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Abstract. Dutch municipalities have a vital role in creating policy concerning natural gas replacement with sustainable sources in the built environment by 2050, i.e., the so-called heat transition. Over the years, information provision from research and consultants to municipal policymaking in the heat transition has covered mainly the techno-economic dimension. However, a gap remains in the social information provision which enables more comprehensive and inclusive decision-making. This study answers the following research question: *What social aspects do municipal policymakers need to consider in municipal heat transition policymaking?* We first conducted a systematic literature review concerning energy users' social drivers to transition from natural gas. Second, we conducted a single case study on the policymaking process of heat transition projects in the municipality of Zoetermeer in the Netherlands. The case study involved heat transition actors with various roles in municipal decision-making, including municipal policymakers, researchers, corporations and citizens. Then we developed a framework of the social drivers of energy users to transition from natural gas. Finally, this framework was enriched in an ex-ante evaluation in a semi-structured workshop. Our study shows that energy users' social drivers can be categorized as behavioural belief, normative belief, and control belief. These social drivers combined with the techno-economic aspects shape the energy users' participation in the heat transformation.

1. Introduction

To achieve its climate targets, the Netherlands is committed to phasing out natural gas by 2050 [1]. This transition is dubbed the heat transition, the heat source shift in the built environment from natural gas to renewable sources (e.g., biogas, renewable electricity, or renewable heat). As the leaders of the local heat transition [2], Dutch municipalities interact with various other stakeholders (i.e., citizens, energy suppliers, network operators, and water companies) so that natural gas can be replaced with a more sustainable alternative. This stakeholders' interplay has led to heat transition as an emerging complex problem [1] where no optimal solution exists [3].

Given this context, Dutch municipalities need to translate their heat transition goals into local action and face the challenge to deal with the fact that there is no clear optimum. Over the years, Dutch municipalities have mainly obtained support from researchers and consultants concerning the technical and economic aspects of municipal decision-making in the heat transition policy [4], e.g., calculations

of the lowest energy users' cost, the lowest social cost, and the minimum investment cost [5]. The social dimension has received less attention in the municipal heat transition policymaking due to the increased degrees of complexity from social factors, e.g., end users' participation and a sense of unfairness. This additional complexity was seen premature when choices derived from the techno-economic analysis have given only a small or empty pool of options [4] and social data is not readily available. However, without accounting for social dimensions, an unrealistic social presumption from oversimplified propositions could misguide policymakers into less advantageous decisions [6] for energy users.

Previous research already focused on the social dimension of the heat transition. For example, Hesselink and Chappin [7] summarize social behavioural barriers in technology adoption. Elbert et al. [8] empirical study introduced social factors that correlate demographic profiles with behavioural belief, normative belief, and participation. However, insights into the social dimension appear not to be used to their full potential. Therefore, there are opportunities to use the information on social drivers to motivate energy users to transition from natural gas. These opportunities can be explored from various heat transition stakeholders' perspectives. This study addresses the knowledge gap in the lack of a deeper understanding of the energy users' social drivers for the heat transition by asking the following question: *What social aspects do municipal policymakers need to consider in municipal heat transition policymaking?*

2. Research design and methodology

Using guidelines from Kitchenham & Charters [9], we first, conducted a systematic literature review to formulate a proposition on energy users' social drivers to transition away from natural gas. In March and April 2020, we searched the Scopus database using a combination of the keywords: 'heat transition' 'building' 'urban', followed by backward and forward snowballing. Our inclusion criteria were: 1) the search result is relevant to the review question, 2) is peer-reviewed, 3) is published in a scientific journal or conference, 4) is recent (five years), and 5) the full text is accessible. We excluded publications with corporate sponsorship and tertiary studies. Eventually, we fully reviewed nineteen documents, from which we derived a proposition of energy users' social drivers for heat transition (see Section 3).

