A framework to increase intention to invest in sustainable heating among Dutch homeowners

Master thesis communication science

University of Twente

Faculty of Behavioral, Management, and Social sciences (BMS)

Enschede, March 2022

Author:

Remco Pieterse (s2571145)

Master student Communication Science

r.pieterse@student.utwente.nl

1st Supervisor:

Prof. Dr. Menno de Jong

Department of Communication science

2nd supervisor:

Dr. Sikke Jansma

Department of Communication Science

Abstract

Purpose - The Dutch government is fighting climate change by retrofitting homes with sustainable heating. Homeowners need to invest in systems themselves and thus play an important role in making the transition work. However, the transition is a major social and technical challenge. Hence, predicting homeowners' intention to invest in sustainable heating is valuable for understanding more regarding their perceptions of this investment. Therefore, this study investigates the intention to invest in sustainable heating among Dutch homeowners and which factors influence them.

Methods – By conducting an online survey (N = 302), intention to invest in sustainable heating and its predictors were studied. Four variations of intention were measured; long-term, short-term, while gas prices are high, and when the government offers more support. Data was collected utilizing convenience and snowball sampling through social media and in collaboration with the network operator 'WestlandInfra', distributing the survey among its employees.

Results – The results showed that intention to invest in sustainable heating is highest while more support is given by the Dutch government, followed by long-term, while gas prices are high and short-term. 95% confidence intervals revealed differences between intention. Meaning, the intention is indeed highest while more government support is provided. Moreover, variations of intention are predicted by different factors. Only one's social circle is significant in all situations. Long-term is predicted the most, followed by short-term, while providing more support, and with high gas prices.

Conclusion – The key takeaway is that intention to invest in sustainable heating is not so easily defined, along with its predictors. One intention (to invest in sustainable heating) is different depending on the situation. Future research should uncover why these differences exist. A theoretical framework is developed showing how the intention to invest in sustainable heating – along with its predictors – differs. Governments could use the framework to influence the predictors, thereby improving intention to invest in sustainable heating among Dutch homeowners.

Keywords: Sustainability, climate change, natural gas-free, sustainable heating, theory of planned behavior, behavioral intention

Acknowledgments

This thesis is written for the completion of the master program of Communication Science at the University of Twente. I would like to thank my 1st and 2nd supervisors, Prof. Dr. Menno de Jong and Dr. Sikke Jansma, for their guidance and providing me with helpful feedback, insights, and critical questions in various stages during my thesis project. Without you, the thesis would not be presented the way it is. Thank you both. I would like to thank Nick van der Hout of WestlandInfra netbeheerder B.V. as well for the help in finding respondents. This proved very useful. Thank you.

Remco Pieterse

March 2022

Table of contents

1. Introduction

Nowadays, the world is fighting climate change. Following the Paris climate agreement, a legally binding international treaty, countries are replacing fossil-based energy systems with renewable energy in order to keep global warming well below 2 degrees Celsius (United Nations, 2015). Governments differ, however, in their approach. Dutch policymakers aim, starting from now, to drastically reduce emissions by retrofitting all homes and buildings with sustainable heating by 2050 (the transition towards sustainable heat). Due to its gas reserves in the province of Groningen, the energy system of The Netherlands consists of 44% of natural gas (Boot, 2021). Therefore, emissions of households are almost entirely produced by natural gas, approximately 15 megatons of CO_2 equivalent (a measure of how much emissions contribute to global warming) in 2020. In comparison, the total emissions in The Netherlands in 2020 was 166 megatons of CO_2 equivalent (Hammingh et al., 2021). Hence, households account for roughly 9% of total emissions.

The transition towards sustainable heat could thus have a significant impact on the total emissions of The Netherlands. National and local governments (such as municipalities) are struggling, however, to get people on board. Transitioning towards sustainable heat is a major technical and social challenge; it requires homeowners to invest in sustainable measures. They play an important role in making the transition work (Milieucentraal, 2021; Scholte et al., 2020). However, uncertainties and questions regarding if the (local) government will live up to its promises, the costs of sustainable heating systems, if the costs are worth the benefits, technical uncertainties (e.g., comfort in homes, ability to produce comfortable temperatures during winter), and concerns regarding subsidies (differences between municipalities, unpredictable in time) cause people to wait and see before considering investing (Jansma et al., 2020; Scholte et al., 2020; Steenbekkers & Scholte, 2019). The difficulties the Dutch government encounters are thus problematic. This may be more pronounced in times of high natural gas prices, which negatively affect homeowners and may have an influence on the adoption of sustainable heat sources. Price increases range between 200 to 300 euros per year, and the national government had to step in to stall the increase (Koster, 2021; NOS, 2021; NVDE, 2021;

Rijksoverheid, 2021). Consequently, energy from renewable sources is currently cheaper than energy from fossil fuels (CAN Europe, 2021).

