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Decided or divided? An empirical analysis of the decision-making process of Dutch homeowners for energy renovation measures

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ABSTRACT

The pace at which energy renovations are made to the existing housing stock must increase if the Netherlands is to reach the energy goals outlined in the nation's climate mitigation policy. In this paper, this challenge is addressed by introducing a novel integrative model for a private homeowner's decision-making process concerning energy renovation measures. The model distinguishes between the various stages of the process, the multiple factors that influence these stages, and the many considerations facing homeowners as they decide to adopt or reject energy renovation measures. Data were collected from interviews with and questionnaires completed by private homeowners in the city region of Parkstad Limburg (NL) who received an energy audit for their home. The findings reveal that various factors are relevant in different stages of the decision-making process. In the first stage, external developments, physical factors, socio-demographic factors, and environmental concerns can trigger an interest in energy renovation measures. In the second stage, homeowners gain knowledge about the measures, and personal background and advice from their social network or from professionals can influence this decision stage. In the third stage, during which financial and economic factors are particularly important, homeowners form an opinion about the energy renovation measures. After implementing the energy renovation measures, homeowners can also influence others in their social network and become ambassadors for further energy-saving changes. Based on the results, policy recommendations are provided to increase the adoption of energy renovation measures by private homeowners.

1. Introduction

According to the United Nations (2018), countries worldwide must triple their efforts to keep global warming below 2 °C and must increase their efforts fivefold to stay below 1.5° [1] and meet the goals of the Paris climate agreements [2]. To contribute to this latter effort, 1.5 million houses in the Netherlands (20% of the housing stock) need to be renovated before 2030 to cut carbon dioxide (CO_2) emissions 49% by that time [3]. This can be realised by energy renovation measures (ERM) such as insulation, high-efficiency glazing, efficient heating and ventilation systems, and renewable energy production (e.g., PV panels) that interact with collective renewable energy solutions on a district level. Despite this technical potential and widespread policies supporting energy renovations [4], the average rate of renovations is between 0.5% and 1.2% per year in Europe [5]. As a result, the energy renovation pace is not on schedule to meet the emission targets [6].

This limited impact of current policy measures can be explained by: 1) instituting non-coercive policy instruments, 2) placing the responsibility for energy efficiency solely on homeowners [7], 3) addressing homeowners in policies as rational decision-makers [4,8–13], and 4) overlooking the social aspects of renovation [4,14–19]. As a direct result, most policies ignore the diversity of concerns and motivations in relation to ERM [4,14–16,18,20,21].

To increase the impact of policies, a more holistic perspective is needed concerning the decision-making process of private homeowners regarding ERM [17,18,22]. This challenge is addressed in this paper by analysing this complex and diverse decision-making process. The main research question of this study is: What are the various stages in the decision-making process of private homeowners concerning energy renovation measures and what are the influencing factors in these

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stages? An interdisciplinary approach for data collection is chosen for the development of a decision-making model for of private homeowners for ERM. Data is collected from three Dutch projects in which home energy audits[1] were offered to private homeowners.

This article is structured in the following way: In the next section, existing literature on the decision-making process of private homeowners is discussed; in Section 3, the research method is explained; in Section 4, the results of this study are presented; in Section 5, the discussion is presented; and in Section 6, the conclusions of the study are presented and recommendations are formulated for policy actions and further research.

2. Background: the decision-making process of private homeowners

2.1. Decision-making stages

In this section, relevant theory and empirical results from others are presented examining the decision-making process of private homeowners for ERM. Previous studies argue that the homeowners' decisions about ERM are not isolated decisions but are situated in daily life and embedded in social practises. This is because the decision-making process of homeowners regarding ERM can be seen as an ongoing practise of home maintenance with multiple decision-making moments [4,14–19,22–29]. According to Rogers [30], there are five stages in the decision process, which are explained in Table 1.

This model has been tested and proved useful in contexts relevant to ERM [22,31,32]. Furthermore, other models using different theories have been developed for the decision-making process concerning ERM [33–35]. Based on these previously developed decision models, we specify six decision-making stages for ERM in this study. These stages define the activities that are taking place in the decision-making process for ERM and are described in Table 2.

Additionally, homeowners have a multitude of considerations and are also subject to a wide variety of influences (to greater or lesser extent) when making their way through the decision-making process [24]. These influencing factors can be more or less relevant in the various stages of the process [33,34]. Despite this, Kastner & Stern [18] point out in their review that only a few empirical studies address the subject and focus mostly on a limited number of variables. Additionally, only a few studies have used a qualitative in-depth analysis of the decision-making process of homeowners in all its complexity and interlinked connections. Therefore, they argue for an integrative, interdisciplinary, theoretical framework explaining energy-relevant investment decisions in which the relationship between variables is also studied.

Therefore, the conceptual framework for the decision-making stages for ERM will be used in this study to investigate the influence of the various factors in the several stages of the decision process. Nevertheless, the framework is applied in a flexible and open way, to leave room for exploring unexpected new leads to gain a better understanding about how decisions are made. This approach is chosen because the aim of the study is to provide a holistic perspective on the stages of the decision-making process of ERM, the many factors homeowners must consider, and the many factors influencing the process. This research will fill the literature gap by developing a novel integrative model of the decision-making process used by private homeowners concerning ERM.

The findings of other studies on the influencing factors in the different stages of the decision-making process are discussed in the sections below.

2.2. Getting interested

Firstly, external developments can create awareness among homeowners to pique their interest in ERM. On the one hand, this can be policy actions such as financial schemes [36], information campaigns, or community energy events [37–39]. On the other hand are grass-roots initiatives and energy co-operatives in which a group of citizens themselves take action to create awareness and organise the implementation of ERM [38,40–43].

Secondly, the physical factors,[2] such as the house itself, can also influence homeowners' decisions to implement ERM in this stage. Homeowners are more willing to consider ERM when they experience poor (thermal) comfort [15,44–47], when they are relatively new homeowners [44,48], or when they want to change the architecture or aesthetics of the house [15,48].

Thirdly, socio-demographic factors can also be important influencers in this 'considering' stage [22,33]. Previous studies argue that there is a possible correlation between socio-demographic factors and homeowners' choices for ERM. There seems to be a positive correlation between younger homeowners and adoption of measures [44,48–50], the presence of younger children [48], and homeowners with a higher education level or higher average income [18,44,48,50–52]. Uncertainty about how long one will stay living in the house can be a barrier to investing in the home [10,22,52]. However, other studies have found that socio-demographic factors such as gender, education, and occupation are rarely related to the adoption of ERM [18].

Fourthly, previous studies have demonstrated that personal norms (among other factors) are important influencing factors in pro-environmental choices; this is also argued in several developed and proved theories (e.g., theory of planned behaviour, [53,54], norm activation model [55], and value belief norm theory [56]). These models have been widely tested in several areas and were confirmed on their predictive power (e.g., [18,57,58]). Furthermore, there were also efforts to include other predictors or factors into more comprehensive frameworks (e.g., [57,59,60]). However, the great majority of these studies focus on curtailment behaviour and rarely on investment decisions such as ERM [18]. Black et al. (1985) reported that major energy investment decisions have different patterns of predictors than energy curtailment behaviour [61] and, therefore, their usability for these decisions is questionable for the adoption of ERM [18].

Nevertheless, these theories and related research indicate that environmental concern or awareness (as a personal norm) is an important influencing factor in the decision-making process [46,50,62–66]. With environmental concern, we mean that people feel responsible for the environment and take action themselves. Conversely, some studies argue that focus on the environment in policy can also be a hindrance, especially for more politically conservative people [13,67,68]. So far, the role of environmental concern in the decision-making process of private homeowners concerning ERM is understudied, and more research is needed to achieve insight into this issue.

