** | ☐ | ☐ | ☐ | ☐ | ☐ |





| | **Awareness** (hearing about it) | **Consideration** (evaluating benefits and costs) | **Decision-making** (committing through a contract) | **Execution** (connection and installation) | **Experiencin** (using the system) |
|---|---|---|---|---|---|
| **Low trust in the project's leading party** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Preferring individual heating solutions over collective systems** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Skeptism about the system's performance** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Resistance to change from current heating system** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Influence of negative experiences from family / friends / neighbours** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **No renewable source for the heat** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Too much effort preparing for the connection** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **High initial investment and installation fees** | ☐ | ☐ | ☐ | ☐ | ☐ |

| | **Awareness** (hearing about it) | **Consideration** (evaluating benefits and costs) | **Decision-making** (committing through a contract) | **Execution** (connection and installation) | **Experiencin** (using the system) |
|---|---|---|---|---|---|
| **Uncertainty about long-term cost savings compared to current heating system** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Perceived risk of monopolistic pricing by network operators, leading to fear of higher future costs** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Concerns about changing policies** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Unclear contractual terms, leading to a lack of understanding of rights and obligations when connecting to a heat grid** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Legal uncertainties around ownership and responsibilities related to the heat network infrastructure and services** | ☐ | ☐ | ☐ | ☐ | ☐ |





## Are there any other *barriers* for you that are not listed above?

**If you are still in the process of being connected,**
**unsure about connecting or currently not willing to connect to a heat grid,**
***what type of support or assurances would you need*** to feel more comfortable connecting to the heat grid?

**If you already have a connection,**
please think about ***what would have been most effective in your decision-making*** process?

The user decision-making process is usually as follows:

**1. Awareness (hearing about it):**

This is the phase where you first hear or learn about the possibility of connecting your home to a heat network.

It may come from a letter, a meeting, a neighbour, or the municipality.

**2. Consideration (evaluating benefits & costs):**

In this phase, you begin to evaluate whether connecting makes sense for you.

You might look into costs, compare it to your current system, ask questions, or read about potential benefits or disadvantages.

**3. Decision (signing a contract):**

Here, you decide whether or not to formally agree to connect.

This might involve signing a contract, committing financially, or confirming your participation.

**4. Execution (connection & installation):**

In this phase, the technical work begins.

Your home may be connected to the system, and installation work might be carried out.

You may also have to make adjustments to your home during this period.

**5. Experiencing (using the system):**

This phase starts once the system is installed and in use.

You begin heating your home with the new system and gain experience with its performance, comfort, service, and costs.

| | **Awareness** (hearing about it) | **Consideration** (evaluating benefits and costs) | **Decision-making** (committing through a contract) | **Execution** (connection and installation) | **Experiencing** (using the system) |
|---|---|---|---|---|---|
| **Clear information and education about the benefits and operation of heat grid** | ○ | ○ | ○ | ○ | ○ |
| **More insights about the actual initial investment and other cost** | ○ | ○ | ○ | ○ | ○ |
| **Increased trust in leading parties** | ○ | ○ | ○ | ○ | ○ |





| | **Awareness** (hearing about it) | **Consideration** (evaluating benefits and costs) | **Decision-making** (committing through a contract) | **Execution** (connection and installation) | **Experiencing** (using the system) |
|---|---|---|---|---|---|
| **Community engagement and feedback opportunities** | ○ | ○ | ○ | ○ | ○ |
| **Customer support incl. service and maintenance** | ○ | ○ | ○ | ○ | ○ |
| **Participation opportunity about the connection process beforehand** | ○ | ○ | ○ | ○ | ○ |
| **Usage price stability guarantees** | ○ | ○ | ○ | ○ | ○ |
| **More financial incentives or subsidies** | ○ | ○ | ○ | ○ | ○ |
| **Option to use heat network for cooling as well** | ○ | ○ | ○ | ○ | ○ |
| **Additional legislation that makes a heat grid connection more attractive** | ○ | ○ | ○ | ○ | ○ |

**Are there any other additional aspects that are not listed above?**

## 5.1_EN Heat Network: Approach & Process (approached)

**Who approached you for a connection to a heat grid?**
[multiple choice possible]

- ☐ **Municipality**
- ☐ **Energy company**
- ☐ **Housing association / VvE**
- ☐ **Independent advisor**
- ☐ **Member(s) of my own community**
- ☐ **Family / Friend / Neighbour**
- ☐ **Other**, please specify:

**How were you approached?**
[multiple choice possible]

- ☐ **E-mail**(s)





