



Kissing natural gas goodbye? Homeowner versus tenant perceptions of the transition towards sustainable heat in the Netherlands

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ARTICLE INFO

Keywords:

Energy transition
Sustainable heat
Homeowners vs. tenants
Natural gas free
Local initiatives

ABSTRACT

To drastically reduce CO₂ emissions and to combat seismic activities, the Dutch government has started down the path towards sustainable heat. This is a major challenge, as 90% of all households must be disconnected from the gas grid. The responsibilities and roles of homeowners and tenants in this transition may differ, which makes it interesting to compare their perceptions. Using a mixed-methods approach, we conducted four focus groups (n = 24) and a survey (n = 1245) in a subsidized and an unsubsidized neighbourhood to explore differences in perceptions of the transition between homeowners and tenants, and the influence of the local context in this regard. Our research shows that homeowners and tenants consider similar themes to be important in the transition towards sustainable heat (focus groups) and that their acceptance of the transition is related to similar predictors, including environmental concerns and trust in the municipality and the civil neighbourhood council (survey). However, the perceptions of these variables differ between homeowners and tenants (survey). Homeowners are less positive about becoming natural gas free, have a stronger wish to be engaged in the transition, are more interested in its various aspects, and have more knowledge about the transition than tenants. Although both groups regard the municipality as the primarily responsible actor in the transition, tenants see the housing corporation as the responsible actor for adjusting their homes and homeowners feel responsible themselves, but doubt whether they have the ability to do so.

1. Introduction

Following the Paris Agreement, various governments have set ambitious targets for replacing their fossil-based energy system with a system based on renewable energy. Governments differ, however, in their choices and pathways to achieve these aims. In the Netherlands, the national government has started down the path towards sustainable heat to drastically reduce CO₂ emissions. With the same policy, the government aims to combat seismic activities caused by gas extraction in Groningen, one of the northern provinces. By 2050 the country should be natural gas free. This is a major challenge: Because of the country's own natural gas reserves the Dutch energy system has an exceptionally high share of natural gas. This has led to a lock-in of the residential sector with almost 90% of all households being connected to the natural gas grid [1,2]. Residential buildings cause approximately 9% of the country's CO₂ emissions, with two-thirds of the energy consumption being spent on heating [3].

A transition towards sustainable heat can thus have a substantial impact on the CO₂ emissions. However, cutting off every household

from natural gas is a major technical and social challenge, as it requires citizens to adopt alternative heating systems and invest in the insulation of their houses [4]. The national government has stated that the transition will be gradually executed by local governments, with an average of 50.000 households per year. To accelerate the transition, the government allocated subsidies of at least four million euros in 2018 to 27 municipalities to disconnect specific neighbourhoods from the gas grid. However, local governments are struggling with getting citizens on board for the transition [5]. The allocated subsidies only cover part of the costs and local governments do not have any legal means to force households to disconnect from the gas grid. Additionally, compared to other European countries, Dutch households appear to be less interested in energy-related home renovations, due to concerns about the investment costs [6].

This study aims to explore and to compare the perceptions of homeowners and tenants—living in a subsidized and unsubsidized neighbourhood—of the transition towards sustainable heat, to get more insights in how to get them on board. In this introduction, first the difference between homeowners and tenants in the transition will be

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<https://doi.org/10.1016/j.erss.2020.101694>

Received 11 September 2019; Received in revised form 29 June 2020; Accepted 8 July 2020

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described (Section 1.1), followed by a discussion of the influence of the local context (Section 1.2) and other factors that might influence the perception of sustainable heat (Section 1.3). The introduction will end with an overview of our research (Section 1.4).

1.1. Homeowners and tenants

The challenge for local governments is to create acceptance for and engage residents in the transition towards sustainable heat. However, there is no such thing as homogenous acceptance. Various stakeholders may have different views on the transition [7,8]. In particular, a distinction can be made between homeowners and tenants. Homeowners need to take action and invest in the transition themselves, while tenants depend on their housing corporation or landlord/lady. Although tenants have little responsibility for implementing energy-efficient measures in their homes, they are still an important stakeholder to consider as housing corporations and landlords need the approval of 70% of their tenants when renovating residential buildings [9]. Van Middelkoop et al. [8] found that Dutch tenants have strong feelings of autonomy regarding their homes and do not want to be forced by the government to make them more sustainable.

In the Netherlands, 60% of the households consist of homeowners, 30% consist of tenants renting from a housing corporation, and 10% consist of tenants renting from a private landlord/lady [10]. It may be expected that the differences in responsibility affect people's attitudes and interests in the energy transition, leading to the question of whether each group needs different approaches to the process regarding communication and engagement. However, little research has been conducted on this topic. Our research question is: To what extent do homeowners and tenants differ in their perceptions of a transition towards sustainable heat?

1.2. Local context

As the transition towards sustainable heat is implemented in specific neighbourhoods, community acceptance and engagement are important for its success. Citizens can influence the transition through their support of or resistance to changes in the heating system and can even decide to become producers of renewable energy themselves through the installation of PV-panels or by participating in a community energy initiative [11]. With regard to the energy transition, Sagebiel et al. [12] found that transparency, the sharing of renewable energy, and democratic control are important aspects that citizens consider before engaging in the transition. However, the local context in which citizens operate is important for their behaviours. Contextual factors identified as drivers for the energy transition include guidance from regional and local governments through expertise and financial support [13], cohesion and trust in other community members, and highly committed community members who actively engage in the transition (e.g., a civil neighbourhood council) [14].

The national subsidies some municipalities received for the transition towards sustainable heat are a contextual factor that might affect the transition in neighbourhoods. They do not only provide financial incentives, but also raise expectations, clarify responsibilities, promote professional input, and facilitate the process in terms of planning and communication. The municipalities that received a subsidy had to develop and commit to a timeframe for the transition in the chosen neighbourhood and start the transition within a year after the subsidy was granted [15]. While earlier research showed that contextual factors influence community acceptance and engagement in the energy transition, no specific connections were made to the transition towards sustainable heat or the distinction between homeowners and tenants. Therefore, our second research question is: To what extent does local context—specifically the distinction between a subsidized and a non-subsidized neighbourhood—affect homeowners' and tenants' perceptions of the transition towards sustainable heat?