2.3. Gaining knowledge

When a homeowner becomes interested in ERM, the next stage is gaining knowledge about the measures being considered [22,30,33,35]. Additionally, other studies point out that knowledge about [59], experiences with [60,69], or competencies of the individual [27] with a certain technology can influence a homeowner's decision to implement ERM. Consequently, a lack of adequate knowledge or information can have a negative effect on a homeowner's decision to invest in ERM [47,48,70–73]. A tailored face-to-face energy audit has been revealed in several studies as an effective tool to overcome this barrier [74–78]. By

[1] An energy audit is advice given by a trained professional to reduce the energy use of the house. This advice includes energy-efficiency measures and renewable energy options.

[2] By physical factors, we mean material aspects whose influence occurs via evaluation.

Table 1
Innovation decision process (based on Rogers [30]).

Innovation decision process	
Prior conditions	Perceived need or problem, social norms, current practises
1. Knowledge stage	In this stage, an individual gains understanding about an innovation
2. Persuasion stage	In this stage, an individual forms a favourable or unfavourable attitude about the innovation
3. Decision stage	This stage leads to the decision to adopt or to reject an innovation
4. Implementation stage	In this stage, the innovation is implemented
5. Confirmation stage	This stage occurs when an individual seeks reinforcement of an innovation decision already made

Table 2
Decision-making stages for ERM, conceptual framework for this study (based on several sources [22,30–35]).

Decision-making stages for ERM	
1. Getting interested	Homeowners start to think of ERM
2. Gaining knowledge	Homeowners are exposed to the existence of ERM and gain an understanding of how these measures function
3. Forming an opinion	Homeowners form a positive or negative attitude and perception towards ERM
4. Making a decision	Homeowners decide to implement or reject ERM
5. Implementing ERM	ERM are implemented in the house
6. Experiencing ERM	Homeowners experience ERM and form a positive or negative attitude towards the measures taken, based on their own experiences

contrast, other studies demonstrate only a weak link between energy audits and homeowners' decisions to invest in ERM [10,79,80] or demonstrate a negative correlation [10,81]. These diverse outcomes of the effect of energy audits are presumably linked to research and sampling methodologies [10,80] and need further investigation.

Regarding this knowledge stage, several studies point out that interpersonal communication, through face-to face exchange, is the most effective way to persuade an individual to adopt an innovation [17,30,32]. Likewise, other studies identified social influence [60,82] and social norms [59,62,83] as influencing factors. After implementing ERM, homeowners can also influence others in their social network to adopt ERM [84] and thereby increase the adoption of ERM by other homeowners. Despite this importance, the influence of advice from homeowners' social networks is an aspect that is not widely studied yet with regard to ERM in homes, and more research is needed on how and when a social network influences a homeowner's decision-making process [16,85].

Next to advice from their social network, other studies have revealed that installers of ERM[3] play an important role in informing homeowners [23,35,44,86–88] but the ERM industry is often seen by the homeowners as unreliable and non-transparent [15,16,23,86]. Therefore, trust and reliability are important issues when homeowners deal with these energy companies [4,23,89]. In addition, other studies point out that installers of ERM often lack knowledge about new technologies and are reluctant to install them [86].

2.4. Forming an opinion

Financial-economic factors are often important in the 'forming an opinion-stage' of the decision-making process in which homeowners form a favourable or unfavourable attitude towards ERM [22,33,90]. Financial motivations can be the perception of a high energy bill [44,91] and a positive project economy [32,48,71]. On the other hand, reported barriers for adoption are lack of finances [10], uncertainty of the benefits [46,92–94], underestimation of the energy savings [95], and a perceived long payback period [10]. Furthermore, homeowners who experience a low energy bill or homeowners who evaluate their house as being in good condition will refrain from taking measures as well [10,44,46,48]. Governmental grants, subsidies, and loans can be important drivers for homeowners to adopt ERM [36].

[3] Installers of ERM: e.g., building contractors, heating installers, installers of PV panels.

2.5. Making a decision, implementing ERM, experiencing ERM

After homeowners have formed an opinion, they will decide whether or not to adopt ERM; this is the 'making-a-decision' stage. If they have decided to make the necessary changes, the 'implementing ERM stage' and the 'experiencing ERM stage' will follow (see Table 2). In these last two stages, the homeowners form a positive or negative perception about the ERM based on their own experiences. These perceptions will influence what they will tell others in their social network about ERM.

3. Research method

3.1. Energy audits for homeowners in the city region of Parkstad Limburg (NL)

The empirical data were collected from three projects in the city region of Parkstad Limburg (NL) after professional advice (an energy audit) was offered to private homeowners regarding making their homes more energy-efficient. The city region, which is located in the south of the Netherlands, comprises eight municipalities and counts 125,885 households [96]. This region was selected as a case study because it is one of the frontrunners on energy strategies in the Netherlands [97] and is home to several projects targeting the existing housing stock. Historically, the city region grew rapidly during the coal mining boom from 1900 to 1960 but has experienced a decline in households since the closing of the mines in the 1970s. As a result, the current average income per household and the average property value are lower than those figures for the Netherlands as a whole, mainly because of fewer job opportunities. The region has both an urban and a rural character, which are strongly intertwined [98]. The study results can also be relevant for regions where the situation is different because regions with less-developed energy strategies can learn from these frontrunners. This study focuses on owner-occupied homes, as they form the majority of the housing stock (56% in NL [99] and 70% on average across the EU [100]).

The three projects (A, B, C) where data were collected have slightly different setups. Project A included all eight municipalities in the city region, Project B was implemented in the municipality of Landgraaf, and Project C targeted the municipality of Nuth. In Project A, only advice was offered; in Projects B and C, the participants also received an offer from local companies to install the energy-saving measures; and Project B also provided financing from the municipality in the form of a low-interest loan. The projects were executed by three intermediary

Table 3
Overview of data sampling and project characteristics.

Case-studies	Project A		Project B		Project C		Total	
Municipalities targeted	City region of Parkstad		Landgraaf		Nuth			
Intermediary organisations	DUW		GEAS		Susteen			
Energy audit	X		X		X			
Offer from companies			X		X			
Financing			X					
Costs[a]	free		€60		€45			
	#	%	#	%	#	%	#	%
Contacted people	420	58%	87	12%	222	30%	729	100%
Interested people	74	54%	20	15%	42	31%	136	19%
Respondents questionnaires	54	59%	-[b]	0%	37	41%	91	12%
Interviews	19	37%	18	35%	15	29%	52	7%

[a] These costs refer to the amount of money homeowners had to pay for the energy audit. The actual costs were higher and were subsidised by the municipality.

[b] No questionnaires were sent out in Project B because of the limited interest. The questions from the questionnaires were added to the interview questions instead.

organisations that were hired by the involved municipalities and provided the advisers for the energy audits (see Table 3). The homeowners received a home visit from the adviser and a written report afterwards with recommendations for ERM.

3.2. Data collection

In this study, data were collected with online questionnaires ($n = 91$) and face-to-face interviews ($n = 52$). The online questionnaires were used to provide preliminary input for the interviews to assist in selecting purposeful samples and to identify (new) topics for further analysis. The questions were therefore merely open-ended questions to explore the topics. The interview method was used to gain a better understanding of the cases in depth and detail, to grasp meaning in a particular (dynamic) context [101], and to allow the homeowners to satisfactorily describe their entire decision-making process and experiences. A quasi-inductive approach was chosen to provide room for new findings and to gain a better understanding about how decisions are made. The semi-structured interview protocol was composed of open-ended questions to guide the conversation with the homeowner about his or her decision-making process, experiences with the energy audit, and any other advice received. In addition, information was collected about the characteristics of the homeowner and the dwelling (see Appendix A). By interviewing the respondents in person, it was possible to correct misunderstandings in the questions and ask follow-up questions if unexpected, but relevant, themes were brought up by the respondent. Furthermore, the personal contact with the homeowner gave the researcher knowledge about the context in which the question was answered [102], and additional information about the physical context of the home could be collected.