- ☐ **Letter**(s)
- ☐ **Community event**(s)
- ☐ **At the door**
- ☐ **News & Social media**, please specify:
- ☐ **Other**, please specify:

**At what stage of the heat network process were you first informed about the project, and was this information sufficient (to make a choice about connecting)?**
[multiple choice possible]

The typical project consists of the following phases:

**1. Initiation (initial plans announced):**
The municipality or project initiators announce the intention to explore or develop a heat network.
This is the earliest stage where plans are still open and under discussion.
**2. Feasibility (studies & investigations):**
In this phase, technical and financial research is done to determine whether a heat network is viable in the area.
This includes calculations on potential costs, energy demand, and number of connections.
**3. Contracting (signing agreements & pricing details):**

Residents are asked to make a formal decision about connecting.
Often, key documents such as contracts and pricing details are shared.
This is the phase when commitment is expected from end-users.

**4. Realization (physical installation & connection):**
Construction begins, both in public spaces and sometimes in or around your home.
Households that agreed to connect are physically linked to the system.

**5. Operation (post-installation experience):**
The heat network is active, and connected users have begun using it in daily life.
This includes heating, billing, maintenance, and customer service.

| | **Initiation** (initial plans annouced) | **Feasibility** (studies and investigations) | **Contracting** (signed agreements & pricing) | **Realization** (physical installation and connection) | **Operation** (post-installation experience) | *a* |
|---|---|---|---|---|---|---|
| **I was informed at this stage** | ☐ | ☐ | ☐ | ☐ | ☐ | |
| **I was engaged to participate in decision-making in this stage** | ☐ | ☐ | ☐ | ☐ | ☐ | |





| | **Initiation** (initial plans annouced) | **Feasibility** (studies and investigations) | **Contracting** (signed agreements & pricing) | **Realization** (physical installation and connection) | **Operation** (post-installation experience) | *a* |
|---|---|---|---|---|---|---|
| **The information / engagement in this stage increased my willingness to connect** | ☐ | ☐ | ☐ | ☐ | ☐ | |

**At what point in the process were you approached about connecting to a heat grid?**
[multiple choice possible]

The typical project consists of the following phases:

**1. Initiation (initial plans announced):**
The municipality or project initiators announce the intention to explore or develop a heat network.
This is the earliest stage where plans are still open and under discussion.

**2. Feasibility (studies & investigations):**
In this phase, technical and financial research is done to determine whether a heat network is viable in the area.
This includes calculations on potential costs, energy demand, and number of connections.

**3. Contracting (signing agreements & pricing**

**details):**

Residents are asked to make a formal decision about connecting.

Often, key documents such as contracts and pricing details are shared.

This is the phase when commitment is expected from end-users.

**4. Realization (physical installation & connection):**

Construction begins, both in public spaces and sometimes in or around your home.

Households that agreed to connect are physically linked to the system.

**5. Operation (post-installation experience):**

The heat network is active, and connected users have begun using it in daily life.

This includes heating, billing, maintenance, and customer service.

- ☐ **Initiation:** when the ideas for a heat transition in my neighbourhood were being formed
- ☐ **Feasibility:** when plans were more concrete, and the decisions heat transition solutions were still flexible
- ☐ **Contracting:** After the decision for a heat grid was made, shortly before I had to decide on connecting or not
- ☐ **Execution:** After the heat grid implementation plans were finalized and the construction was about to start
- ☐ **Operation:** When there was an offer and a heat grid available and I could shortly connect to an existing heat grid
- ☐ [ ] **Other**, please specify:





## What information did you receive?

[multiple choice possible ]

| | **Initiation** (initial plans annouced) | **Feasibility** (studies and investigations) | **Contracting** (signed agreements & pricing) | **Realization** (physical installation and connection) | **O** in ex |
|---|---|---|---|---|---|
| **The initial investment and connection fees** | ○ | ○ | ○ | ○ | |
| **Explanations about potential benefits** | ○ | ○ | ○ | ○ | |
| **Explanations about potential disadvantages** | ○ | ○ | ○ | ○ | |
| **Estimation of potential cost savings on my energy bill** | ○ | ○ | ○ | ○ | |
| **Information about the impact on my property value** | ○ | ○ | ○ | ○ | |
| **Information about funding opportunities like loans and subsidies** | ○ | ○ | ○ | ○ | |
| **Information about which party will lead the project** | ○ | ○ | ○ | ○ | |
| **Indication about the project duration and timeline** | ○ | ○ | ○ | ○ | |
| **The works that need to be done in the area prior to the connection** | ○ | ○ | ○ | ○ | |