1.3. Other factors influencing the perception of the transition towards sustainable heat

Next to the distinction made between homeowners and tenants and the local context, there are other factors that may influence the perception of the transition towards sustainable heat as well. In earlier (quantitative and qualitative) studies, various factors influencing residents' attitudes, intentions, and behaviours were found [2,8,16–22], which can be divided into five categories: financial aspects, knowledge and information, process related factors, environmental concerns, and socio-demographic characteristics. Most of the earlier studies focused solely on homeowners and concentrated on renovation measures instead of including both homeowners and tenants and investigating the sustainable transition as a whole. Nevertheless, they provide relevant insights for this study.

The first factor involves the financial aspects of the transition. The few studies that have compared the perceptions and motives of homeowners and tenants regarding energy-efficient measures have predominantly focused on this factor. For homeowners, financial concerns involve the question of whether their investments would pay off through a decrease in energy use and an increase in the value of their house [17,22]. Homeowners who perceived energy-efficient measures as a good investment and/or received a government loan or subsidy were more inclined to adopt these measures, while a lack of money and an aversion to delayed gain prevented investing in energy-efficient measures [17,22]. Tenants' concerns involved the question whether the decrease in energy use would cover the higher rent [16,21]. Mixed results were found when comparing the importance of financial aspects for homeowners and tenants. Franke et al. [23] found that financial motives for energy efficiency were more important for homeowners than for tenants, as purchase decisions are more long-term oriented and cost-intensive than are rental decisions. Other researchers concluded that financial motives were equally important for homeowners and tenants [6,21,24].

A second factor is knowledge and information. This includes technical knowledge—the steps that need to be taken to make the home more energy efficient—and policy knowledge—the regulations and possible financial instruments [19,20]. Broers et al. [17] found that homeowners who have technical knowledge, who feel that they can gain access to objective information, and/or who heard about positive experiences from their network, are more inclined to adopt energy-efficiency measures. In contrast, Ebrahimigharehbaghi et al. [18] and Wilson et al. [22] identified a perceived lack of credible information as an important barrier for homeowners to adopt sustainable measures. The knowledge component might be especially relevant for homeowners, who need to arrange and implement sustainable measures themselves, while tenants must rely on their housing corporation or landlord/lady.

A third factor involves the process of the transition, including policy-making, the complexity of the process, and trust in responsible agents. In their system analysis of drivers and barriers to a transition towards biomass gasification as an alternative for natural gas, Miedema et al. [2] found a lack of mandatory policy agreements to be one of the biggest obstacles for the transition within the private and rental sectors. Additionally, Van Middelkoop et al. [8] found that homeowners and tenants, despite their strongly felt autonomy for their houses, supported government policies on energy performance improvements to existing homes. However, both studies were conducted before the Dutch policy about disconnecting every household from the gas grid was issued, and it remains to be seen whether homeowners and tenants are still in favour of government policies towards sustainable heat. The complexity of the process was also identified as a barrier. Ebrahimigharehbaghi et al. [18] and Wilson et al. [22] found that complexities related to carrying out energy measures, the cognitive burden (or transaction costs) of making complex and irreversible investment decisions, and the foreseen 'hassle factor' of having one's daily life disrupted by

renovations are relevant barriers for homeowners. Governments or other actors could guide the transition by organizing the installation of energy-efficient measures and preselecting relevant sustainable alternatives in combination with financing options, or using project managers to guide the entire process for homeowners [17,20]. However, research on the acceptance of local energy projects showed that such actions can only be effective when the responsible actors are trusted [25–27]. For homeowners, the most obvious responsible actor is the local government, responsible for the vision and the plan for the transition in their neighbourhood; for tenants, the most obvious responsible actor are housing corporations or landlords/ladies, in charge of insulating homes and implementing new heating systems.

A fourth factor involves environmental concerns—i.e., the extent to which people feel responsible for the environment and are willing to take actions. Both Broers et al. [17] and Ebrahimigharehbaghi et al. [18] found that environmental concerns play an important role in triggering interest in energy-efficient measures. They concluded that this factor is especially relevant in the early stage, as it correlates with awareness about the transition and motivation to search for information. Similarly, Koirala et al. [28] found environmental concerns to be one of the predictors of citizens’ willingness to participate in local energy initiatives.

The fifth factor involves citizens’ background variables. It seems to be easier for highly educated people to acquire the relevant knowledge and skills for the transition [17,18]. Furthermore, a negative correlation was found between age and the adoption of measures, since older people might feel less certain whether their investment will pay off during their remaining time living in their homes [29]. These studies focused on homeowners; whether such relations exist for tenants as well is thus far unknown.

1.4. This study

To compare homeowner and tenant perceptions of the transition towards sustainable heat and to study the influence of the local context, we conducted a mixed-method study including homeowners and tenants from two different neighbourhoods. First, we conducted a series of focus groups to explore relevant issues about the transition towards sustainable heat in perceptions of homeowners and tenants. We used focus groups, because the interaction of the participants might reveal new viewpoints and provide insights into their underlying knowledge and motives [30]. Second, we conducted a survey, based on insights from the focus groups and from the literature. The aims of the survey were: (1) to compare the perceptions homeowners and tenants have on relevant aspects of the transition towards sustainable heat, (2) to compare the antecedents of both groups’ attitudes towards becoming natural gas free, and (3) to study the influence of the local context.

Two neighbourhoods from two different neighbouring municipalities in the East of the Netherlands were selected. Both neighbourhoods were designated by their municipality as a pilot case in the transition. The neighbourhoods had comparable characteristics, including a similar proportion of homeowners and tenants (mostly renting from housing corporations) and diverse types of homes (apartment-buildings, bungalows, terraced houses), with a majority of them being poorly insulated. Furthermore, both neighbourhoods had inhabitants with a wide variety in socio-economic status and from different age groups. An important difference between the neighbourhoods was that, just before our study started, one municipality received a subsidy of more than 4 million euros for accelerating the transition in the neighbourhood involved by supporting the disconnection of at least 500 houses from the gas grid, while the other did not. When receiving the subsidy, the municipality of the subsidized neighbourhood had to draw up a timeframe and start within a year; for the unsubsidized neighbourhood, there was no time frame. Furthermore, in the subsidized neighbourhood, a campaign for raising awareness about becoming natural gas free was launched, and several newsletters were

sent to all households; in the unsubsidized neighbourhood only one newsletter was sent to every household.