This study aims to research homeowners' perceptions regarding their intention to transition towards sustainable heat. More specifically, the intention to invest in sustainable heating systems. Moreover, previously mentioned studies included a limited number of variables (e.g., socio-demographic, trust in the government, or concerns for the environment) and measured their relationship with and effect on attitude only. More factors might influence attitude. Hence, this study will explore and uncover influential factors of homeowners' intention towards investing in sustainable heating to get insights into their opinions and how to get them on board. Using the Theory of Planned Behavior as a theoretical basis, a comprehensive framework consisting of multiple factors that influence intention and attitude will be developed based on empirical findings. This results in the main research question: ***"Which factors influence Dutch homeowners' intention to invest in sustainable heating?"***

By conducting this study, complexities regarding decarbonization will be further understood at a household level. More specifically, homeowners' intention to invest in sustainable heating in The Netherlands and which factors predict their intention, further understanding what drives people to fight climate change by replacing their fossil-based heating systems with sustainable ones. Moreover, the predictors could be influenced to get homeowners on board the transition towards sustainable heating and get them to create an intention to invest in said systems. Additionally, governments may use the results to make further adjustments to policies.

2. Literature review

Theoretical contributions from behavioral studies will be examined to get an overview of the field. First, research regarding the transition towards sustainable heat in The Netherlands will shed light on the current situation. Second, evidence regarding behavioral intention will shed further light on the theoretical basis for this study. Finally, factors that potentially influence the intention to invest in sustainable heating will be discussed, resulting in the research model used for this study.

2.1 Research regarding the transition towards sustainable heat in The Netherlands

Several studies regarding the transition towards sustainable heat in The Netherlands exist, primarily focusing on attitude or support for the government policy of switching from natural gas towards sustainable heating (Jansma et al., 2020; Scholte et al., 2020; Steenbekkers & Scholte, 2019).

Opinions seem to be divided. Scholte et al. (2020) found 49% of homeowners in favor, 27% not in favor, 16% neutral, and 8% to not have an opinion regarding transitioning towards sustainable heat. Even though people seem to agree with the need to fight climate change, switch to and save energy, reduce emissions, or change ways of living, they are more skeptical of specific policies or measures to achieve this and rather wait for the government to act. People may agree with the policy in general, but, not how it is executed (Scholte et al., 2020). Additionally, uncertainties regarding the transition towards sustainable heat result in people to wait-and-see. They wait for the right moment, want to be sure of their choice, think the technology will develop further, wait for costs to go down, or are not sure the government will keep its promises (Steenbekkers & Scholte, 2019). The Dutch government thus has difficulties convincing people. Supporting this, Jansma et al. (2020) found no significant differences in attitude towards becoming natural gas-free while comparing homeowners in subsidized and unsubsidized neighborhoods. Subsidies provided by the government seem not to make substantial differences. However, more policy knowledge was present in subsidized areas; one knows more about the transition towards sustainable heat while receiving subsidies. Nevertheless, attitude seems to be somewhat neutral.

The aforementioned studies indicate that attitude toward the transition to sustainable heat is divided. People agree at least somewhat with the need to combat climate change and switch to sustainable energy sources. However, while most agree with the gas transition, many people are still against it and have a wait-and-see attitude. For example, people may have different ideas about how The Netherlands should become natural gas-free and, therefore, not support the current policy.

2.2 Intention towards using and purchasing sustainable heating systems

Intention towards using and purchasing sustainable heating systems has been subject to more research compared to the gas transition in The Netherlands. For instance, intention regarding the willingness to pay for cleaner heating (Xie et al., 2021), to (not) use sustainable heating (Chen et al., 2016; Karytsas, 2018), and purchase intention (Kumar et al., 2022). Xie et al. (2021) found a relatively low willingness to pay large sums of money for cleaner heating in rural China. Citizens are willing to pay an average of 157 dollars annually, compared to the USA with 720 dollars. However, the authors emphasize that the reason for this difference needs to be examined. Nevertheless, the intention to use sustainable heating such as solar water heaters is relatively high. Moreover, financial support results in less of a burden towards purchasing, resulting in a higher intention to buy solar water heaters (Chen et al., 2016; Kumar et al., 2022). On the contrary, Karytsas (2018) found that only 10% of respondents have an intention to install ground-based-heat pumps, showing there may still be a long way to go before sustainable heating takes over from natural gas heating. Reasons against the intention to install heat pumps are: 1) not able to make the decision on their own (people live in apartments or are tenants), 2) high installation cost, 3) no financial capital, 4) no space, 5) not aware of the technology, and 6) disruption of the household.

Considering the studies mentioned above, behavioral intention has been researched to some extent. However, results vary between systems. The Theory of Planned Behavior can explain factors that may influence behavioral intention. For example, Kumar et al. (2022) may have found a form of perceived behavioral control (financial burden), and Chen et al. (2016) used the TBP to explain usage intention.

2.3 The Theory of Planned Behavior

The Theory of Planned Behavior (TPB) by Ajzen (1991) helps explain and understand human behavior, influenced by behavioral intention, which is *"Assumed to capture the motivational factors that influence a behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior.* (Ajzen, 1991, p. 181)*."* intention is determined by attitude, subjective norm, and perceived behavioral control. The more favorable attitude and subjective norm, and the greater perceived behavioral control, the higher behavioral intention one shows. Perceived behavioral control, however, affects actual behavior as well. One with the intention but not the ability may not perform the behavior (Ajzen, 1991). Fig. 1 shows the TPB.