| | **Initiation** (initial plans annouced) | **Feasibility** (studies and investigations) | **Contracting** (signed agreements & pricing) | **Realization** (physical installation and connection) | **O** in ex |
|---|---|---|---|---|---|
| **The works and efforts needed to prepare my house for the connection** | ○ | ○ | ○ | ○ | |
| **Information about potential nuisances during installation** | ○ | ○ | ○ | ○ | |
| **Information about technical working of heat grid** | ○ | ○ | ○ | ○ | |
| **The heat source that will be used** | ○ | ○ | ○ | ○ | |
| **Information about heat usage cost** | ○ | ○ | ○ | ○ | |
| **Information about maintenance and support after connection** | ○ | ○ | ○ | ○ | |
| **Information about why a heat transition would be needed in the first place** | ○ | ○ | ○ | ○ | |
| **Personalized cost-benefit analysis** | ○ | ○ | ○ | ○ | |
| **Other**, please specify: | ○ | ○ | ○ | ○ | |

## How frequently have you been contacted about the connection?

- ○ **Only once, when all details and the offer were ready**





- ○ **A few times during key decision-making phases of the project** (like the choice for a heat transition solution, the market parties getting involved, the choice for an area to be connected and the planning)
- ○ **Regular updates throughout the project timeline**
- ○ **I actively participated in a participation- and decision-making process**
- ○ **Other**, please specify:

## At what stage did you feel you had enough information to make a decision about connecting to a heat grid

- ○ **I knew enough right from the start**
- ○ **After the technical and financial studies were shared**
- ○ **Once the legal terms were clarified**
- ○ **When the heat grid was already being installed**
- ○ **I needed to experience it (at someone else's place) before deciding**
- ○ **Never, I still don't feel like I have enough information**

## In what language(s) have you been approached?

[multiple choice possible]

- ☐ **Dutch**
- ☐ **English**
- ☐ **German**
- ☐ **French**
- ☐ **Polish**

☐ **Turkish**

☐ **Arabic**

☐ **Other**, please specify: ____

## How did you experience this approach?

Rate the following statements:

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| **The information provided was clear and understandable** | ○ | ○ | ○ | ○ | ○ |
| **There was an information overload** | ○ | ○ | ○ | ○ | ○ |
| **There was a lack of information about the potential benefits and drawbacks of connection to a heat grid** | ○ | ○ | ○ | ○ | ○ |
| **The steps required for connecting to the heat grid were easy to follow** | ○ | ○ | ○ | ○ | ○ |
| **The information was easily accessible (via website or information point)** | ○ | ○ | ○ | ○ | ○ |





| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| **The information was sufficient for making a decision or not** | ○ | ○ | ○ | ○ | ○ |
| **My questions and concerns were heard and addressed** | ○ | ○ | ○ | ○ | ○ |
| **The communication about costs was transparent** | ○ | ○ | ○ | ○ | ○ |
| **I was kept well-informed throughout the whole process** | ○ | ○ | ○ | ○ | ○ |
| **There was one central communication point / person** | ○ | ○ | ○ | ○ | ○ |

## Rate the following statements about being connected to a heat grid

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| **I am overall satisfied with my choice for connecting to a heat grid** | ○ | ○ | ○ | ○ | ○ |
| **I have experienced the promised expected benefits** | ○ | ○ | ○ | ○ | ○ |

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| **I would recommend a heat gridconnection to others** | ○ | ○ | ○ | ○ | ○ |
| **I would prefer another heating system over a heat grid connection** | ○ | ○ | ○ | ○ | ○ |
| **I think there is some room for improvement in the connection process** | ○ | ○ | ○ | ○ | ○ |

## 5.2_EN Heat Network: Approach & Process (not approached)

**If you were to be approached (again) about connecting to a heat grid, who would you prefer to approach you?**
[multiple choice possible]

- ☐ **Municipality**
- ☐ **Energy company**
- ☐ **Housing association / VvE**
- ☐ **Independent advisor**
- ☐ **Member(s) of my own community**
- ☐ **Friend / Family / Neighbour**
- ☐ **Other**, please specify: ______





**How would you like to be approached?**
[multiple choice possible]

- ☐ **E-mail**(s)
- ☐ **Letter**(s)
- ☐ **Community event**(s)
- ☐ **At the door**
- ☐ **News & Social media**, please specify: ______
- ☐ **Other**, please specify: ______

**At what point in the process would you *prefer* to be approached about connecting to a heat grid?**
[multiple choice possible]

The typical project consists of the following phases:

**1. Initiation (initial plans announced):**
The municipality or project initiators announce the intention to explore or develop a heat network.
This is the earliest stage where plans are still open and under discussion.
**2. Feasibility (studies & investigations):**
In this phase, technical and financial research is done to

determine whether a heat network is viable in the area.
This includes calculations on potential costs, energy demand, and number of connections.