2. Study 1 – Focus groups

2.1. Method

2.1.1. Design and instrument

Separate focus groups with homeowners and tenants were conducted. All the focus groups were based on the same guideline and addressed four themes: (1) the transition towards sustainable heat in general, (2) alternatives for natural gas, (3) the actors involved in the transition, and (4) the implementation process.

In a short introductory round, the participants were asked to explain why they liked or disliked living in their neighbourhood. After that, a short video was shown explaining the basics of the Dutch policy towards sustainable heat. The participants were then asked to discuss their opinions and feelings about this policy. Then, they saw a video explaining the three most viable alternatives for natural gas (electrical heat pump, biomass, and district heating). Again, the participants were asked to discuss these issues. After that, the participants were asked to write down and subsequently discuss the actors they thought are or should be involved in the transition. Finally, the participants discussed what they thought an ideal process of the transition towards sustainable heat would look like.

2.1.2. Participants and analysis

Four focus groups were conducted, two in each neighbourhood with homeowners and tenants being included separately. The focus groups were held in the neighbourhoods’ community centres and were led by the first two authors. Participants were recruited with the help of civil neighbourhood councils (which organize social activities and represent citizens in local policies) and housing corporations. They were told that the focus groups would be about their opinions on plans for the transition towards sustainable heat in their neighbourhood. Every session consisted of six participants, with a total of 24 (12 in each neighbourhood; 12 tenants and 12 homeowners), all of whom were at least 18 years old (see Table 1).

The sessions lasted between 1.5 and 2 hours, and were audio recorded and transcribed for analysis. The transcripts were coded by the first two authors using thematic analysis, following the four main themes of the focus group guideline. During the coding process, the first theme (the transition in general) was divided into two subthemes (knowledge about and attitude towards the transition), and the other themes remained the same.

Table 1
Participants in the focus groups.

	Homeowners Subsidized	Homeowners Unsubsidized	Tenants Subsidized	Tenants Unsubsidized
<i>Homeowners vs. tenants</i>				
Housing corporation	/	/	6	6
Private landlord/lady	/	/	/	/
Homeowner	6	6	/	/
<i>Gender</i>				
Male	3	4	4	2
Female	3	2	2	4
<i>Energy label</i>				
Low	4	6	5	6
Middle	1	/	1	/
High	1	/	/	/

2.2. Results

During the analysis of the transcripts it became clear that the homeowners and tenants in both neighbourhoods addressed similar issues and had similar concerns.

2.2.1. Knowledge about the transition

Both homeowners and tenants in both neighbourhoods emphasized that they had little knowledge about the national policy of the transition towards sustainable heat and even less about the plans for their neighbourhood. They had all heard in the news media about the intention of the national government to cut off every household from natural gas by 2050, but had no idea what this would mean for their neighbourhood or themselves. One participant, for example, stated, *“We all read in the newspaper that we’re at the start of an immense transition, but nowhere it is explained what exactly will happen”* (homeowner, unsubsidized neighbourhood). Some participants had an idea of the implications of and difficulties related to making the infrastructure suitable for alternatives of natural gas. They mostly referred to adjustments needed in the electricity net of their houses and difficulties with insulating their houses, both of which were often mentioned in relation to costs. An illustrative comment was, *“It will cost thousands of euros to insulate my house in such a way that it will be suitable for an alternative to natural gas. I have a house that was built in the 1930 s, which is always draughty. Who will pay for this insulation?”* (homeowner, unsubsidized neighbourhood). Most participants did not think they had much knowledge about possible alternatives for natural gas. They had heard about technical solutions such as district heating, electrical heat pumps, biomass, geothermic heat, heat from hydrogen, and nuclear energy through news media and via word-of-mouth. However, most did not have an idea about the working principles or effects of these alternatives. Only for district heating, which has existed in the Netherlands for a long time, did most of the participants have some ideas—mostly negative, as they remembered stories of malfunctioning.

2.2.2. Attitudes towards the transition

When the participants were asked how they felt about the idea of becoming natural gas free, most homeowners and tenants in both neighbourhoods responded negatively. The costs and feasibility were most often mentioned as concerns. Homeowners emphasized the installation costs of alternatives for natural gas, including insulating their homes and adjustments in the heating infrastructure. Tenants were afraid of an increase in their monthly rent due to the construction needed in their homes. One tenant explained, *“I already asked for adjustments in my house to increase the insulation. The housing corporation told me it would cost me 80 euros extra per month, which I simply cannot afford”* (tenant, unsubsidized neighbourhood). Furthermore, several participants referred to the magnitude of the policy, doubting whether it would truly be possible to cut off every household from natural gas. Nevertheless, most participants also saw benefits for the environment. They agreed it was important to decrease CO₂ emissions for future generations. One participant stated, *“Something needs to happen to keep the earth liveable for our children”* (tenant, subsidized neighbourhood). Other benefits mentioned, albeit less frequently than the environmental argument, were that the transition would decrease seismic activities in Groningen and that it would make the Netherlands less vulnerable, as the Dutch dependence on importing natural gas from other countries (such as Russia) would decrease.

2.2.3. Alternatives for natural gas

Almost all participants had a preference for natural gas and raised concerns when talking about alternatives, including sustainability, effects on comfort, long-term viability, and installation and utilization costs. Regarding sustainability, they doubted whether the heat used for district heating, which is often derived from waste processing or industry, is really sustainable. The same issue was raised when talking

about biomass. Another concern involved their comfort of living, which could be negatively influenced by the alternatives. Some participants expected that an electrical heat pump would cause noise and occupy much space in their homes. Some also feared that it would be difficult to reach a comfortable temperature in cold winters with district heating or electrical heat pumps. Furthermore, participants expected that manure combustion for biomass energy could lead to odour nuisance. When talking about long-term viability, participants doubted whether it would make sense to change the entire infrastructure of gas pipes for a new alternative, as in the future, other alternatives (such as hydrogen power) might be suitable for distribution through gas pipes. They also doubted whether there would be enough heat to provide district heating to all households or enough biomass to burn. Installation costs and utilization costs were not only mentioned when talking about the transition in general, but also in relation to the alternatives. In particular, the electrical heat pump was considered to be an expensive alternative. The participants emphasized that for all alternatives to be effective, houses should be insulated, which would cost large amounts of money. Finally, participants talked about communal versus individual alternatives. District heating is clearly a communal alternative, while electrical heat pumps are an individual alternative. Most tenants had a preference for a communal alternative, while homeowners did not have a clear preference.