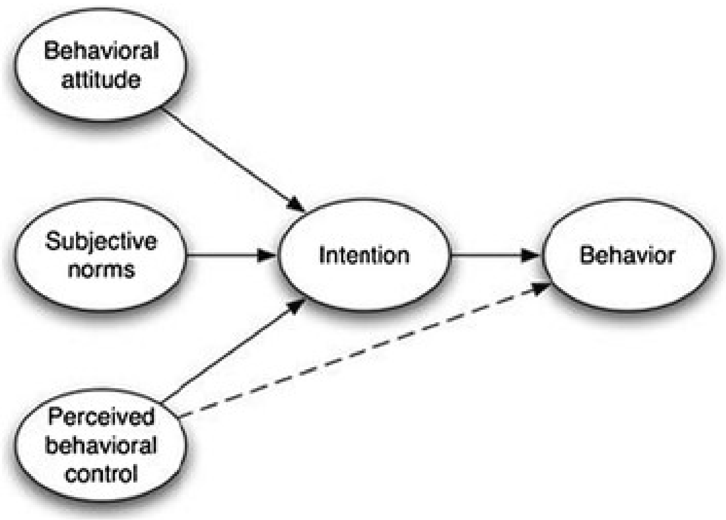

Figure 1: The Theory of Planned Behavior (Ajzen, 1991)

Actual behavior is determined by behavioral intention. Generally, the stronger the intention to engage in some behavior, the more likely its performance (Ajzen, 1991). Moreover, intention can change over time or through (unforeseen) events (Ajzen, 1991). Developments in The Netherlands regarding the (sustainable) heating of homes call for further investigations of the effects on intention. In other words, long-term might differ from short-term intention (time difference), and developments such as increasing gas prices and changing government support (it is argued that subsidies should become available for homeowners to get them on board (Steenbekkers & Scholte, 2019)) might affect intention as well, according to Ajzen's reasoning.

The TPB is, however, not without its criticisms. A brief description will be given of common critiques utilizing the article of Ajzen (2011): (1) Frequent criticisms are concerned with the TPB being too 'rational', not taking cognitive and rational thinking into account, resulting in biased behavior. However, the TPB is concerned with specific, goal-oriented behavior. Beliefs that shape attitude, subjective norm, and perceived behavioral control are far from rational since these beliefs are often formed by emotion or other self-serving motives. (2) Sometimes, intention is a poor predictor of actual behavior. This could have multiple reasons beyond one's control, i.e., the strength of the relationship between intention and actual behavior is moderated by control over the behavior. Ajzen (2011) emphasized that this low relationship may mean we are approaching the limits of reasoned action. (3) Past behavior could often predict future behavior, and the TPB has been criticized for not considering this. However, past behavior fails to be considered a criterion of the TPB because it needs to be a causal antecedent of intention. Instead, it functions as a proxy of habit strength. Meaning, the more a behavior is performed in a stable context, the more it comes under the control of external cues at the expense of intention (Ajzen, 2011). In addition, while it has been found that past behavior as a construct adds predictive validity, the residual effect was not found on intention (Fishbein & Ajzen, 2011, Chapter 9; Hassandra et al., 2011). Despite additional criticisms, the TPB is still a valid and widely used model to predict specific goal-oriented behavior such as using, purchasing, or retrofitting renewable energy (e.g., Halder et al., 2016; He et al., 2019; Liobikienė et al., 2021; Proudlove et al., 2020). Therefore, the TPB is a viable framework to use as a basis for this study.

2.3.1 Attitude

Attitude is the degree to which an individual has a positive or negative opinion of some behavior, which develops from beliefs about the behavior (or object) in question. Each belief links to a particular outcome (Ajzen, 1991). As a determent of intention, attitudes are generally recognized as pivotal in understanding and predicting human behavior and are rooted in perceived costs, risks, and benefits (Ajzen, 2001, as cited in Huijts et al., 2012).

In the context of environmental behavior, multiple studies confirmed the influential power of attitude on intention (e.g., Halder et al., 2016; Park & Ohm, 2014; Rezaei & Ghofranfarid, 2018). Attitude has long been shown to influence behavioral intention towards conservation and consumption behavior (Yazdanpanah et al., 2015). Suppose one agrees with, finds it good, valuable, or wise to use renewable energy. In that case, a greater preference, consideration, and intention to use said systems will be shown (Park & Ohm, 2014; Yazdanpanah et al., 2015). As one of the most important predictors, attitude must be carefully studied and understood to increase intention to use renewable energy (Halder et al., 2016; Yazdanpanah et al., 2015). Attitude functions as a mediator between various beliefs such as relative advantage, awareness, moral norms, and intention to use renewable energy systems and can significantly improve the exploratory power of predicting intention (Rezaei & Ghofranfarid, 2018). The same may hold for attitude towards investing in sustainable heating. Hence, including attitude in present study might be essential since it could be the number one predictor of and add exploratory power in predicting intention. Interestingly, Halder et al. (2016) found differences in the effect attitude exerts on intention which might prove valuable in this study. Attitude is a significant predictor of intention to use bioenergy in Finland. While in India, social factors are predominantly of importance. The author emphasized that the difference can be attributed to the fact that Finland is relatively high in individualism and India relatively low. The Netherlands is a highly individualistic country (Hofstede et al., 2010), and hence might result in attitude exerting a significant influence on intention to invest in sustainable heating.