Second, we explored the proposition, using a single case study focused on the social factors that are witnessed or expected for energy users in a specific Dutch municipality to transition from natural gas. We followed the case study approach from Yin [10]. The case study included the decision-making process of pilot projects in two neighbourhoods in the municipality of Zoetermeer in the Netherlands throughout 2020. The case was bounded to focus on the component of heat transition drivers, the main actor's dynamics and activities to define and assess the municipal heat transition policymaking. The data was collected from three groups of actors to represent Head's [11] policy lenses: policymakers, researchers, and practitioners (corporations and citizens). The selected policymakers were involved in policymaking on sustainability and social aspects in the two neighbourhoods in the Zoetermeer municipality. The selected researchers were involved in either modelling or research in the heat transition in the Zoetermeer municipality. They were experts from universities or research institutes. The practitioners were involved (or planned to be involved) in the Zoetermeer heat transition, including representatives of social housing companies, energy distribution companies and citizens. Our primary data collection was (60-110 minutes) semi-structured interviews in English using video calls (i.e., Microsoft Teams and Skype) between April and June 2020. We interviewed five policymakers, four researchers, and five practitioners to explore both the current and the ideal information needed by the stakeholders in the heat transition decision-making. Then the qualitative data analysis was conducted using an iterative middle approach coding, a guided grounded theory (see [12]) with evolving predefined code references. In the coding process, three phases of coding were done namely: open coding, axial coding and selective coding (see [13]). The case study results are used to form the basis correlation framework of energy users' social drivers to transition from natural gas (see section 4).

Third, we evaluated the case study findings using an artificial evaluation (i.e., not a real environment observation [14]) which was also an ex-ante evaluation (i.e., based on possible results [15]). Three experts are from Delft University of Technology and an independent research organization, (TNO;

Netherlands Organisation for Applied Scientific Research). The expert evaluation was conducted in June 2020 in a sixty-minute semi-structured workshop. The first expert domain is in evidence-based policymaking. The second expert domain is in public administration. The third expert domain is in multi-actor management and framing. From the evaluation, we derived an enriched correlation framework of the social drivers of energy users to transition from natural gas (see Section 4).

3. Literature review: energy users' social drivers to transition from natural gas

Our literature indicates that energy users' (homeowners or tenants) social drivers can be divided into three categories: behavioural belief, normative belief, and control belief. Social drivers relate to individual (or community) characteristics that cover human social and cultural factors that affect humans' behaviour and attitude [5]. Human behaviour is driven by behavioural belief, normative belief, and control belief [16,17]. Behavioural belief motivates an individual to act (e.g., pain, pleasure). Normative belief is community truth that could influence behavioural beliefs (e.g., peer pressure). Control belief is the perception of an own capability to act (regardless of their actual capability). E.g., if an individual believes they will not have the time to renovate their house, they will not behave positively towards house renovation regardless of their capability. Human behaviour defines their social drives.

Behavioural belief (acceptance) of energy users comprises perception, knowledge and ownership status. To understand energy users' behavioural beliefs, it is important to understand energy users' motivation [18–21]. First, energy users want to be free to decide what needs to be done in their homes [22]. Therefore, it is important to understand their perception of what is necessary and what is not [23,24]. Second, perception shifts based on knowledge [24–26]. Therefore, it is essential to establish transparency and energy literacy on the options of energy transition [24]. Third, path dependency [21] and energy users' perception of fairness [27] can also influence energy users' behavioural beliefs in the heat transition. Trust can also be achieved from good pilots in the proximity of the energy users [28] and local benefit [29]. Lastly, the ownership status of energy users influences their behavioural beliefs. E.g., homeowners have less acceptance but have better knowledge of heat transition than tenants [2,7].

Normative belief is built by stakeholder engagement and peer pressure. Stakeholder engagement is important to develop trust and commitment to invest in energy transition [30]. Stakeholder engagement is needed as the transition outcome is relying on the stakeholder interplay over a long period [7,31]. Energy users are more likely to adopt technology that their peers have adopted [7,32].