2.2.4. Actors involved in the transition

When the participants talked about actors they thought were involved in the transition, they often immediately discussed whether they trusted them or not. The local government was most often mentioned as the main responsible actor for the implementation of the transition in the neighbourhoods. However, especially in the subsidized neighbourhood, both homeowners and tenants doubted whether the local government had the intentions and capacity to steer the transition in the right direction. One participant said, *“The local government is responsible for the whole transition (...) I am especially concerned about the lack of expertise in the local council regarding this topic”* (homeowner, subsidized neighbourhood). In the unsubsidized neighbourhood, the participants also saw the local government as the main actor, but were less negative about it.

Another actor often mentioned by homeowners and tenants were housing corporations. Tenants thought housing corporations were responsible for the necessary adjustments in their homes. One participant stated: *“I am a tenant, if the housing corporation wants to change the house I am living in, they are responsible for it”* (tenant, subsidized neighbourhood). Although the tenants had some complaints regarding the sustainability measures implemented so far by their housing corporations, they did not doubt the intentions of this actor in the transition. Homeowners saw housing corporations as an important actor as well, as they thought housing corporations had major influence in the decision-making process within their neighbourhood. One participant said, *“I think that a housing corporation, which has much more houses in the neighbourhood than me as a homeowner, has an important say in the process”* (homeowner, unsubsidized neighbourhood). Some participants were sceptical about this role, while others thought it was good to have some major players at the table. Other actors mentioned by both homeowners and tenants, but to a far lesser extent and in a neutral way, were the civil neighbourhood council, energy companies, and the net distributor.

2.2.5. Implementation process

All the participants found it important to be informed about the process of the transition. They emphasized that they want to be engaged in the early stages of the process, before pivotal decisions have been made. One participant said, *“I think it is important that they [the municipality] keep us informed about the different steps that are being taken in the process, and not just communicate about some moments of decision making in which we as residents can give our opinion without having any*

knowledge about the whole process" (homeowner, subsidized neighbourhood). Not all participants wanted to be actively engaged in the process though. Some preferred a more passive form of engagement, thinking it would suffice to be informed about the overall process and important developments. However, homeowners and tenants in both neighbourhoods argued that the option of active engagement should be offered for a variety of themes, including the planning, the financial aspects, the choice of an alternative of gas, technicalities, and communication.

2.2.6. Conclusion

The themes that were discussed during the focus groups overlap with the determinants of the acceptance for the transition towards sustainable heat that have been found in the literature (see Section 1.3) but also provide additional insights. Financial considerations, environmental concerns, the role of trust in prominent actors, knowledge about alternative technologies and the transition process, and participation options also emerged from previous studies as important factors in the transition towards sustainable heat.

In addition to the literature, the focus groups drew attention to concerns regarding the characteristics of the potential alternatives of natural gas. Although both homeowners and tenants recognized the importance to combat climate change, they had doubts about the sustainability of some alternatives of natural gas and, related to this, the long-term viability of alternatives. Another concern mentioned by both groups related to the influence of a different heating system on their comfort of living (e.g., the noise from electrical heat pumps). Furthermore, homeowners and tenants discussed the pros and cons of adopting and implementing a communal versus individual alternative.

3. Study 2 – survey

3.1. Design and instrument

The questionnaire was constructed based on the results of the focus groups and the literature and consisted of five constructs: (1) knowledge about the transition (5 items), (2) environmental concerns (3 items), (3) attitude towards the Netherlands becoming natural gas free (2 items), (4) attitude towards the neighbourhood becoming natural gas free (2 items), and (5) preferred engagement in the transition (4 items). Furthermore, several single-item questions were asked about trust in different actors involved in the transition (municipalities, civil neighbourhood councils, housing corporations, energy companies, and net distributors), areas of interest (financial aspects, technical aspects, choice of alternative solutions, planning, and communication), and the importance of characteristics of alternatives for natural gas (installation costs, utilization costs, communality, comfort of living, sustainability, and long-term feasibility). These items were approached as single item questions as we wanted to study trust in all specific actors and interest in all specific areas, and not in general levels of trust or interest. All the questions were asked using five-point Likert scales (see Table 2). The questionnaire took between 10 and 15 min to fill out.

As the questionnaire was not based on existing scales, we first tested the validity of the constructs by conducting a principal-component factor analysis (with varimax rotation) using all items measured for the five constructs. This led to a distinction between policy knowledge and technical knowledge. Furthermore, the attitude towards becoming natural gas free could not be divided in national and local level, but was combined into one construct. Environmental concerns and engagement remained as constructs (see Table 2). We then tested the reliability of the final constructs; all constructs appeared to be reliable, with Cronbach's alphas higher than 0.75 (see Table 2).

3.2. Respondents

The survey aimed at adult citizens in both neighbourhoods and was sent on paper together with a newsletter to every household in both

neighbourhoods. Citizens could return the questionnaire by mail, hand it in at the community centres in their neighbourhood, or fill it out online (through a link provided in the questionnaire). More than 9500 questionnaires were distributed (3,583 in the subsidized neighbourhood and 6,000 in the unsubsidized neighbourhood), of which 1,272 were returned. Questionnaires that were less than half completed were discarded and in total 1,245 questionnaires (619 in the subsidized neighbourhood and 626 in the unsubsidized neighbourhood) were used for the analysis.

Table 3 gives an overview of the respondents' background characteristics. The respondents ranged in age between 18 and 95 years old. A majority of the respondents who filled out the questionnaire were homeowners (62%). In the unsubsidized neighbourhood the percentage of homeowners (66%) was larger than in the subsidized neighbourhood (58%). Most of the homeowners were male (70%) and relatively highly educated (51%). Their average age was 56 years old. Tenants (38%) were in the minority. Most of the tenants rented their house through a housing corporation (90%). The male–female ratio was better in this group (54% male) than in the group of homeowners, they had an average age of 54.7 years old, and were less highly educated than homeowners (71% had a lower or intermediate educational level). In the subsidized neighbourhood there were relatively more tenants and lower-educated respondents than in the unsubsidized neighbourhood.

3.3. Results

To answer the research questions, we conducted various analyses in SPSS. First, we tested whether the perceptions on the various elements of the transition towards sustainable heat differed between homeowners and tenants, also looking for the role of the context (whether the neighbourhood received a subsidy for the transition towards sustainable heat). Second, we compared which variables explain homeowners' and tenants' overall attitudes towards becoming natural gas free.