Attitude is thus an important factor to consider. When homeowners agree with investing in sustainable heating, find it good, or beneficial, their intention to invest might be higher. Based on the literature found, the following hypothesis is formulated:

Hypothesis 1: *Attitude positively influences intention to invest in sustainable heating*

2.3.2 Subjective norm

Subjective norm refers to the perceived social pressure to perform a behavior (Ajzen, 1991). Friends, family, neighbors, colleagues, and other important people could put some pressure on one's behavior. It refers to the (dis)approvements of other people, how they behave, and their expectations (Ajzen, 1991). Entities other than, for example, friends or family could put pressure on an individual as well. For instance, people may model their behavior according to others they believe are experts or like them, for instance, doctors (Fishbein & Ajzen, 2011). Doctors are seen as experts, and according to the authors, one's behavior could be shaped by them. It stands to reason that differentiating between two types of social pressures in the subjective norm construct is beneficial since a comprehensive understanding might be obtained. For instance, friends and family might pressure one to perform a behavior, but, an expert might say otherwise.

In the context of renewable energy, several studies proved the predictive power of subjective norm. Friends' opinions are significant in forming an intention to use solar water heaters and electric fuel cars (Chen et al., 2016). Moreover, opinions, encouragements, and the behavior of colleagues, neighbors, and peers alongside important people in one's life are influential in forming an intention to sign up to green electricity and renewable energy usage as well (Halder et al., 2016; Irfan et al., 2020;

Ozaki, 2011). When one's social circle has a favorable opinion, invests in sustainable heating systems, and encourages to do the same, the intention to invest in the systems might be higher. Similarly, it has been found that installers can convince people to change heating systems alongside social influences such as neighbors (Freyre et al., 2021; Rai et al., 2016). Installers are the most chosen source of information regarding new heating systems, more so than interpersonal sources (neighbors, friends, family) and government advisers. When installers make first contact with a (potential) adopter, less value is placed on social contacts, even if the presence of solar panels in neighborhoods could directly or indirectly spark the initial motivation to install the systems yourself, making these actors effective in influencing the diffusion and acceptance of new sustainable systems (Mahapatra & Gustavsson, 2007; Owen et al., 2014; Rai et al., 2016). However, installers must have favorable opinions towards particular technologies. An installer could believe the technology will develop quickly and therefore may advise not to install the system at a particular moment in time (Owen & Mitchell, 2015). This is further supported by Owen et al. (2014), who argued that the motivation of installers, relating to their internal drivers and thereby prioritizing certain technologies over others, is likely important in creating an intention to adopt renewable energy.

Whereas no direct evidence was found in the literature (to the researcher's knowledge) for the influence of installers' opinions on intention to invest in renewable energy, it is clear that installers are of significance in the adoption process. Therefore, it is hypothesized that if homeowners believe installers stand behind sustainable heating and will advise installing the systems, the intention to invest might increase. Based on the findings in the literature, two hypotheses will be formed:

Hypothesis 2a: One's social circle has a positive influence on intention to invest in sustainable heating

Hypothesis 2b: Perceived installers' opinion positively influences the intention to invest in sustainable heating

2.3.3 Perceived behavioral control

Perceived behavioral control is defined as the perceived ease or difficulty to perform a behavior. It predicts intention. However, it is as well argued that actual behavior is partially predicted by perceived behavioral control (Ajzen, 1991). This sounds logical; if one has the intention but not the ability, one might not perform the behavior. It reflects an individual's perception of factors that promote or hinder a behavior and is commonly affected by knowledge, resources, and obstacles (Yee et al., 2021). When one has the knowledge and resources available, fewer difficulties arise, resulting in more control over the behavior (Ajzen, 1991).

Multiple factors thus might promote or hinder the intention to invest in sustainable heating. The most notable found in the literature is financial abilities. If people believe to have the financial abilities (or are able) to buy renewable energy systems, their usage intention will be higher (Liobikienė et al., 2021; Rezaei & Ghofranfarid, 2018). Liobikienė and colleagues found financial abilities to have the second most substantial effect on the intention to use renewable energy systems. Not surprisingly, government support helps in increasing financial abilities and should be provided to help citizens (Rezaei & Ghofranfarid, 2018). If one believes not to have the financial abilities (or is not able) to buy, purchase intention will be lower. Karytsas (2018) supports this and found that the lack of funds resulted in having no intention to buy ground-based-heat pumps. Thus, one feeling to have the funds may have a higher intention to buy and vice versa. Simply put, one able to pay the costs for sustainable heating may show a higher intention to invest.

A second factor found in the literature is perceived knowledge of renewable energy systems. Knowledge (or lack of) could result in a higher (or lower) behavioral intention. Ajzen (1991) noted that second-hand information (e.g., from companies) could reduce perceived difficulties to perform a behavior. In other words, the access and availability of information might also play a role. Considering this, Ozaki (2011) found access to information about green technologies to positively correlate with green tariffs' adoption intention. Information is needed to compare systems and decide to buy renewable energy. Hence, when one perceives information to be available and not difficult to understand, one might better determine whether investing in renewable energy is a good idea. When people are capable, find it easy, overcome obstacles, and have the knowledge enabling them to engage in renewable energy investments, their intention will be higher (Yee et al., 2021). Additionally, people with sufficient information about renewable energy can better use the systems, which helps develop their usage intention (Alam et al., 2014; Jabeen et al., 2019). Thus, this study proposes the following:

One with sufficient knowledge of sustainable heating systems available, who understands the information, and knows what needs to happen to get sustainable heating installed, will be easier able to evaluate whether they should invest, therefore support investment intentions.