Data collection was completed between October 2017 and June 2018; private homeowners were recruited by email through the municipalities. Interested homeowners received the online questionnaire and a sample of these respondents were selected for interviewing. Due to the fact that only homeowners who responded are studied, there is a possible selection bias as this group may not represent the entire sample. The interviews were conducted in person by the researcher (first author) and a research assistant at the homeowner's house. The homeowners received a gift voucher of 20 euros for their participation. The interview data were analysed every 5 to 10 interviews and discussed by the research team (authors). The interview protocol was adjusted when found necessary after analysis of the data. Data collection was ended when data saturation was reached and no new data relevant to the research themes emerged [103]. The interviews were digitally recorded, stored (with permission of the respondent), and transcribed. All interviewees were given pseudonyms from the transcript stage onwards.

The sampling led to an interview sample containing private homeowners who exhibit a high rate of adoption of ERM (78%), have an average age of 54, are predominantly highly educated (56% having a bachelor degree or beyond, in contrast to the average of 30% in the Netherlands [104]), and demonstrate an average share of households with children living at home, namely 37% (33% in average in NL, [105]). They also live in a single-family house,[4] have a larger living area (181 m^2) than average in the Netherlands (140 m^2) [106], and have an average house value of €224,000, which is lower than average in the Netherlands (€230,000) [107]. This can be explained by the fact that the houses in this region have a lower house value than in other regions of the country [107] (see Appendix A).

The findings are therefore fairly representative of homeowners with a medium-high socio-economic status who live in regions (or countries) with similar energy strategies targeting private homeowners and who live in a similar climate such as the Netherlands. This sample group is relevant because current policies in the Netherlands have not yet succeeded in engaging this group of middle-class homeowners to largely implement ERM to meet the national energy and climate goals [23]. Another aspect regarding this study sample is the high share of adopters of ERM (78%),[5] which indicates that this sample is not an average sample of the population but contains of a high number of 'early adopters'. Rogers [108] points out that 'early adopters' generally have a higher socio-economic status than 'later adopters', which is in line with our sample. Moreover, the high adoption rate can also be explained by the fact that the targeted group was already interested in energy renovation measures because they applied for an energy audit. However, the insights into the decision-making process of these early adopters can also be relevant for other homeowners whose situation is different [43,109,110].

3.3. Data analysis

The objective of our analysis is to better understand the diversity of homeowners' experiences in the decision-making process of ERM. The results from the questionnaires and the interview transcripts were used to systematically analyse the transcripts using the thick analysis method [111] and using qualitative software (Atlas.t 8.1). Various coding and analysis techniques were used: 1) thematic (deductive) coding based on the theoretical framework; 2) argumentation coding and analysis, to provide insight into the reasoning of the homeowners in their decision-making process about making their homes more energy-efficient; and 3) open coding, to look inductively to other methods of data organisation that could lead to different results. These techniques were used to explore; compare; and find patterns, linkages, and differences [101,112]. The data provide a holistic perspective on the different stages of the decision-making process, the multitude of considerations facing the homeowners, and the influencing factors in the different stages of this process. Consequently, the data are used to develop an integrative model of the decision-making process of homeowners.

4. Results

4.1. The decision-making model

Based on the studied findings, a decision making model could be

[4] Condominiums were excluded from the data collection because of their joint decision-making process.

[5] There are no data about the share of adopters in the total number of contacted people.

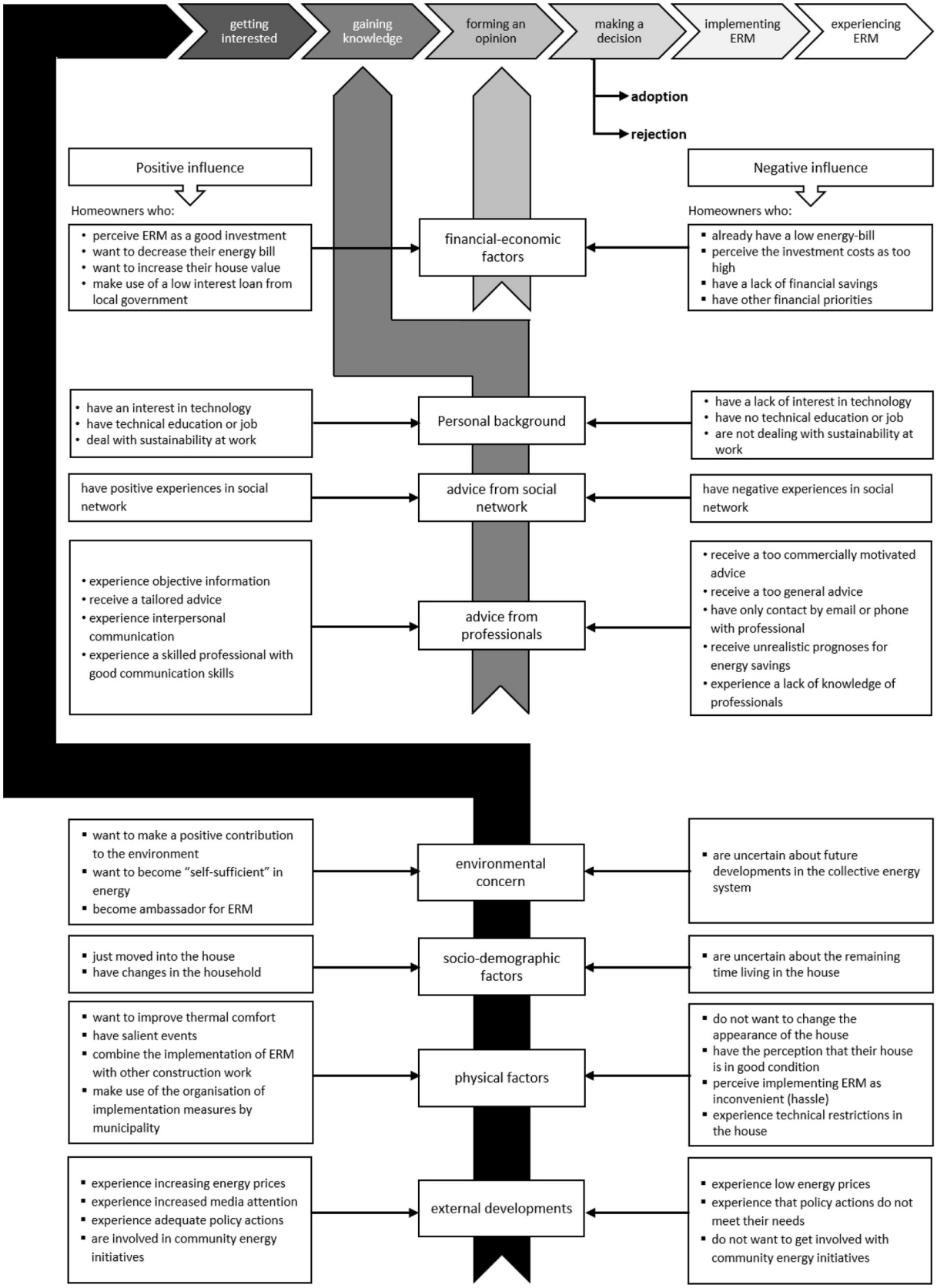

Fig. 1. Decision-making model of homeowners for energy renovation measures (Figure based on 22, 30–35] and the empirical material collected for this paper).
"have changes in the household": e.g. children born, working at home, less able to walk stairs
"salient events": e.g. boiler breaking down, broken window.

discerned that emphasises the various stages of the decision-making process and the multiple factors that influence the homeowners in their decision to adopt or reject ERM. Fig. 1 illustrates the decision-making model in which, on top, the six decision stages are presented. The various influencing factors are positioned in the middle. On the left, the factors that can have a positive influence are presented, and on the right, the factors that can have a negative influence are listed. The decision-making model points out that in the 'getting interested stage', external developments, physical factors, socio-demographic factors, and environmental concern are influencing factors. In the 'gaining knowledge stage', personal background and advice from others (social network or professionals) are important, and in the 'forming an opinion stage', financial-economic factors are important. In the next stage, homeowners will make a decision to adopt or reject ERM. When they decide to adopt ERM, the homeowners will also go through the 'implementing ERM stage' and the 'experiencing ERM stage'. These last three stages are not discussed in further detail in this section because this study focuses on the stages prior to the decision-making.