3.3.1. Comparison of perceptions on the transition

To compare the mean scores of homeowners and tenants on the various constructs, and to see whether the neighbourhood influenced the scores, we conducted MANOVAs, which compares the perceptions of groups on more than one dependent variable. The variables included in one MANOVA should be related (moderate to strong correlation) [31]. Based on a Pearson correlation analysis, we found four groups of dependent variables with moderate to strong correlations with each other but not with the other variables. We therefore created four groups of variables and conducted four MANOVAs. These groups of variables were labelled as: (1) *attitudes towards the transition*, including environmental concerns, attitude towards becoming natural gas free, and the trust variables, (2) *knowledge about the transition*, including policy knowledge and technical knowledge, (3) *interest in the transition*, including preferred engagement and areas of interest, and (4) *importance of characteristics of alternatives*. The independent variables were homeowners versus tenants and subsidized versus unsubsidized neighbourhood.

The multivariate analysis showed significant differences between homeowners and tenants on the combined sets of variables for each of the four groups of dependent variables (see Table 4). Furthermore, interaction effects were found for the combined sets of variables relating to attitudes towards the transition, interest in the transition, and importance of characteristics of alternatives (see Table 4). This outcome indicates that on these sets of variables, the differences between homeowners and tenants diverged in the two neighbourhoods.

When the results for the dependent variables were considered separately, significant differences between homeowners and tenants were found for all variables, except for environmental concerns (see Table 5). Most of the effect sizes were very small; however, for technical knowledge, attitude towards becoming natural gas free, trust in the civil

Table 2
Instrument questionnaire.

Construct	Items	Scale	Cronbach's alpha
Policy knowledge	How familiar are you with... 1) the plans of the national government regarding the transition towards sustainable heat. 2) the plans of the municipality regarding the transition towards sustainable heat. 3) the plans regarding the transition towards sustainable heat in the neighbourhood.	1 = very unfamiliar – 5 = very familiar	0.82
Technical knowledge	How familiar are you with... 1) the possible alternatives other than natural gas to heat houses in a sustainable way. 2) the adjustments needed in houses for making them suitable for sustainable heat.	1 = very unfamiliar – 5 = very familiar	0.87
Environmental concerns	1) I think it is important to use renewable energy, such as energy from solar panels or wind turbines. 2) I want to improve the environment. 3) We should all contribute against climate change.	1 = totally disagree – 5 = totally agree	0.83
Attitude towards becoming natural gas free	1) I am positive about the idea that the Netherlands will be completely natural gas free in 2050. 2) It is better for the environment if every household will be disconnected from the gas grid. 3) I am proud of my neighbourhood being a frontrunner in the transition towards natural gas free. 4) I think it is not fair that plans are being made for my neighbourhood as one of the first neighbourhoods of the municipality to be disconnected from the gas grid. (R)	1 = totally disagree – 5 = totally agree	0.87
Preferred engagement in the transition	How do you want to engage in the transition towards natural gas free in your neighbourhood? 1) I want to be informed about the transition. 2) I want to take part in the discussion about the transition. 3) I want to engage in the decision-making process. 4) I do not want to be actively involved. (R)	1 = totally disagree – 5 = totally agree	0.76
Trust in actors (single-item questions)	To what extent do you trust the following actors in taking into account your needs and wishes in the transition? 1) Municipality 2) Civil neighbourhood council 3) Housing corporation 4) Energy company 5) Net distributor	1 = no trust at all – 5 = a lot of trust	/
Areas of interest (single-item questions)	How important do you consider the following areas to be involved in? 1) Financial aspects 2) Technical aspects 3) Choice alternative solutions 4) Planning 5) Communication	1 = not important at all – 5 = very important	/
Importance of characteristics of alternatives (single-item questions)	How important do you consider the following characteristics when choosing for an alternative for natural gas? 1) Installation costs 2) Utilization costs 3) Communalty 4) Comfort of living 5) Sustainability 6) Long-term	1 = not important at all – 5 = very important	/

neighbourhood council, engagement, and most of the areas of interest, small effects were found. For the difference in trust in the housing corporation the effect was moderate.

Homeowners and tenants had similar environmental concerns but were less convinced about becoming natural gas free. Regarding the latter, tenants were more positive than homeowners. Homeowners had slightly more technical knowledge and policy knowledge than tenants, but both groups indicated a low to moderate level of knowledge for both variables. Both homeowners and tenants felt a desire to be engaged in the transition, but homeowners had a stronger wish for this inclusion. They considered all areas of interest (financial aspects, technical aspects, choice for alternative solutions, planning and

communication) to be more important to be engaged in than did tenants.

Homeowners and tenants also differed in their trust in the various actors involved in the transition. Tenants were more positive than homeowners and had a particularly high level of trust in the civil neighbourhood council. Homeowners only had positive expectations for the civil neighbourhood council and were relatively negative about all the other actors. They were most negative about housing corporations, as they did not think this actor would represent their interests. Tenants had considerably more trust in housing corporations.

When the respondents were asked about the characteristics that should be taken into account when choosing an alternative to natural

Table 3
Background characteristics of the respondents.

	Homeowners subsidized	Homeowners unsubsidized	Tenants subsidized	Tenants unsubsidized
<i>Homeowners vs. tenants</i>				
Tenant	/	/	250	171
Private landlord	/	/	6	39
Homeowner	351	406	/	/
<i>Gender</i>				
Male	259	267	139	111
Female	89	130	115	95
Mean age (SD)	58.1 (14.1)	54.1 (15.5)	60.4 (15.8)	47.6 (19.4)
<i>Educational level</i>				
Low	26	34	74	37
Middle	135	167	132	80
High	183	199	46	86
<i>Living situation</i>				
Living alone	48	84	136	121
Alone + children	10	17	19	19
Living together	172	160	90	41
Together + children	115	124	11	12
Other	6	19	0	16

Table 4
Wilks' lambdas of multivariate analysis for four groups of variables.