Previous studies show that perceived financial abilities and knowledge about heating systems may increase intention to invest in sustainable heating. Hence, two hypotheses have been formulated:

Hypothesis 3a: Perceived financial abilities positively influence intention to invest in sustainable heating

Hypothesis 3b: Perceived knowledge of sustainable heating systems positively influences intention to invest in sustainable heating

2.4 Beliefs shaping attitude

Attitudes are shaped by beliefs one holds regarding a behavior. These beliefs are formed by associating them with certain attributes i.e., objects, characteristics, or events, and are linked to an outcome. Naturally, the attributes will be favorable or unfavorable, thereby shaping the attitude towards a behavior (Ajzen, 1991). This section discusses homeowners' beliefs that shape their attitude towards investing in sustainable heating. Essentially, factors that may influence attitude. First, environmental beliefs will be discussed, followed by benefits, barriers, and trust in the national government.

2.4.1 Environmental beliefs

This first section is concerned with beliefs people hold regarding the environment. Multiple environmental beliefs can be found in the literature, the first is *environmental concern*, defined as the degree of awareness, support, and willingness to contribute to a solution regarding environmental problems (Dunlap & Jones, 2002). In short, high concern for the environment results in a higher attitude towards various environmental behaviors. For instance, suppose one wants to improve the environment, thinks society is not environmentally friendly, or is concerned about climate change. In general, this person will have a favorable attitude towards different environmental behaviors (e.g., using renewable energy or becoming natural gas-free) (Chung & Kim, 2018; Jansma et al., 2020;

Liobikienė et al., 2021). Hence, environmental concern might influence attitude towards investing in sustainable heating. Moreover, Dutch citizens more concerned about the environment are more willing to adopt renewable energy renovation measures, with environmental concern as the second most chosen motivation after saving energy (costs) (Broers et al., 2019). Hence, environmental concern is essential to include in this study. When homeowners are concerned about the environment, their attitude toward investing in sustainable heating might be higher.

Hypothesis 4: *Environmental concern positively influences attitude towards investing in sustainable heating*

Next to environmental concern, Grębosz-Krawczyk et al. (2021) argued that *perceived environmental responsibility* is essential in the adoption process of solar panels. It is concerned with people's responsibility to combat climate change. It relates to the user's duty to safeguard the environment and ensure activities do not threaten the ecosystem or others (Zheng et al., 2020).

The effect of perceived environmental responsibility on attitude has not been subject to much research. The handful of existing studies suggests a positive influence. For instance, a higher drive to behave more environmentally responsible is related to a more favorable attitude towards sustainable purchasing (Haytko & Matulich, 2010; Joshi & Rahman, 2019). Meaning, believing to be responsible, involved in fighting climate change, and thinking about environmental protection to start at oneself correlates with a favorable attitude toward sustainable purchasing. Considering this, the relationship between perceived environmental responsibility and attitude has been empirically tested. Zheng et al. (2020) found attitude to mediate the perception of environmental responsibility and green buying behavior. In other words, showing responsibility does not translate into action unless a favorable attitude is observed. Based on these findings, this study argues that perceived environmental responsibility positively influences attitude towards investing in sustainable heating.

Hypothesis 5: *Perceived environmental responsibility positively influences attitude towards investing in sustainable heating*

The last environmental belief found in the literature is *perceived environmental impact*, referring to the impact of sustainable heating on the environment. Multiple studies include the environmental impact as a benefit of renewable energy systems (e.g., Kim et al., 2014; Park & Ohm, 2014). However, benefits are distinguishable by personal (e.g., cost savings) and collective benefits (society as a whole) (Huijts et al., 2012), perceived environmental impact will be considered a collective benefit and, therefore, a separate belief.

Environmental impact could be considered a reason for adoption and positively affect attitude (Claudy et al., 2013; Malik & Singhal, 2017). The effect of perceived environmental impact (reducing pollution/greenhouse gasses) as a reason for adoption is just behind economic benefits (Claudy et al., 2013), proving that the impact of renewable energy on the environment is important for people. Increasing knowledge of the environmental advantages of green products is recommended since it results in people being able to form favorable opinions (Malik & Singhal, 2017). Moreover, if more value is placed on pollution reduction, environmental protection, or ecological reasons in general, one is more likely to purchase renewable energy systems such as solar panels (Grębosz-Krawczyk et al., 2021).

This study proposes that a higher perception of the environmental impact of sustainable heating in terms of, for example, pollution reduction or fighting global warming results in a more favorable attitude towards investing.

Hypothesis 6: Perceived environmental impact positively influences attitude towards investing in sustainable heating

2.4.2 Benefits of sustainable heating

The second belief discussed is *benefits*. The benefits of sustainable heating might show to significantly affect attitude. Benefits could be divided into personal, e.g., cost reduction or personal emission reduction, and collective benefits that affect society as a whole (Huijts et al., 2012). Huijts and colleagues argued that attitudes are rooted in benefits next to costs, risks, and effects. Hence, perceived benefits might influence attitude towards investing in sustainable heating, as Huijts et al. (2012) proposed in their framework.