Considering that the model is developed from empirical evidence in a specific region, we do not suggest that this model is comprehensive. Extending the scope of data collection can generate further elaboration of this model. Nevertheless, the decision-making model thus provides an overview of the decision-making process used by private homeowners concerning ERM. The influencing factors in the various decision stages found in this study are discussed in the next sections.

4.2. Getting interested

4.2.1. External developments

External developments can trigger homeowners to begin thinking about ERM. During the time of the interviews (September 2017 to June 2018), additional media attention was focussed on the announcement that the national government was seeking to decrease natural gas consumption in the Netherlands partly due to the problems with extraction in the north of the country and the dwindling national gas reserves. (Natural gas provides 41% of the total national energy consumption) [3,113]. Some homeowners explained that it was not clear what this would mean for their personal situation. For instance, Donald wants help to disconnect his house from the natural gas network:

> 'I would consider disconnecting the house from the natural gas if the municipality would take over a bit of technical expertise, maybe offer a subsidy and take some of the risk. Then we would consider it faster'. (Male respondent, age 57, PV panels)

Another possible development that could have triggered homeowners to begin thinking about ERM is the national net-metering scheme to promote small-scale renewable energy installations such as rooftop PV panels [38]. However, this scheme has been the subject of political debate for a few years, and it will be phased out starting in 2023 [114]. Despite this, the city region of Parkstad launched a still-active PV panel project in 2016 to stimulate placement of residential rooftop PV panels. In this project, all details are arranged for the homeowner: installation of the photovoltaic (PV) panels, a 15-year guarantee and service, and an optional low-interest-loan from the municipality. Some of the interviewees (25%) also participated in this project, and they appreciated it greatly, for instance, Roos:

> 'Before I participated in the PV panel project, I had to do everything myself. What helped me a lot was that they guided me step for step in the decision-making process. In addition, they also organised the tax refund which was something I dreaded before because I have so much on my mind. So I was very happy with that. Everything went well; they arranged everything, from installation to all the administrative things. I did not have to do anything'. (Female respondent, age 54, participant in the Parkstad PV panel project)

A third external development was that 21% of the interviewees made use of the low-interest loan from the municipality to finance their PV panels (see Appendix A). In addition, five of the interviewees made use of a low-interest loan to promote several sustainable measures for private homeowners from the province of Limburg (where Parkstad is located). In addition, at the time of the interviews, the community-network project 'Buurkracht' was active in several neighbourhoods in Parkstad [115] but only one interviewee mentioned participating in such a meeting so the impact of this project cannot be discerned from the study results. Additionally, at the time of the interviews, there were no local energy co-operatives active in the Parkstad region [116].

When reflecting on the results of the various approaches taken in Projects A, B, and C (see Table 3), the results reveal that an 'all-in-one offer' such as in Project B is the most effective. This is because three barriers are addressed in this approach: the lack of knowledge is addressed by the energy audits, the fear of 'hassle' or inconvenience is addressed by organising the implementation of the ERM, and financial barriers are addressed by offering a loan from the municipality. This is further explained in the next sections.

4.2.2. Physical factors

Next to external developments, physical factors can also trigger homeowners to begin considering ERM because they want to improve their living conditions. These physical factors were also mentioned in the interviews. Firstly, the perceived (thermal) comfort in the home was mentioned as an important motivator to implement ERM by 58% of the adopters in the interviews and by 31% of the respondents of the questionnaire (see Tables 5 and 6). Secondly, the age of the house could be a motivator for renovation, as older houses often need updates to improve energy efficiency according to current standards and comfort levels. However, the box plots in Fig. 2 illustrate only a small difference between the age of the houses owned by adopters (1967) and non-adopters (1972); this can be due to sample bias. Thirdly, some homeowners (38%, see Table 5) face technical restrictions that make it difficult to implement energy-efficiency measures, especially in older houses. This is illustrated in Fig. 2: The median year the house was built is 1969 for all interviewees and the median is 1954 for houses that face technical restrictions. Reasons for these technical restrictions are the absence of a cavity wall or limited space under the ground floor for insulation or the unwillingness to demolish the floor finishing. Another technical restriction mentioned was that the roof was unsuitable for PV panels because of a northerly orientation. Fourthly, another building-related barrier that influences some homeowners' decisions is the prospect of changing the aesthetics of the house (19%, see Table 5). This is especially the case for those living in older, more characteristic, houses. Fig. 2 illustrates that the median year the house was built is 1963 for all interviewees and 1952 for homeowners who do not want to change the aesthetics of the house. These aesthetic-related measures include insulation on the outside of the façade (8%), high-efficiency (HE) glazing (6%), and PV panels (15%). Arnold is still hesitant to install PV panels on his red tile roof but has installed other measures:

> 'Since we insulated the roof and the walls, it has become more pleasant in winter: It stays warm longer and in summer it gets less warm, but we do not like the appearance of current PV panels, so we will wait for future developments'. (Male respondent, age 35, roof and cavity wall insulation, HE-glazing, HE-gas boiler)

The results of the questionnaires reveal another barrier for implementing ERM: 20% of the respondents perceive their house as in a good condition (see Table 5) and do not think they need more ERM. Additionally, the installation of ERM is perceived as inconvenient by some homeowners; two respondents referred to the need to clean up the attic or storage room to install insulation. Other homeowners combine the implementation of ERM with other construction work (23%, see Table 5), such as an extension or changes in the floorplan. This is mainly done by younger homeowners who have just purchased the house or a few years after the purchase, which is demonstrated in Fig. 2.