	Wilks' Lambda	F (df, error df)	Partial η ²
<i>Attitudes towards the transition</i>			
Homeowners vs. tenants	0.87***	27.17 (7, 1089)	0.13
Subsidized vs. unsubsidized	0.96***	7.42 (7, 1089)	0.04
Interaction effect	0.98**	3.44 (7, 1087)	0.02
<i>Knowledge about the transition</i>			
Homeowners vs. tenants	0.99***	9.17 (2, 1196)	0.02
Subsidized vs. unsubsidized	0.89***	72.83 (2, 1196)	0.11
Interaction effect	1.00	1.07 (2, 1196)	
<i>Interest in the transition</i>			
Homeowners vs. tenants	0.96***	8.60 (6, 1183)	0.04
Subsidized vs. unsubsidized	0.98**	3.91 (6, 1183)	0.02
Interaction effect	0.99**	3.00 (6, 1183)	0.02
<i>Importance of characteristics of alternatives</i>			
Homeowners vs. tenants	0.95***	10.90 (6, 1162)	0.05
Subsidized vs. unsubsidized	0.97***	6.89 (6, 1162)	0.03
Interaction effect	0.99**	2.91 (6, 1162)	0.02

Note: **p < .01, ***p < .001.

Table 5
Mean scores homeowners vs. tenants and subsidized vs. unsubsidized neighbourhoods.

	Homeowners	Tenants	Partial η ²	Subsidized	Unsubsidized	Partial η ²	Interaction Partial η ²
<i>Attitudes towards the transition</i>							
Attitude natural gas free	3.16 (1.00)***	3.51 (0.95)***	0.03	3.37 (0.92)	3.22 (1.07)		0.00*
Environmental concerns	4.02 (0.77)	4.11 (0.82)		4.05 (0.74)	4.07 (0.85)		0.01**
Trust in municipality	2.84 (1.12)*	3.00 (1.15)*	0.01	2.91 (1.11)	2.90 (1.16)		0.00*
Trust in civil neighbourhood council	3.49 (1.08)***	3.77 (1.02)***	0.01	3.76 (1.08)***	3.44 (1.02)***	0.02	
Trust in housing corporations	2.45 (1.15)***	3.23 (1.16)***	0.09	2.82 (1.26)	2.70 (1.20)		
Trust in energy companies	2.58 (1.07)**	2.80 (1.13)**	0.01	2.73 (1.10)	2.60 (1.12)		
Trust in net distributor	2.61 (1.07)*	2.77 (1.14)*	0.01	2.71 (1.08)	2.64 (1.11)		
<i>Knowledge about the transition</i>							
Policy knowledge	2.98 (1.07)*	2.89 (1.10)*	0.02	3.30 (1.05)***	2.59 (0.99)***	0.1	
Technical knowledge	2.76 (1.17)***	2.48 (1.19)***	0.04	2.75 (1.17)**	2.56 (1.19)**	0.01	
<i>Interest in the transition</i>							
Preferred engagement	3.54 (0.81)***	3.23 (0.83)***	0.04	3.52 (0.78)***	3.32 (0.86)***	0.02	
Interest in financial aspect	4.15 (0.88)***	3.89 (1.06)***	0.02	4.13 (0.93)***	3.97 (0.99)***	0.01	0.01**
Interest in technical aspects	3.88 (0.96)***	3.54 (1.11)***	0.03	3.84 (1.00)***	3.67 (1.06)***	0.01	0.01*
Interest in choice alternative solutions	4.08 (0.87)***	3.79 (0.99)***	0.03	4.09 (0.89)***	3.85 (0.96)***	0.02	
Interest in planning	3.86 (0.94)***	3.68 (1.04)***	0.01	3.93 (0.90)***	3.65 (1.04)***	0.03	0.01**
Interest in communication	4.06 (0.96)**	3.93 (1.04)*	0	4.13 (0.92)***	3.89 (1.05)***	0.02	0.00*
<i>Importance of characteristics of alternatives</i>							
Installation costs	4.37 (0.77)***	4.21 (0.91)***	0.01	4.38 (0.76)***	4.24 (0.87)***	0.01	0.01**
Utilization costs	4.41 (0.70)	4.45 (0.73)		4.48 (0.66)**	4.36 (0.75)**		0.00*
Communality	3.67 (1.07)**	3.86 (0.99)**	0.01	3.68 (1.04)	3.80 (1.04)	0.01	
Comfort of living	4.35 (0.69)	4.31 (0.81)		4.35 (0.73)	4.31 (0.75)		
Sustainability	4.16 (0.83)*	4.27 (0.84)*	0.01	4.19 (0.77)	4.20 (0.84)		
Long term	4.37 (0.79)	4.39 (0.81)		4.45 (0.71)	4.31 (0.87)		

gas, they thought that installation costs, utilization costs, comfort of living, sustainability and viability in the long term were all important to take into account. Whether the alternative can be a communal solution was considered slightly less important. Homeowners considered installation costs to be more important than tenants, and tenants considered sustainability and communality of the alternative to be more important than homeowners.

In both neighbourhoods, the respondents had a similar attitude towards becoming natural gas free. The subsidy given to one of the neighbourhoods to get the transition started apparently did not influence citizens' attitude about becoming natural gas free. However, respondents in the subsidized neighbourhood had more policy knowledge, slightly more technical knowledge, felt a stronger wish to be engaged in the transition, and were more interested in all thematic areas than those in the unsubsidized neighbourhood (see Table 5). In particular, the difference in policy knowledge was substantial. An explanation of the higher level of policy knowledge could be that to receive the subsidy, for the subsidized neighbourhood plans had already been made and the municipality communicated about them in various

ways (newsletters, meetings, and website), while the municipality of the unsubsidized neighbourhood had communicated less about the transition. As plans in the subsidized neighbourhood were more specific than those in the unsubsidized neighbourhood, citizens may have felt a stronger need to be engaged. Additionally, the respondents from the subsidized neighbourhood had significantly more trust in the civil neighbourhood council than did the respondents in the unsubsidized neighbourhood. This higher level of trust can be explained by the presence of a very active council in the subsidized neighbourhood, which had existed for decades, while in the other neighbourhood, the civil council had been established just one year prior to the survey.