Claudy et al. (2013) found personal benefits such as economic gains or independence from fossil fuels to be a significant reason for adopting renewable energy. Moreover, perceptions of personal benefits such as economic or security gains have been shown to positively influence attitude toward energy renovations and energy-efficient products (Akroush et al., 2019; Ebrahimigharehbaghi et al., 2019). Furthermore, home values increase by approximately 17% with the installation of solar panels, an additional benefit and driver of renewable energy adoption and heating system selection (Karytsas, 2018; Qiu et al., 2017).

In this study, perceived benefits will be further defined as personal benefits since homeowners – as individuals – will look at the personal benefits of investing in sustainable heating. Collective benefits might be significant as well, hence, perceived environmental impact has been included in this study as discussed in the previous section. Thus, perceived benefits such as cost reduction, increases in home value, or a safer home may influence attitude.

Hypothesis 7: *Perceived benefits positively influence attitude toward investing in sustainable heating*

Another potential benefit is concerned with the impact of sustainable heating on the *living comfort* of one's home. In other words, what sustainable heating brings to one's home regarding comfort and quality of living.

People have negative expectations regarding sustainable heating and living comfort. Some think that heat pumps produce lots of noise and take up space in their homes. Others fear that reaching a comfortable temperature during winter will be challenging (Jansma et al., 2020). This is troublesome since comfort of living is an essential factor when choosing an alternative heating system and is even one of the top drivers to purchase, install, or renovate to renewable energy (Broers et al., 2019; Ebrahimigharehbaghi et al., 2019; Gram-Hanssen et al., 2012; Karytsas, 2018; Murphy, 2016). Energy-efficient renovation is mainly driven by the perception of comfort of living, not so much by technical information (Murphy, 2014). Naturally, one wants to live in comfort. For instance, improved air quality is often mentioned in the study by Gram-Hanssen et al. (2012).

No studies have examined the possible influence of the perceived change in living comfort due to sustainable heating systems on attitude. One with the perception of increases in living comfort by means of, for example, comfortable temperature gains or better air quality might show a more favorable attitude towards investing in sustainable heating. As a driver of sustainable investments, increasing living comfort might affect attitude. Despite findings by Jansma et al. (2020) regarding negative expectations on the comfort of living, a neutral attitude towards becoming natural gas-free was found. Moreover, a possible influence of perceived comfort of living on attitude was not ruled out. Therefore, this study hypothesizes that homeowners with a more favorable perception of changes in living comfort due to sustainable heating might show more positive attitudes.

Hypothesis 8: Perceived change in living comfort due to sustainable heating installation positively influences attitude toward investing in sustainable heating

2.4.3 Barriers of sustainable heating

Next to perceived benefits of sustainable heating, beliefs regarding barriers exist which may negatively influence attitude. The first belief found in the literature is *perceived financial costs*, simply referring to the amount of money sustainable heating systems cost. In the Netherlands, the cost is essential when (not) supporting the gas transition since it is the number one concern among Dutch citizens (Gemeente Enschede, 2020; Steenbekkers & Scholte, 2019). Retrofitting homes with sustainable heating costs up to 30000 euros, depending on the type of home (Van Gerven & Akimoto, 2018). Naturally, this may pose a significant barrier and negatively influences attitude toward investing. Engelken et al. (2018) shed further light on these findings; perceived financial cost indeed negatively influences attitude towards purchasing renewable energy system components. The same was found by Korcaj et al. (2015) regarding the adoption of residential photovoltaic (solar) systems. One could argue that perceptions of costs are connected to financial abilities in the perceived behavioral control construct (section 2.3.3). However, costs are concerned with one's belief of how much (or not) sustainable heating costs and financial abilities are concerned with one's investment capabilities. Someone might have the financial abilities and still have a less favorable attitude towards investing due to the high cost. Therefore, the following hypothesis is formulated:

Hypothesis 9: Perceived financial costs negatively influence attitude toward investing in sustainable heating

An additional barrier regarding investing in sustainable heating is *perceived inconveniences*. More specifically, inconveniences during the installation process. Logically, the installation process might cause disruptions in ordinary life (Ebrahimigharehbaghi et al., 2019). According to De Vries et al. (2020), inconveniences could be present at any stage during the decision-making process: (1) The awareness stage is mostly about complex information which is difficult to understand. In this study, this stage is concerned with perceived behavioral control. Access to information and knowledge about sustainable heating might make it easier or more difficult to invest. (2) The consideration stage is concerned with disruption in one's home. Karytsas (2018) found not only reasons to install heat pumps – such as the comfort of living – to be important, but inconveniences to hinder the installation. For example, the lack of space and disruptions in households. In line with Karytsas (2018), Wilson et al. (2015), Aravena et al. (2016), and Karytsas & Theodoropoulou (2014) described common inconveniences such as disruptions during installation to hinder renewable renovations in homes. It is not entirely clear what is meant by disruptions of homes. However, the disruptive impact of retrofitting homes (e.g., the amount of work needed in homes) and ease of (or effort needed) installation could be seen as disruptions in one's home (Aravena et al., 2016). (3) The actual decision stage, where the application of loans or subsidies is regarded as inconvenient and might refer to the time needed to install systems completely. Administrative work required due to government regulations and policies increases the time necessary to install systems such as solar panels (Reindl & Palm, 2021). In The Netherlands, applications for permits or grants to make the installation of heat pumps possible might be required (Milieucentraal, 2018), increasing the time before a system is installed. In addition, arranging the installation of renewable energy, from choosing, comparing, and asking for quotas could be seen as an inconvenience or barrier (Palm, 2018). The decision-making process will not be examined in the present research. However, the consideration stage might be interesting since one might compare new heating systems (sustainable or not), looking at the advantages and disadvantages (de Vries et al., 2020), which may result in an intention to invest in a particular system. In addition, the amount of work needed to invest (e.g., the application for loans or subsidies) in the actual decision stage might translate to one's intention to invest. Therefore, the time and arrangement of installation will be considered an inconvenience.