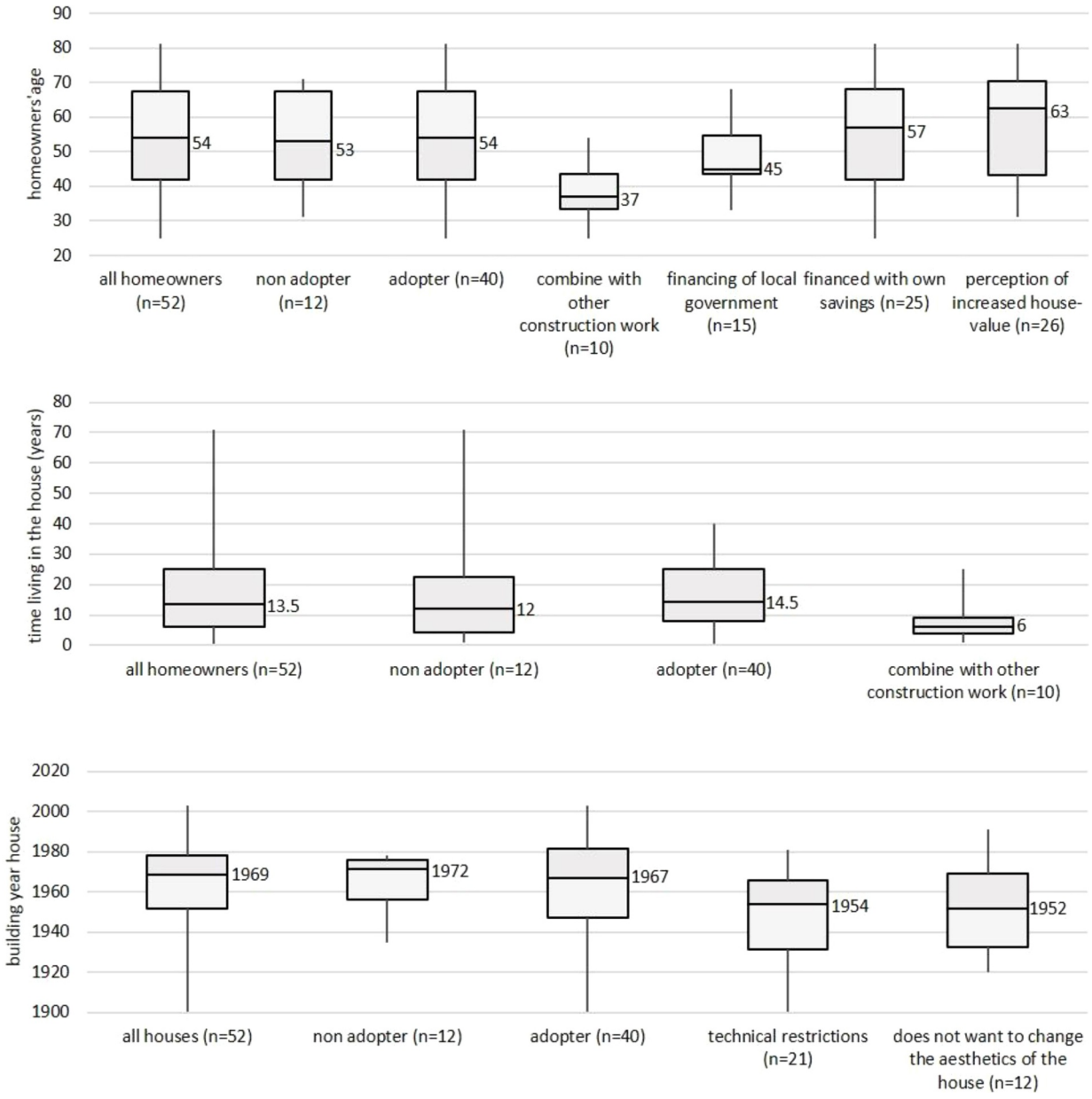

Fig. 2. Box-plots of interview results.
Top: boxplot of homeowners' age of 1. all homeowners, 2. non-adopters 3. adopters, 4. homeowners who combine the implementation of ERM* with other construction work, 5. homeowners who make use of financing of local government, 6. homeowners who have financed the ERM with their own savings, 7. homeowners who have the perception of an increased house value after implementing ERM.
Middle: boxplot of time living in the house (years) and 1. all homeowners, 2. non-adopters, 3. adopters, 4. homeowners who combine the implementation of ERM with other construction work.
Bottom: boxplot of building year house of 1. all houses, 2. houses from non-adopters, 3. houses from adopters, 4. houses with technical restrictions, 5. houses from homeowners who do not want to change the aesthetics of the house.

The median age for ERM adopters is 54 years and the median age is 37 years for people who combine ERM with other construction work on the house. Furthermore, the median for time lived in the house is 14 years for adopters and 6 years for people who combine ERM with other construction work.

4.2.3. Socio-demographic factors and environmental concern

Socio-demographic factors can have an influence on homeowners in the 'getting interested stage'. The interview results reveal that for the adopters, 58% are younger than 60 years, 37% have children living at home, and 56% have a bachelor degree or higher, which is much higher than the average of 30% in the Netherlands [104] (see Appendix A). Furthermore, an important personal driver for homeowners is environmental concern and the willingness to act upon this: 56% of the respondents of the questionnaire mention this as a priority along with 62% of the interviewees (see Tables 5 and 6). This includes, for example, Truus, who wants to take responsibility for the environment:

> 'You also have to take responsibility yourself. You can think "my time will come", and it will, but I do not think that's a good idea to leave the world behind without my own contribution'. (Female respondent, age 53, PV panels, roof and cavity wall insulation, HE-glazing)

In addition, 'becoming self-sufficient' for energy supply (15% in

questionnaires, 25% in interviews, see Tables 5 and 6) can be a motivation related to environmental concern. The main drivers for this are having more control of energy costs, making a positive contribution to the environment and becoming less dependent on energy utilities. This is illustrated by Tamara:

> 'At some point I just decided to become green. In the long run, I want to become self-sufficient in energy'. (Female respondent, age 33, roof insulation, HE-glazing, PV panels)

It can be expected that in the future, more homeowners will be motivated to become self-sufficient when the consequences of climate change become more visible and energy prices increase.

4.3. Gaining knowledge

The results of this study demonstrate that when homeowners begin to think of ERM, they obtain their information in various ways. On the one hand, a homeowner's background seems to be an important influencing factor: More than half of the interviewees (52%) report having a technical education or job or becoming familiar with sustainability at work (see Table 5). This includes Piet, who has worked as a financial controller at a pension fund:

> 'Sustainability became more and more important at work, and as a result I got "infected" with it. I learned that investing in the environment is a good thing and that it has good revenues in the long run'. (Male respondent, age 66, PV panels, cavity wall insulation, HE-glazing)

On the other hand, homeowners ask also others for advice on ERM. Next to the received energy audits, homeowners search the internet for information on company and semi-public websites. Additionally, they ask installers of ERM for advice. Moreover, the results indicate that homeowners' social networks are important sources for information as well. These three types of information sources—the municipality (energy audits), advice from installers of ERM, and advice from the homeowners' social network—are described below.

4.3.1. Energy audits from a municipality

The results reveal that homeowners experience the audits in a different way (see Table 5). On the one hand, the majority (69%) appreciate the objective advice. Ria, for instance, explains her reaction:

> 'I found it very convenient because now I did not have to delve into the matter myself. Otherwise I have to make comparisons between different measures, companies, technical specifications, etc., and that is really not my cup of tea. I find it hard to motivate myself for doing that, so it is also laziness. It is great that the municipality does that for you. … It was very clear, what he told me, in just normal language, not too detailed and not too technical, otherwise I would not understand it. That gives confidence and trust when it is clear, and he also placed it in my context'. (Female respondent, age 53, PV panels and floor insulation)

On the other hand, the less satisfied homeowners found the advice too general and containing irrelevant information. For instance, Felix offered the following advice to improve this:

> 'They should do more customisation and work more with the neighbourhood associations. They have to listen to the experiences of what people already have done and look at how they can deliver customised solutions in the right way, because the houses here are not uniform. I think that would be a big step forward'. (Male respondent, age 68, PV panels)

Another aspect, that some of the less satisfied homeowners mentioned, is that they missed detailed information about specific, less diffused technologies. Hans states:

> 'They told nothing new. The advice is meant for someone who has no idea what to do; if you have informed yourself, then the advice is less useful'. (Male respondent, age 35, roof and cavity wall insulation, PV panels)

This demonstrates that the knowledge level of these homeowners was higher than addressed in the energy audit. A total of 40% of the homeowners already had quite a lot of knowledge about ERM before they received the energy audit (Table 5). Moreover, some homeowners perceived the energy audit as less than objective and indicated that the advice was too 'commercial' because certain companies were recommended. This includes Rob:

> 'I attended the information meeting and signed up for an energy audit. I had the impression that it was a sales pitch. I never received a thorough report. I only received a financial offer which I can apply for myself'. He suggests an energy help desk as a possible solution for this: 'That they set up an "energy help desk" where people get objective information, no commercial information but a fair and neutral story. The municipality could be a kind of an intermediary and select good and trustworthy companies'. (Male respondent, age 45, roof and cavity wall insulation, HE-glazing, shutters and PV panels)

Next to the content of the energy audit, the skills of the adviser seem to be an important factor as well, including reliability and effective communication skills. Karin appreciated the adviser's skills:

> 'It was a good advice and a friendly man to talk to. He saw my problems and wanted to think along, and it was also pleasant conversation'. (Female respondent, age 44, cavity wall insulation, PV panels)

In contrast, others pointed out that the adviser lacked communication skills, such as what Arjan experienced while renovating his house and building an extension:

> 'The adviser was very technically competent, but you also need sales skills when giving an energy audit'. (Male respondent, age 43, roof and cavity wall insulation, PV panels)

To summarise, homeowners appreciate the objective, independent advice in an energy audit provided by a municipality if this advice is customised to their specific situation and their knowledge level of ERM. Next to technical expertise, the energy auditor must have communication and organisational skills.