Control belief is built by community empowerment, social intermediaries, and access to finance. Therefore, it is important to keep the project development close to the energy users [28,33]. There is a different sense of control belief in being an energy owner or producer compared to being a distant consumer [34]. Community co-ownership may be advantageous to increase the control belief of energy users compared to private ownership [29,35]. The presence of social intermediaries can also improve to help energy users' confidence to transition [36]. Heat transition social intermediaries are social constructs that intermediate energy users and heat transition projects. Additionally, energy users' access to finance influences their control belief to transition from natural gas [6].

This literature review defines the proposition of energy users' social drivers to transition from natural gas which is further explored in the case study and evaluation presented in Section 4.

4. Case study and evaluation findings

This section presents the framework to describe the energy users' social drivers to transition away from natural gas as summarised in Table 1. The findings are based on findings from the case study, enriched with an ex-ante expert evaluation workshop.

4.1. Behavioural belief drivers

We derived four factors related to behavioural beliefs of energy users that are important to consider in heat transition policymaking: citizen's perception of the heat transition, energy users' knowledge of heat transition, living status and energy users' sense of fairness. We discuss each of these factors below.

Table 1. Energy users' social drivers to transition away from natural gas.

	Drivers	Explanation
Behavioural belief	Perception of the heat transition	Image of heat transition to the energy users
	Heat transition knowledge	Energy users' understanding of the heat transition
	Living status	Whether the energy user lives on the property
	Sense of fairness	Energy users' understanding of how the heat transition can be reasonable, right, and just
Normative belief	Stakeholders' engagement	The heat transition managers' engagement with other heat transition stakeholders
	Social cohesion	Contacts quality (frequency and duration) between neighbours
	Peer pressure	Neighbours influence of the energy users' behaviour
Control belief	Social intermediaries	Structures that represent the community
	Property ownership	Whether the energy user owns the property
	Community empowerment	Empower the community with co-ownership of heat transition ideas, design, or facilities
	Financial condition belief	Energy users' view of their financial capability
	Market knowledge	Energy users' pragmatic expertise to do heat transition
	Presence of an exit strategy	Risk mitigation means to allow energy users to discontinue their participation

The *perception of the heat transition* comes from the wide range of energy users' motivations as described in the literature [19–25]. Since the heat transition target is not only the usual suspect, the early movers. The municipality needs to expand their agenda to be able to capture the community motivation, e.g., the street safety, their home, and parks. To drive the resident's perception to the positive side, the research confirmed the need to touch subjects that are in proximity to the life of the resident (local benefit). Policymakers and researchers agreed on the need to integrate the energy users' motivation into the heat transition strategy (e.g., their priorities in life or their complaints about the neighbourhood). Therefore, the policymakers should understand the motivation of the energy users' perception of heat transition and then incorporate them to shift the energy users' perceptions positively. This has been one of the main efforts of the policymakers in the social departments in the municipality of Zoetermeer. The idea from the municipality of Zoetermeer is to embed community projects with heat transition. This will increase heat transition attractiveness. They see that the benefit will be two ways since heat transition can also support solutions for social problems by providing higher social cohesion in the community.

Researchers, policymakers, and practitioners confirmed the literature [25–27] that *energy users' heat transition knowledge* is one of the most crucial drivers in heat transition. The policymakers saw that knowledge sharing through transparency and openness will support an equal decision-making process based on mutual trust. As the municipality has neither mandate nor wishes to enforce the energy users to transition from natural gas, knowledge transfer is the most sensible action they can take. In contrast, the municipality also believes that communication over energy transition needs to happen only if a reasonable techno-economic solution has been formed. This belief does not align with the practitioner's belief that participation that happens only at the end of the process is a form of free will containment. The municipality is still actively trying to find effective strategies for the knowledge sharing process.