To the researcher's knowledge, no studies have investigated the influence of perceived inconveniences during the installation of sustainable heating systems on attitude. However, one could argue that individuals who perceive the installation of sustainable heating to come with more inconveniences might have a less favorable attitude toward investing in sustainable heating.

Hypothesis 10: Perceived inconveniences negatively influence attitude toward investing in sustainable heating

2.4.4 Trust in the national government

The last belief discussed is *trust in the national government*. In The Netherlands, newly constructed homes are still being connected to the natural gas network. People ask questions if the Dutch government is still committed, resulting in distrust, which may be an important factor in accepting the transition and has been shown to positively influence attitude toward pollution policies (Konisky et al., 2008; Steenbekkers & Scholte, 2019). Considering this, during a focus group, Jansma et al. (2020) found that trust in local politics, such as municipalities, is important in becoming natural gas-free. Municipalities are often the most mentioned as the main responsible actors for the transition. However, doubts that these actors had the intention and the capability to steer the transition in the right direction were present. In a follow-up survey study, homeowners mentioned not trusting municipalities and were relatively negative. Nevertheless, trust in local political actors such as municipalities significantly and positively influences attitude towards becoming natural gas-free. When one trusts municipalities to facilitate the gas transition, attitude toward becoming natural gas-free will be more favorable (Jansma et al., 2020). In line with this, Scholte et al. (2020) argued that policy goals and trust in the people who formulate them are crucial for supporting the gas transition.

Trust in the national government and its ability to facilitate the gas transition may positively influence attitude towards investing in sustainable heating. Specifically, if people trust the government to keep its promise to be natural gas-free and trust the government's ability, their attitude toward investing in sustainable heating might be higher.

Hypothesis 11: *Trust in the national government positively influences attitude toward investing in sustainable heating*

2.5 Research model

Table 1 gives an overview of the hypotheses. The research model is presented in Fig. 2. The four different variations of intention to invest in sustainable heating are displayed, including the Theory of Planned Behavior and the factors hypothesized to influence attitude.

Table 1: Hypotheses

Number	Hypothesis
H1	Attitude positively influences intention to invest in sustainable heating
H2A	One's social circle has a positive influence on intention to invest in sustainable heating
H2B	Perceived installers' opinion positively influences the intention to invest in sustainable heating
H3A	Perceived financial abilities positively influence intention to invest in sustainable heating
H3B	Perceived knowledge of sustainable heating systems positively influences intention to invest in sustainable heating
H4	Environmental concern positively influences attitude toward investing in sustainable heating
H5	Perceived environmental responsibility positively influences attitude toward investing in sustainable heating
H6	Perceived environmental impact positively influences attitude toward investing in sustainable heating
H7	Perceived benefits positively influence attitude toward investing in sustainable heating
H8	Perceived change in living comfort due to sustainable heating installation positively influences attitude toward investing in sustainable heating
H9	Perceived financial costs negatively influence attitude toward investing in sustainable heating
H10	Perceived inconveniences negatively influence attitude toward investing in sustainable heating
H11	Trust in the national government positively influences attitude toward investing in sustainable heating