4.3.2. Advice from installers of ERM

The second type of information source is advice from installers of ERM. In the interviews, homeowners said a significant amount of information about ERM can be found on corporate websites but that they find it difficult to assess this information, especially when applying it to their specific situation. They said they cannot decide what is reliable and suitable information from the massive amount of information available on the internet. In addition, seven homeowners (see Table 5) mentioned that the information provided by installers is often ambiguous and that different installers say different things because they are promoting their own products, which is not always the best solution for the homeowner. As a result, homeowners express doubt about what the best choice is for them. For instance, Ellen wants to insulate her roof and install PV panels:

> 'All the companies claim to have "the holy grail"; there is an overkill of websites, you don't know whom to believe because they all have a different approach or philosophy'. She suggests a centralised website with objective information: 'I think you can make something like an internet platform, for example, with the most frequently asked questions and checklist, organised by the government. … I have asked several companies about an offer for one brand of PV panels,

Table 4
Key findings interview results.
Percentages have been rounded up or down to the nearest whole number. The researchers want to point out that the percentages must be treated with caution because of the limited sample sizes.

		Non-adopters (n = 12)*		Adopters (n = 40)*	
Influencing factors		#	%	#	%
Socio-demographic	uncertainty about remaining time living in the house	3	25%	8	20%
Personal background	in contact with sustainability at work	2	17%	8	20%
	technical education or job	5	42%	17	43%
	financial-economic education or job	2	17%	9	23%
	high knowledge level of ERM	4	33%	17	43%
Environmental concern	environmental concern	7	58%	25	63%
	becoming self-sufficient	1	8%	12	30%
Physical factors	technical restrictions house	2	17%	18	45%
	aesthetics as barrier	3	25%	7	18%
	improve comfort	5	42%	23	58%
Implementation of ERM	prefers local companies	2	17%	4	10%
	appreciates service by municipality	2	17%	13	33%
	combine with other construction work	0	0	9	23%
Financial –economic factors	want to increase house value	2	17%	24	60%
	have financing of local government	0	0	15	38%
	already a low energybill	1	8%	2	5%
	(some) ERM are too expensive	10	83%	21	53%
	have other financial priorities	4	33%	2	5%
	want to decrease energy costs	9	75%	30	75%
	ERM = good investment	2	17%	8	20%
Advice	satisfied with energy audit*	6	55%	25	74%
	influenced by social network	8	67%	31	78%
	ambassador of ERM	2	17%	24	60%
	lack of reliable and suitable information	1	8%	6	15%

* Only 45 homeowners received an energy audit in this sample (11 non-adopters, 34 adopters), so the percentage is based on this total.

and they advised me something else regarding the different components of the system. How is that possible? That you get completely different advice about one product?' (Female respondent, age 32, floor insulation, HE-glazing)

Homeowners often ask installers directly for advice, frequently combined with an offer request. Some interviewees point out that they prefer a local company (12%, see Table 5) or an installer who is known in their social networks. Another finding is that homeowners seem to be more willing to trust a certain installer if that person provides advice combined with a site visit to their homes and is focussed on the homeowner's personal circumstances and wishes. Sabina and Tanja state about this:

'The man who made an offer for replacing the roof came here and was very honest and open. We made good arrangements. His offer clearly showed what he was going to do and what not. We have more trust in people who give an honest advice and are enthusiastic. Therefore, we chose him'. (Female respondents, ages 34 and 38, roof and cavity wall insulation, HE-glazing, HE-gas boiler, shutters)

In contrast, unrealistic promises about possible energy savings generate little trust in the installer, as Daan points out:

'Some companies say that you will save so much, then I say, "That's interesting because it means that I'm going to save more than I use at the moment" '. (Male respondent, age 68, non-adopter)

Another bottleneck in implementing ERM is the lack of knowledge among installers about upcoming technologies and materials. Edwin reports the following:

'I noticed that companies are not really responding to the new developments. The installers need to be trained because they lack knowledge'. (Male respondent, age 67, roof insulation, HE-glazing, PV panels)

In summary, homeowners encounter difficulty finding reliable and suitable information for their specific situations. Homeowners often prefer local installers of ERM who are known in their social network. A visit to their home with personalised advice is appreciated and leads to trust in that installer.

4.3.3. Advice from social network

The third source of information is the social networks of homeowners such as family, friends, neighbours, and colleagues. Most of the adopters (78%, see Table 5) mention that discussions with people in their social networks influenced their energy renovation choices in a positive way. This held true for Derk and Rita:

'We talked to people who already had PV panels like friends and neighbours before deciding for them ourselves'. (Male respondent, age 72, and female respondent, age 70, PV panels)

Another phenomenon addressed by the homeowners in the interviews is that 50% of the interviewees (see Table 5) actively advise people in their social network about ERM. They become ambassadors (or 'opinion leaders') [108]) for ERM. Rogers [117] says, 'Potential adopters look to early adopters for advice and information about an innovation. The early adopter is considered by many to be "the individual to check with" before adopting a new idea'. This happened in the case of 'ambassador' Cor:

'I brag about my PV panels and energy savings to people I know. A man came here with pen and paper to ask about the PV panels, so yes, I advertise them'. (Male respondent, age 73, HE-glazing, PV panels)

The high share of ambassadors in this sample can perhaps be explained by the fact that this group of homeowners can be seen as early adopters (see Section 3.2) and they are therefore more informed than the majority of homeowners [108].

To summarise, a social network is a strong influencing factor in a homeowner's decision-making process. Additionally, some adopters also become influencers or 'ambassadors' in their network.

Table 5
Results questionnaires, barriers of non-adopters and motivations of adopters (respondents could select multiple options).

Barriers of non-adopters (n = 20)		Motivations of adopters (n = 71)	
House is already in good condition	20%	Improve comfort	31%
Already a low energy bill	5%	Environmental concern	56%
Too expensive	30%	Saving energy (costs)	72%
Other priorities	25%	Becoming self-sufficient	15%
Lack of right information	10%	Setting an example	1%
Planning to do	20%	Personal interest	1%
Other reasons	20%		

4.4. Forming an opinion

When homeowners have gained knowledge about ERM, they start to form an opinion about the measures in the next stage, during which financial-economic factors can have significant influence. The results from the questionnaires demonstrate that saving energy (also saving money) is the most-mentioned motivation (72%) for adoption. In the group of non-adopters, financial barriers were mentioned the most: either 'too expensive' (30%) or having 'other priorities' (25%) for their time or money (see Table 6). The findings of the interviews reveal that a homeowner's age is strongly connected to how the ERM are financed. Most older adopters (17 adopters are age 60 and older) financed the measures with their own savings (82%); among the younger homeowners, only 48% did so. (Twenty-three adopters are younger than 60; see Tables 4 and 5). An explanation can be that older homeowners have fewer expenses (lower mortgage, no kids living at home) than younger homeowners and have had more time to build their savings. Younger homeowners appreciate the low-interest loans offered by the local government because they often do not have enough savings or have other financial priorities. Fig. 2 demonstrates that the median age for the adopters is 54 years, the median age for people who financed the measures with their own savings is 57, and the median age for homeowners who used financing from the local government is 45. Interviewees who invested their savings in ERM explained that their return on investment in ERM is higher than on their savings account because of the current low interest rates. This is especially the case with PV panels, where homeowners have the perception of a short payback time. For example, Mike sees ERM as a good investment and tries to convince others:

> 'I told a friend this morning, "You are crazy not to do it when you have savings." At the bank you get 0.5% and when you invest it in PV panels, you get a return of 8 to 15%'. (Male respondent, age 62, PV panels, a solar water boiler and a heat pump)

Another outcome is that half of the interviewees believe the measures they took will increase the value or saleability of their home (see Table 5). Fig. 2 reveals that this is especially the case for the older homeowners. The median age for all adopters is 54 years and the median age for homeowners who perceive an increased house value is 63 years. This is illustrated by a quote from Cor (age 73), who renovated his entire house after purchase:

Table 6
Results questionnaires, type of adopted energy renovation measures (n = 71).