Various interaction effects were found between homeowners vs. tenants and subsidized vs. unsubsidized neighbourhood. These effects were found in environmental concerns, attitude towards becoming natural gas free, and trust in the municipality. Homeowners in the subsidized neighbourhood were more positive towards becoming natural gas free ($M = 3.28$, $SD = 0.90$) and showed greater environmental concerns ($M = 4.07$, $SD = 0.68$) than those in the unsubsidized neighbourhood ($M = 3.05$, $SD = 1.06$; $M = 3.98$, $SD = 0.84$). For tenants this was the other way around: The tenants in the unsubsidized neighbourhood were more positive about becoming natural gas free ($M = 3.53$, $SD = 1.00$) than those in the subsidized neighbourhood ($M = 3.49$, $SD = 0.90$). Furthermore, the tenants in the unsubsidized neighbourhood had more environmental concerns ($M = 4.22$, $SD = 0.83$) than those in the subsidized neighbourhood ($M = 4.02$, $SD = 0.82$). With regard to the respondents' trust in the municipality, homeowners in the subsidized neighbourhood were more positive than those in the unsubsidized neighbourhood, whereas tenants were more positive in the unsubsidized neighbourhood than in the subsidized neighbourhood. However, the effects of these interactions were extremely small (see Table 5). Additionally, interaction effects were found in the preferred level of engagement, the various thematic areas of interest (finances, technical aspect, and planning) and in the importance of characteristics of alternatives (installation costs, utilization costs, and communality). Tenants in the subsidized neighbourhood had a stronger need for engagement ($M = 3.33$, $SD = 0.79$) than tenants in the unsubsidized neighbourhood ($M = 3.10$, $SD = 0.86$), but this difference was less apparent between homeowners in the subsidized neighbourhood ($M = 3.66$, $SD = 0.75$) and in the unsubsidized neighbourhood ($M = 3.43$, $SD = 0.84$). The same pattern was found for the thematic areas of interest. With regard to the importance of the installation costs, homeowners and tenants in the subsidized did not differ, but homeowners in the unsubsidized neighbourhood found this characteristic significantly more important than tenants. Furthermore, tenants in the subsidized neighbourhood gave a slightly higher score to the importance of the utilization costs and communality of the alternatives than homeowners in the subsidized neighbourhood, while this was the other way around for the unsubsidized neighbourhood. However, all of these interaction effects were extremely small (see Table 5).

3.3.2. Antecedents of the attitude towards becoming natural gas free

To gain insight into the acceptance of the transition towards sustainable heat, we conducted regression analyses both for homeowners and tenants and for the subsidized and unsubsidized neighbourhoods. Attitude towards becoming natural gas free was used as the dependent variable, and the respondents' background characteristics (educational level, gender, and age), environmental concerns, policy knowledge, technical knowledge, and trust in various actors were used as the predictors. Additionally, in the regression analysis for homeowners vs. tenants, the type of neighbourhood (subsidized vs. unsubsidized) was included, and in the regression analysis for the neighbourhoods, homeowners vs. tenants was included. The results of these analyses are summarized in Table 6.

The percentage of explained variance was high in all cases (between 50% and 55%). For both homeowners and tenants, environmental concerns proved to be an important predictor of the attitude towards

Table 6

Results of the regression analysis for homeowners and tenants (dependent variable: attitude towards becoming natural gas free).

	Homeowners	Tenants	Subsidized	Unsubsidized
Subsidized vs. unsubsidized	-0.04	-0.05	/	/
Homeowner vs. tenant	/	/	-0.07*	-0.08*
Age	0.01	-0.13**	-0.07	-0.02
Gender	-0.03	0.05	0.03	0.04
Level of education	-0.01	-0.07	-0.05	-0.02
Environmental concerns	0.47***	0.51***	0.48***	0.50***
Policy knowledge	0.06	-0.01	0.08*	-0.02
Technical knowledge	-0.01	-0.04	-0.04	0.00
Trust in municipality	0.27***	0.15**	0.19***	0.26***
Trust in civil neighbourhood council	0.09**	0.11*	0.11**	0.08*
Trust in housing corporations	0.02	0.07	0.03	0.03
Trust in energy companies	0.04	0.17*	0.11	0.08
Trust in net distributor	0.02	-0.06	0.03	-0.06
R ²	0.53	0.50	0.51	0.55
F	61.94***	35.88***	46.19***	55.01***
df	12	12	12	12

Note: Scores represent standardized coefficients; * $p < .05$, ** $p < .01$, *** $p < .001$.

becoming natural gas free. Furthermore, in both cases trust in the municipality and trust in the civil neighbourhood council were significant antecedents. Some interesting differences between the two groups were found. For homeowners, policy knowledge played a significant role, while this was not the case for tenants. For tenants, trust in energy companies was a significant antecedent. Additionally, younger tenants were generally more positive about the transition than older tenants. No differences were found in the regression analyses of the subsidized and unsubsidized neighbourhoods. For both neighbourhoods, homeowner vs. tenant, environmental concerns, trust in the municipality, and trust in the civil neighbourhood council were significant antecedents of the attitude towards becoming natural gas free.

All regression analyses show that environmental concerns are an important antecedent of attitude towards becoming natural gas free. Furthermore, the analyses show that the municipality and civil neighbourhood council are perceived as important actors in the transition to sustainable heat. When the level of trust in these actors is high, the attitude towards becoming natural gas free is more positive. Interestingly, for tenants as well as for homeowners, housing corporations do not play a significant role. It was expected that this actor would be important especially for the tenants.

4. Discussion

The aim of this research was to compare homeowner and tenant perceptions of the transition towards sustainable heat, and to study the influence of the local context, in terms of a subsidized versus an unsubsidized neighbourhood, on this perception. We conducted a mixed-methods study, including focus groups with homeowners and tenants from a subsidized and unsubsidized neighbourhood and a large-scale survey study among homeowners and tenants from both neighbourhoods. Below, we first summarize and interpret the findings of both studies. We then address the limitations of our research and propose directions for future research. The section ends with practical implications that follow from our findings.

4.1. Main findings

The focus groups showed that homeowners and tenants differ in how they see their roles in the transition towards natural gas free.

Although both groups see the municipality as the ultimately responsible actor in the process, tenants consider their housing corporation to be responsible for adjusting their homes, while homeowners feel responsible themselves. Homeowners feel that they lack a clear representation in the transition, are concerned about the power of housing corporations in the process, and feel uncertain whether they have the abilities to make the right decisions. Despite these differences in roles and responsibilities, the focus groups showed that homeowners and tenants consider similar themes to be important in the transition.