The *living status* of the energy users (homeowners or tenants) has influenced the different levels of acceptance in transitioning from natural gas. As we saw in the literature [2,7], we also found in the study case that homeowners, who are not energy users, have less motivation to transition from natural gas or to improve their house conditions. The policymakers saw this homeowner group's motivation to renovate their houses as mostly business. Therefore, if no economic incentive is given, the behavioural belief of homeowners on heat transition will remain unchanged. This study and literature both indicated that living status has impacted the control belief of energy users (see Section 4.2).

The *energy users' sense of fairness* is grasped in a more complex way in the case study compared to the literature. The literature mentioned fairness is seen in how the cost is divided over the benefit [28]. The practitioners (citizen initiatives) believe that fairness comes also from the freedom of choice. They mentioned that it is unfair to present only the best solutions from the municipality's perspective. The energy users should be able to get a fair share of participation or say starting from the beginning of the process. Thus, the energy users should be willing in taking more responsibility for the result in the later stage. On the other hand, the policymakers argue that although fairness is vital, since no realistic strategy has been drafted, they should focus on formulating economically realistic choices. Total freedom can be very expensive. They see the need to find the balance between society's cost and freedom of choice.

4.2. Normative belief drivers

The interviewees in our examined case and the evaluators emphasized the importance of five social factors to be considered in heat transition policymaking: stakeholder engagement, co-creation, social cohesion and peer pressure. We will discuss each of these factors below.

As we found in the literature [7,31], from the study case, we also found that *stakeholders' engagement* holds an important role in creating the normative belief of the energy users. Additionally, the research and policymakers saw that the crucial point in the stakeholder engagement is the point of contact existence, frequency of contact, and influence over the engagement. If the municipality wants to drive energy users with the transition idea, it is vital to create a strategy to reach them. In this case, a clear mechanism over the neighbourhood representative can open interaction between the municipality and the energy users. With a strong engagement, the municipality can open the channel to promote the transparency of information that they deem critical. Therefore, the municipality is starting with neighbourhoods that already have a strong point of contact e.g., social housing corporations or owners' associations (VVE). Additionally, we also evaluated that the *co-creation* between energy users and the municipality is also a driver to create a positive normative belief toward heat transition. Co-creation will stimulate not only community empowerment (Section 4.3) but also create political legitimacy. To design and implement a co-creation process, the municipality needs to provide the community with sufficient immediate knowledge and transparent communication.

The case study also described *social cohesion* as heat transition is described by the policymakers as the neighbourhood inhabitant's closeness toward each other. This social cohesion can be seen in the number of contacts between neighbours and their interaction duration. Social cohesion is expected to accelerate perception sharing in the neighbourhood. And it is also expected that social cohesion is increasing in the heat transition process as the neighbourhood is given an interesting topic to discuss. Consequently, heat transition participation will increase social cohesion in the neighbourhood.

Lastly, *peer pressure* from the literature [7,32] is confirmed by practitioners as an important driver to increase participation in heat transition solutions. Seeing that people have succeeded in the transition and are happy about their choice, has tempted other people to also adopt the transition and make changes of their own. A practitioner described this function as "enabling the other party to transition".

4.3. Control belief drivers

We found seven aspects to impact the control belief concerning municipal heat transition policymaking: social intermediaries' presence, property ownership, community empowerment, financial condition belief, energy users' heat transition knowledge and exit strategy presence.

Social intermediaries' presence is an essential driver to allowing communication between the municipality and energy users. This driver has been described by both the literature [36], the policymakers and researchers. The municipality has been using social intermediaries such as homeowner associations or housing corporations to bridge heat transition discussions in neighbourhoods. Additionally, from the ex-ante evaluation, existing social structures (e.g., social clubs, mosques, churches) are potential heat transition intermediaries. Usually, these social structures have a tight social cohesion that can support a fast process that promotes successful policymaking [37]. The municipality should use these social structures to bridge the heat transition knowledge sharing.

Property ownership is shown to be an important driver in the control belief to transition towards sustainable heating. Policymakers, researchers, and practitioners believe that the direct energy users (homeowners and tenants) are the stakeholders who should and could decide to transition from natural gas. However, energy users who do not own the dwelling might have low to no power to decide on heat transition investments. On the other hand, the homeowner, who is not the direct user of the heat, might find it hard to request a higher rent that is needed to compensate for the investment cost.