Adopted energy renovation measures	
PV panels	55%
HE-glazing	26%
Façade insulation	23%
Roof insulation	22%
Floor insulation	18%
Heat pump	7%
Solar water heater	3%

> '… Because our home is also our piggy bank. Suppose we have to go to a nursing home then I can get a better price for a home that is up to date'. (Male respondent, age 73, PV panels, roof and façade insulation, HE-glazing, HE-gas boiler)

5. Discussion and conclusion

5.1. The decision-making process and implications for policy-makers

This paper introduced a novel model for the decision-making process of private homeowners who are considering installing energy renovation measures. The model distinguishes between the various stages of the process, the multiple factors that influence these stages, and the many considerations facing homeowners as they decide to adopt or reject energy renovation measures. The results demonstrate that energy decisions are not isolated but are situated in daily life with multiple decision moments; they are influenced by many factors [15,22–24,29]. Moreover, these influencing factors are important in the various stages of the decision-making process [23,33,34]. To improve the impact of policies, we suggest that it is vital that correct policy actions are deployed for the particular stages of the decision-making process to be successful and lead to higher adoption of ERM by homeowners [23,34].

5.1.1. Getting interested

The model illustrates that the first stage (getting interested) is the most important as this is the moment that people begin to think about energy renovation measures; this was confirmed in previous research [29]. Policy actions will succeed only if people who were not considering ERM at first begin thinking about it. However, at this time, policy-makers tend to focus on the decision-makers, the homeowners who are already considering ERM [29], and less on the homeowners who are not. To target the latter group as well, policy actions can be effective in increasing environmental awareness. This is necessary because the results reveal that homeowners who have an environmental concern and are willing to act on this are more likely to begin considering ERM, which confirms previous studies that demonstrate a positive relationship between environmental concern and adoption of pro-environmental measures [41,50,53,59,62,86,118]. We suggest the following three policy actions to increase environmental awareness to influence the consideration stage in the decision-making process:

Firstly, governments are able to influence external developments in this stage by creating or stimulating external developments. This can be done by ensuring more media attention about the subject, stimulating energy communities, launching grass-roots initiatives, and supporting local energy co-operatives by raising awareness and attracting public support [41]. By targeting neighbourhoods, information about ERM can be shared among homeowners living in similar homes and having similar socio-economic backgrounds [119]. To be successful, however, these community approaches must be tailored to the characteristics of the neighbourhood and the specific needs of the homeowners [39,85].

Secondly, policy actions can be designed to target the homeowners' specific needs because homeowners will begin considering ERM if they want to improve their living conditions to match their changing needs [17,26,29], such as improving their thermal comfort [15,44–47] or enhancing aesthetics [15,48]. In addition, policy actions can target specific homeowners who are planning to change the layout of their house through an extension or a remodelling because ERM are often combined with other construction work. This has also been demonstrated in other studies [14,22,43,44,48]. Salient events (e.g., boiler breaking down, broken window) or changes in the household (e.g., moving, retiring, having children) can also be good moments to inform homeowners about the possibilities for their homes [90].

Thirdly, policy actions can specifically target homeowners who are less likely to adopt at this moment because they are older, less educated, or have a lower income (also suggested in [39,118,119]). The

results of this study illustrate that owners of newer homes and highly educated homeowners are more likely to adopt ERM; these results have also been exhibited in previous studies [44,48–52]. Additionally, other studies have indicated that income can have a positive influence on adoption of ERM [18] but this is not studied in this research.

5.1.2. Gaining knowledge

If homeowners begin to think about ERM, they will gain more information about the measures in the knowledge stage. A lack of knowledge about ERM can negatively influence the adoption [44,47,48,59,70,72]. Personal background—such as an interest in technology [13,86], a technical background, or familiarity with sustainability issues at work—can also influence the decision-making process because of the higher level of awareness about ERM. Specific policy actions can focus on increasing knowledge levels of private homeowners about ERM so they can make informed decisions.

Firstly, local governments can offer credible, objective advice about ERM focussed on the homeowner's specific situation, knowledge levels about ERM, personal needs, and preferences in which the non-energy benefits for ERM also are revealed. In this study, homeowners received an energy audit for their home arranged by intermediary organisations on behalf of the municipality. These intermediaries and energy auditors can play an important role in adoption of ERM by private homeowners, as indicated in previous studies [26,29,35,120,121]. The results demonstrate that individual homeowners have their own specific expectations about an energy audit. A 'one-size-fits-all' audit will be less successful than in-person advice tailored to a homeowner's specific needs. This conclusion has also been confirmed in several studies [18,74–78,80,122,123]. Additionally, the findings of this study reveal that advice must be targeted to the homeowner's specific situation, needs, and preferences [39,86,124,125]; if the advice is too general, homeowners have difficulties relating to it [126]. Moreover, the energy auditor or adviser needs to understand and adjust to the homeowner's wishes, interests, circumstances, and knowledge level to provide tailored energy advice in a dialogue with the homeowner [82,123]. Objectivity, technical knowledge, and communication skills are also important features for an energy auditor or adviser [123,124].

Secondly, this study reveals that positive experiences from a homeowner's social network can aid the adoption of ERM. Additionally, social networks are a possible point of intervention for local government because potential adopters are more likely to pay for energy-efficiency changes when they receive information from someone in their social network who already did so. These outcomes confirm previous studies which reveal that the role of advice from social networks has a positive effect on the adoption rate of ERM [16,18,23,30,41,52,85,86,119,127,128]. In addition, grass-roots community energy initiatives and renewable energy co-operatives can raise awareness among homeowners to take action [38,40–43]. Moreover, local governments can facilitate 'ambassadors' [108] to demonstrate their ERM in their homes so that other potential adopters can look at, feel, and listen to these measures to test their aesthetics, comfort, and noise. This is also recommended in other research [39,52,85] and implemented in policies as well, but on a rather small scale (e.g., Blok voor Blok [129], Buurkracht [130], and HOOM [131] in the Netherlands). More insights are needed into how this group of ambassadors could be increased to create a larger impact on the adoption of ERM. A possibility to do so is by organising this in energy communities, grass-roots initiatives, and/or local energy co-operatives.

Thirdly, policy-makers can engage installers of ERM (companies) in the promotion of their products because they also play an important role as adviser in a homeowner's decision-making process, as demonstrated in this study and in previous literature [23,44,86–88]. However, the ERM industry is often seen by the homeowners as unreliable and non-transparent [15,16,23,86]; therefore, trust and reliability are important issues when homeowners deal with companies [4,23,89]. However, the results reveal that these issues can be enhanced by a personal visit by the installer at their home who provides realistic projections of energy savings and works through the changes with the homeowner. Another barrier pointed out by the homeowners in this study is the lack of knowledge of some installers about new technologies. As a result, these companies will advise the most familiar technologies and are reluctant to suggest new technologies. Additionally, an installer may be an expert in his product but lacks knowledge about an overall approach to improving energy efficiency throughout the entire house [86]. Because of this fragmented market, this often results in contradictory advice [16]. Policy actions can facilitate educational programs for installers [16] to improve their knowledge about new technologies and the necessary integrative approach for making homes more energy-efficient.

5.1.3. Forming an opinion

After gaining enough knowledge about ERM, homeowners form a certain attitude and perception towards ERM in this stage. Now, financial-economic factors become more important; this has also been identified in other studies [10,48]. Local government can address the financial barriers that some homeowners have by offering financing options such as low-interest loans or subsidies. Another barrier that can influence this stage in the decision-making process is the perception of inconvenience or the 'hassle factor' of making energy-efficiency improvements [10,43,109,132]. Local governments can help by organising the installation of ERM by skilled and trustworthy local companies such as the PV panel project in Parkstad (see Section 4.2). Moreover, governments can combine energy audits, financing options, organisation of ERM installation, and guarantees into an all-in-one offer that has also been suggested in previous research [133]. Other research also suggests using project managers to guide the entire process for the homeowner [86]. These suggestions have been executed successfully, for instance, in the Blok voor Blok project in the Netherlands. Here, intermediary organisations were subsidised by the national government to guide homeowners through the entire decision-making process. The organisations offered energy advice to homeowners and helped select and install the measures in a 'one-stop' fashion. Street ambassadors and demonstration houses have been deployed as well to raise awareness among homeowners. The project ended in 2014 and some initiatives were carried on in other projects [129]. However, these initiatives failed to scale up to a larger population and more insights are needed into how this can be done.