The comparisons of survey scores between homeowners and tenants revealed differences that correspond to their different roles. Tenants are more positive than homeowners about becoming natural gas free, as they might see fewer hurdles and costs in the process. They may expect the process to be guided by their housing corporation or landlord/lady and the immediate consequences of the transition may be less salient to them. This difference also reflects the higher levels of trust tenants have in all parties involved in the transition. Homeowners, on the other hand, indicate to have more technical and procedural knowledge about the transition, have a stronger wish to be engaged in the process, and have more interest in every aspect of the transition than tenants do. This reflects their individual responsibilities in the transition to sustainable heat. When assessing the importance of characteristics of alternatives for natural gas, investment costs are more important to homeowners, whereas tenants take a somewhat broader perspective, with more attention for communality and sustainability.

As useful as it is to draw attention to such differences, it seems equally important to highlight that, given the effect sizes found, the differences are actually rather small. Although it is clear that homeowners, compared to tenants, have a stronger wish to be engaged in the process and are more interested in all aspects of the transition, tenants also find it important to be engaged and show interest in these aspects. In line with earlier research [12] it seems important to engage citizens—not only homeowners but also tenants—in the transition process. In a similar vein, although investment costs are more important to homeowners than to tenants, tenants also appear to have an eye for them (which they presumably expect to see reflected in their monthly rent). And, likewise, homeowners also think that communality of alternatives for natural gas deserves attention. In all, the differences between homeowners and tenants must be seen as nuances, not as fundamental differences.

The regression analyses showed that similar antecedents matter for homeowners' and tenants' attitude towards becoming natural gas free. The most important antecedent for both groups is environmental concerns. This finding suggests that local energy transition projects need to be embedded in a broader context in which the challenge of climate change and the importance of a comprehensive energy transition is kept high on the societal agenda. Earlier research showed that homeowners' environmental concerns positively affects their willingness to adopt energy-efficient measures [17,18]. Our study confirms this finding and shows that it also applies to tenants.

Trust in relevant actors is the other important antecedent for homeowners and tenants. Apparently both groups are not only affected by intrinsic considerations, but also by their trust in relevant actors. This finding confirms earlier studies showing that trust in actors involved is an important success factor for local energy projects [25–27]. Trust in the municipality is an important antecedent of residents' attitude towards becoming natural gas free. Both the focus groups and the survey showed that homeowners and tenants doubt whether the municipalities have the capacity to guide the transition and the willingness to consider their interests. The other significant trust variable, in the civil neighbourhood council, received much higher scores from homeowners and tenants. This may be because this actor is closer to the residents and has stronger ties with the neighbourhood involved. This finding confirms the results of Van der Schoor et al. [14].

The regression analysis for tenants had two puzzling results. First, despite the prominence of housing corporations in the transition

process, as underlined in the focus groups, trust in the housing corporation was not a significant antecedent of tenants' attitude towards becoming natural gas free. It is plausible, however, that this trust factor will become significant when the scope of the transition moves from the neighbourhood to the housing corporation. Second, tenants' trust in energy companies appeared to be a significant antecedent of tenants' attitude towards becoming natural gas free. They may have thought of district heating as one of the plausible outcomes of the process.

Both the focus groups and the survey show that homeowners and tenants need more than a general story about the necessity of the energy transition. They also actively think about characteristics of alternative options, not only in terms of consequences for themselves but also as a solution to climate change, and do not take the sustainability and long-term viability of some of the proposed alternatives (district heating and bio-energy) for granted.

Even though it must be stressed that our study was a field comparison and not a quasi-experiment, our findings also shed some light on the effects of a national subsidy on the dynamics in a neighbourhood in transition. Residents from the subsidized neighbourhood scored higher on knowledge, preferred engagement, and interests than residents from the unsubsidized neighbourhood. Their response rate to our survey was also higher. This might be due to the more specific plans and communication activities within the subsidized municipality. However, the differences between the neighbourhoods were generally small, indicating that a generic subsidy may have more effects at the system level than on individual perceptions.

4.2. Limitations and future research

This research, however, does have some limitations. An important limitation involves the survey sample. Our response rate was 18% in the subsidized neighbourhood and 10% in the unsubsidized neighbourhood. Citizens who returned the questionnaire might be more interested in the topic and have more extreme opinions (in favour or against) than citizens who did not. This is a common problem with questionnaires, but it is something to consider when interpreting the results.

Second, the dependent variable of our study was attitude towards becoming natural gas free. While attitudes give an indication of people's acceptance of the transition towards sustainable heat, we did not measure behavioural intentions or actual behaviour. Citizens may agree with the policy of natural gas free, but this may not result in action (paying for insulation or adjustments, accepting higher costs, passively or actively supporting the transition). Acceptance is an important first step in motivating citizens to action, but future research should also include behavioural variables.

Third, we only compared the overall categories of homeowners and tenants, but there may be relevant variations within these categories. One can think of tenants renting from housing corporations versus tenants renting from private landlords/ladies. One can also think of homeowners in different price segments. Likewise, it may be interesting to differentiate more in types of homes, for instance comparing already insulated homes with poorly insulated ones. Future research could focus on further differentiating the findings in our study.

A fourth limitation is that our study involved cross-sectional data focusing on an early stage of the transition process. Future research should complement our findings by longitudinally analysing how the perceptions and behaviours of homeowners and tenants evolve over time. This can be done quantitatively (by administering the same questionnaire at subsequent stages in the process) or qualitatively (by following the transition processes in-depth in a limited number of households from both groups).

4.3. Practical implications

Our results provide several insights for local governments on how to

engage residents in a transition towards sustainable heat. First, local governments should treat homeowners and tenants as important stakeholders and offer them to participate in the process. A low-threshold governmental body in the vicinity of the residents, such as a civil neighbourhood council, may play an invaluable role here. Second, even though their roles and responsibilities differ, homeowners and tenants do not seem to differ fundamentally in their views on the transition to sustainable heat. They may be approached in similar ways, with some small differences in emphasis. One such difference is that homeowners are not organized, feel like they are left to their own devices, and do not feel represented in the process. Third, it appears to be important for local projects to keep the societal issue of climate change and the nationwide challenge of the energy transition high on people's agenda. The degree to which people acknowledge the urgency of the challenge is strongly related to their attitudes in specific local projects. Fourth, it is important to realize that trust in the capability and benevolence of actors plays an important role in such transition processes. Actors responsible for the transition must actively work on their trustworthiness to the homeowners and tenants.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors want to thank the province of Overijssel for making this research possible through their funding, which was part of a larger funding programme for the MVI-E Brigade. We also want to thank the municipality of Enschede and Hengelo and the housing corporations De Woonplaats, Domijn, Ons Huis and Welbions for distributing the questionnaires.

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