Discussion over the *community empowerment* comes from the practitioner (citizen initiatives). They mentioned that besides the empowerment in a form of facility (co-)ownership as found in the literature [29,35], the empowerment can come from participation together with the municipality to co-design the solution. When the citizen (co-)owns the idea and strategy to transition, they are more likely to accept the risk that comes with the transition (e.g., price increase). This driver is also confirmed in the expert evaluation workshop. However, the policymakers saw that currently, citizens' willingness to take part in ownership or decision-making is low.

We also evaluated from the case, that different treatments between the early adopter and other energy users need to be given so that early adopter can actively increase their influence to empower the other energy users to start the transition. Therefore, inclusion (starting from problem definition) for this active citizen in the heat transition policymaking needs to be supported. Therefore, these active citizens not only act to represent the citizen but also function as a tool to communicate success stories.

The energy user's belief in their control is also influenced by energy users' *financial condition belief.* Besides access to finance as presented in the literature [6], the financial condition belief relied also on energy users' belief in a reasonable payback period. Access to finance might be influenced by their economic status such as their financial options, income, age and savings. In the case of collective investment, this access to finance might increase based on the condition of the neighbourhood's social intermediaries. The belief in a rational payback period is influenced by energy users' priorities and personal investment plans, such as a thirty-year investment which is not suitable for older people.

Energy users' heat transition knowledge on the heat transition cost is also considered important by both researchers and policymakers. If the information on the cost (time and money) of house renovation and heat transition is readily available (both goods and service) over the year, it will bring more confidence to the energy users. Energy users will be encouraged to transition from natural gas if the knowledge of possible heat transition investment options is easily accessible. Currently, the information on the price of house renovation service and goods are not easily available for research as the cost fluctuate based on demands (e.g., the same heat pump price is fluctuating in autumn and spring). This fluctuation has hindered the capability of energy users to access investment knowledge.

Additionally, from the ex-ante expert evaluation, we also discuss that the *presence of an exit strategy* is important to boost the confidence to transition from natural gas. Exit strategies are described as loss or risk mitigation means which allow participants to discontinue their participation in an investment in the case of failure [38]. We discussed that without an exit strategy, the fear of being trapped in a failed investment might prevent energy users to transition from natural gas. Negotiation on an exit strategy from certain investments is needed to accelerate initiatives [39].

5. Conclusions

This study fills the gap in the social information provision which enables more comprehensive and inclusive heat transition decision-making. Using a literature review, case study, and evaluation workshop, we identified social drivers to transition from natural gas in three categories: behavioural, normative, and control beliefs. Behavioural belief is determined by citizens' perception of the heat transition, energy users' knowledge of heat transition, living status, and energy users' sense of fairness. The normative belief is determined by stakeholder engagement, social cohesion, and peer pressure. The control belief is determined by social intermediaries' presence, property ownership, community empowerment, financial condition belief, energy users' heat transition market knowledge and exit strategy presence. These social drivers combined with the techno-economic aspects shape the energy

users' participation in the heat transformation. They provide a checklist for municipal policymakers of what factors they need to consider in developing heat transition policies.

To the best of our knowledge, this study is among the first to present the exploration of how social drivers are influencing energy users' behaviour towards municipal heat transition from the perspectives of municipal policymakers, researchers, corporations, and citizens. Thus, this study contributes to developing the heat transition strategy for the municipalities by adding to the body of knowledge of municipal heat transition policymaking, an exploration of energy users' social drivers to transition from natural gas in the case of the municipality of Zoetermeer in the Netherlands.

Our case study is limited to a particular case concerning the Dutch municipal heat transition with proactive municipal policymakers in a high-density neighbourhood. We recommend future research to examine whether our findings hold in other contexts, such as other municipalities, both using qualitative and quantitative research.

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