**3. Contracting (signing agreements & pricing details):**
Residents are asked to make a formal decision about connecting.
Often, key documents such as contracts and pricing details are shared.
This is the phase when commitment is expected from end-users.

**4. Realization (physical installation & connection):**
Construction begins, both in public spaces and sometimes in or around your home.
Households that agreed to connect are physically linked to the system.

**5. Operation (post-installation experience):**
The heat network is active, and connected users have begun using it in daily life.
This includes heating, billing, maintenance, and customer service.

☐ **Initiation:** when the ideas for a heat transition in my neighborhood are being formed

☐ **Feasibility:** when plans are more concrete, and the decisions for a heat transition solution are being explored

☐ **Contracting:** after the decisions for a solutions are made, shortly before I have to decide on connecting or not

☐ **Execution:** After the heat grid implementation plans were finalized and the construction was about to start





☐ **Operation:** when there is an offer and heat grid available, and I can shortly connect to an existing heat grid

☐ [ ] **Other**, please specify:

**What information would you like to receive when you are approached at your preferred point?**
[cross all the boxes that apply to you]

| | **Initiation** (initial plans annouced) | **Feasibility** (studies and investigations) | **Contracting** (signed agreements & pricing) | **Realization** (physical installation and connection) | **O** in ex |
|---|---|---|---|---|---|
| **The initial investment and connection fees** | ☐ | ☐ | ☐ | ☐ | |
| **Explanations about potential benefits** | ☐ | ☐ | ☐ | ☐ | |
| **Explanations about potential disadvantages** | ☐ | ☐ | ☐ | ☐ | |
| **Estimation of potential cost savings on my energy bill** | ☐ | ☐ | ☐ | ☐ | |
| **Information about the impact on my property value** | ☐ | ☐ | ☐ | ☐ | |
| **Information about funding opportunities like loans and subsidies** | ☐ | ☐ | ☐ | ☐ | |
| **Information about which party will lead the project** | ☐ | ☐ | ☐ | ☐ | |

| | **Initiation** (initial plans annouced) | **Feasibility** (studies and investigations) | **Contracting** (signed agreements & pricing) | **Realization** (physical installation and connection) | **O** in ex |
|---|---|---|---|---|---|
| **Indication about the project duration and timeline** | ☐ | ☐ | ☐ | ☐ | |
| **The works that need to be done in the area prior to the connection** | ☐ | ☐ | ☐ | ☐ | |
| **The work and efforts needed to prepare my house for the connection** | ☐ | ☐ | ☐ | ☐ | |
| **Information about potential nuisance during installation** | ☐ | ☐ | ☐ | ☐ | |
| **Information about technical working of heat grid** | ☐ | ☐ | ☐ | ☐ | |
| **The heat source that will be used** | ☐ | ☐ | ☐ | ☐ | |
| **Information about heat usage cost** | ☐ | ☐ | ☐ | ☐ | |
| **Information about maintenance and support after connection** | ☐ | ☐ | ☐ | ☐ | |
| **Information about why a heat transition would be needed in the first place** | ☐ | ☐ | ☐ | ☐ | |
| **Personalized cost-benefit analysis** | ☐ | ☐ | ☐ | ☐ | |
| **Other**, please specify | ☐ | ☐ | ☐ | ☐ | |





## How frequently would you like to be contacted about the potential connection?

- ○ **Only once, when all details about connecting to the heat grid and the financial offer are ready**
- ○ **A few times during key decision-making phases of the project** (like the choice for a heat transition solution, the market parties getting involved, the choice for an area to be connected and the planning)
- ○ **Regular updates throughout the project timeline**
- ○ **I want to actively participate in the decision-making process for a heat transition solution in my neighbourhood**
- ○ **Other**, please specify:

## In what language(s) would you prefer to be approached?

[multiple choice possible]

- ☐ **Dutch**
- ☐ **English**
- ☐ **German**
- ☐ **French**
- ☐ **Polish**
- ☐ **Turkish**
- ☐ **Arabic**
- ☐ **Other**, please specify:

## 6_EN Survey as Intervention

### Did this survey change your perception about heat grids and your willingness to connect to such?

- **Yes, I feel more positive** about connecting to a heat network
- **Yes, I feel more negative** about connecting to a heat network
- **No, not at all**

### Did this survey change your perception about heat grids?

**If yes,** please explain why and how

### What improvements in the approach & communication process for a heat grid connection would you suggest to better engage with households like yours?