5.1.4. Making a decision, implementing ERM, and experiencing ERM

Even though the last three stages in the decision-making process were not studied in detail in this study, some conclusions can be made. When homeowners decide to adopt ERM (in the 'making a decision stage') the next stages are 'implementing ERM' and 'experiencing ERM' (see Fig. 1). In these last two stages, the homeowners form a positive or negative perception about ERM based on their own experiences, and this perception will influence what they will tell others in their social network about ERM.

To summarise, this study illustrates that the decision-making process of private homeowners for energy renovation measures is divided in several stages and that these stages are influenced by multiple factors that can be different for every homeowner.

5.2. Limitations and implications for further research

In this study, a novel integrative model for a homeowner's decision-making process concerning ERM is developed. The decision-making model is developed based on empirical evidence in a specific region with a limited sample size and with a high share of adopters. Therefore, we do not suggest that this model is comprehensive. Extending the scope of data collection can generate further elaboration of this model. Further studies could test a wider set of factors, such as cultural aspects and neighbourhood characteristics, along with testing the influencing

factors in the last three stages of the decision-making process. Moreover, follow-up research could investigate further which factors are important in which stage. Additionally, further research could study whether some factors also influence other factors and are therefore interlinked. It would be useful to test the relationship of the developed model on larger samples for making generalisations to a larger population and also test it on groups such as those with less education and lower incomes in different regions and geographical areas. Validation of the model in expert groups (e.g., policy-makers) could also be a valuable addition for the further development of the decision-making model and the policy actions.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.25385/zuyd.7887095.

Appendix A

Table A-1.

Table A-1
Study sample with characteristics of the 52 interviewees.

Name*	project	age	ERM taken last 5 years**	participant PV panel project yParkstad	years living in house	children living at home***	Bachelor degree or more***	building year house	living area house (m2)	type of dwelling****	house value (x1000)
non-adopters (*n* = 12)											
Cor	C	67	–	0	1	0	0	1966	165	D	€ 177
Daan	A	68	–	0	33	0	1	1954	231	D	€ 340
Danny	C	37	–	0	5	1	1	1978	200	D	€ 271
Frans	C	69	–	0	45	0	0	1970	192	D	€ 265
Linda & Sven	C	41	–	0	1	1	1	1978	419	SD	€ 267
Loes & Tjalle	C	54	–	0	19	0	0	1955	119	SD	€ 120
Moniek	A	51	–	0	16	1	0	1974	176	SD	€ 160
Sander	B	52	–	0	11	0	1	1973	174	D	€ 284
Stijn	B	31	–	0	2	1	1	1976	112	SD	€ 223
Ton	A	71	–	0	71	0	0	1935	114	T	€ 112
Walter	B	55	–	0	6	1	1	1976	152	SD	€ 193
Wout	A	42	–	0	13	1	0	1957	107	TC	€ 119
adopters (*n* = 40)											
Arjan	A	43	RI, FI, PV	1	8	1	1	1933	237	D	€ 366
Arnold	C	35	HEB, RI, CVI, HEG	0	10	1	0	1952	105	SD	€ 164
Arthur	C	73	HEB, PV	0	14	0	0	1996	117	SD	€ 203
Bart	B	31	PV	0	3	0	1	1994	143	SD	€ 267
Bas	B	68	PV	1	26	0	1	1990	202	SD	€ 315
Ben	A	81	CWI, PV	1	38	0	0	1969	163	SD	€ 175
Cor	A	73	HEG, PV	0	1	0	0	1988	95	T	€ 205
Derk & Rita	A	72	PV	0	39	0	1	1979	211	D	€ 333
Donald	B	57	PV	1	12	0	1	2003	183	D	€ 376
Ed & Valerie	B	67	RI, FI, CWI, HEG, HEB, PV	0	17	0	1	1949	177	SD	€ 245
Edwin	C	67	RI, HEG, PV	0	34	0	1	1978	182	D	€ 273
Elene	C	25	CWI, FI, RI	0	2	0	1	1965	144	D	€ 229
Ellen	A	32	FI, HEG	0	8	0	1	1931	201	SD	€ 153
Els	A	37	FI, ST, HEB, PV	0	6	1	0	1965	146	D	€ 176
Eric	A	68	RI, ZP	0	16	0	1	1966	159	T	€ 211
Evan	C	73	HEG, HEB, PV	0	33	0	0	1955	192	D	€ 215
Evert	A	63	PV	1	15	0	1	1932	361	TC	€ 336
Felix	C	68	PV	0	15	0	1	1930	312	D	€ 297
Hans	A	35	CWI, RI, PV	0	10	1	0	1968	196	TC	€ 146
Harry & Wilma	B	71	RI, CWI, FI, HEG, PV	0	29	0	0	1962	178	D	€ 216
Jan	A	42	CWI, HEG, PV	0	12	0	0	1966	166	TC	€ 204
Jules	B	45	CWI, HEG, PV	1	8	0	1	1951	114	SD	€ 130
Karin	A	44	CWI, PV	0	0	1	0	1920	141	SD	€ 120
Maud & Ferry	C	42	PV	0	4	1	1	1988	151	D	€ 295
Mike	C	62	HP, PV, SB	0	21	0	0	1978	154	SD	€ 219
Oscar	B	55	PV	1	39	0	1	1989	98	SD	€ 154

(*continued on next page*)

Table A-1 (*continued*)

Name*	project	age	ERM taken last 5 years**	participant PV panel project yParkstad	years living in house	children living at home***	Bachelor degree or more***	building year house	living area house (m2)	type of dwelling****	house value (x1000)
Piet	A	66	CWI, HEG, PV	1	40	0	0	1975	119	T	€ 122
Ralf	B	52	HEB, PV	1	25	1	1	1991	196	D	€ 288
Ria	C	53	FI, PV	0	13	0	1	1979	144	T	€ 157
Rob	B	45	RI, CWI, HEG, ST, PV	0	6	1	1	1976	297	D	€ 338
Roos	B	54	ST, PV	1	25	0	0	1984	143	SD	€ 176
Sabina & Tanja	A	38	RI, HEG, HEB, ST	0	1	1	0	1941	115	TC	€ 76
Sandra	C	54	PV	0	30	0	0	1900	199	D	€ 275
Stefanie	B	44	RI, HEB, PV	0	15	1	0	1965	130	D	€ 204
Sven & Ruth	B	63	PV	0	8	0	1	1992	242	D	€ 348
Tamara	A	33	RI, HEG, HEB	0	5	0	1	1914	277	TC	€ 223
Tess	B	42	HEG, HEB	0	13	1	1	1975	134	TC	€ 193
Tom	A	64	CWI, HEG, PV	0	24	0	1	1981	214	SD	€ 193
Truus	B	53	CWI, RI, HEG, PV	1	18	1	0	1915	248	TC	€ 277
Wim	B	73	RI, FI, HEG, HEB	0	27	0	1	1920	243	SD	€ 208
Average	**–**	**54**	**–**	**–**	**17**	**–**	**–**	**1963**	**181**	**–**	**€ 224**
Percentage			**–**	**21%**	**–**	**37%**	**56%**	**–**	**–**	**–**	**–**

* Names of respondents have been changed to safeguard their anonymity.

** FI: floor insulation, RI: roof insulation, CWI: cavity wall insulation, HEG: high efficiency glazing, HEB: HE gas boiler, PV: photovoltaic panels, HP: heat pump ST: shutters, SB: solar boiler.

*** 0 = no, 1 = yes.

**** D = detached, SD = semi-detached, T = terraced, TC = terraced corner house.

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