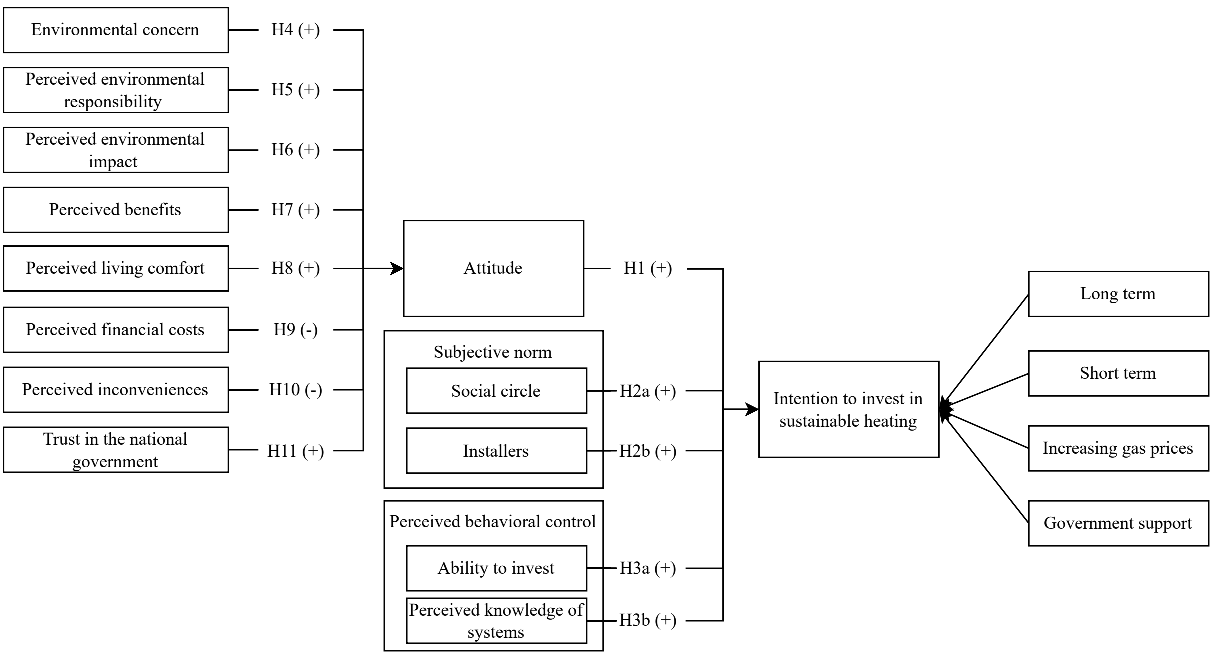

Figure 2: Research model

3. Methods

The purpose of this study was to measure the influence of the independent variables on intention to invest in sustainable heating. A quantitative research method, a survey, was used. By doing this, perceptions of attitude, subjective norm, perceived behavioral control, and beliefs influencing attitude could be measured. Qualtrics was used for construction and distribution. This allowed respondents to finish using their own device, own environment, and own time. The survey was in Dutch since the study was conducted among Dutch homeowners. Before distribution, approval of the ethics committee of the faculty of Behavioral, Management, and Social sciences of the University of Twente was given. The data was collected in approximately one month. This section continues with a description of the procedures, followed by a detailed depiction of the respondents. Third, the chosen measures will be described. Finally, scale construction will be discussed.

3.1 Procedure

The survey started with an introduction and informed consent stating that participating was completely voluntary and anonymous. Respondents needed to agree with their participation. After consent, two filter questions were asked, namely if one was a homeowner or a tenant and if one already lived natural gas-free. This was done to ensure respondents met the criteria for participation. Hereafter, background questions (e.g., gender, age, type of home) were asked. Finally, the constructs were presented. First, the Theory of Planned Behavior constructs, thereafter the belief constructs in randomized order. After completion, the participants were given the option to leave their email addresses in exchange for a summary of the results, however, this was not expected and was not a requirement for completing the survey. After, the respondents were thanked for their participation. On average, the survey took 11 minutes to complete.

3.2 Respondents

The survey was aimed at homeowners in The Netherlands and distributed online via convenience sampling through social media (Facebook, LinkedIn, Instagram) by asking homeowners such as friends, family, and colleagues to fill out the survey. Facebook groups designed for placing surveys were utilized as well. In addition, snowball sampling by asking respondents in person and online to send the questionnaire to other homeowners was used. Lastly, in collaboration with a network operator in the Dutch region of ‘Westland’, WestlandInfra, the questionnaire was distributed among its employees. In total, three hundred eighty-two people filled out the survey. Out of the sample, 26 did not finish, 35 were not homeowners, and 19 already lived natural gas-free. These were discarded, leaving 302 for further analysis. The respondents are aged between 20 and 84, with a mean age of 43 years old. 52% are male and 48% female. Most respondents live in the province of Zuid-Holland (40%), followed by Overijssel (37%) and Utrecht (15%), and primarily live in a ‘terraced home’ (30%), ‘semidetached home’ (21%), ‘corner home’ (20%), or apartment (19%). 2% of respondents live in something other. Interestingly, political party preference roughly followed the last elections’ voting behavior. Most respondents vote for ‘VVD’ (25%), followed by ‘D66’ (18%) and ‘PVV’ (7%). 11% did not want to answer. Table 2 gives a complete overview of the respondents’ background characteristics.

Table 2: Background characteristics

Demographics	Frequency	Percent
Age:		
18 - 24	8	3%
25 - 34	89	30%
35 - 44	70	23%
45 - 54	76	25%
55 - 64	45	15%
65+	14	5%
Gender:		
Male	157	52%
Female	144	48%
Prefer not to say	1	0%
Type of home:		
Apartment	57	19%
Corner home	59	20%
Detached home	26	9%
Farm	3	1%
Semidetached home	62	21%
Terraced home	90	30%
Other	5	2%

Table 2 (continued)

Demographics	Frequency	Percent
Build year home:		
< 1900	8	3%
1901 - 1920	11	4%
1921 - 1940	20	7%
1941 - 1960	45	15%
1961 - 1980	100	33%
1981 - 2000	54	18%
2001 - 2021	64	21%
Province of residence:		
Flevoland	6	2%
Gelderland	3	1%
Groningen	2	1%
Limburg	2	1%
Noord-Brabant	4	1%
Noord-Holland	7	2%
Overijssel	111	37%
Utrecht	44	15%
Zeeland	1	0%
Zuid-Holland	122	40%
Years central heating needs replacing		
< 4	61	20%
5 - 9	146	48%
10 - 14	62	21%
15 - 19	28	9%
20 >	5	2%
Political party preference:		
VVD	76	25%
D66	53	18%
PVV	21	7%
CDA	21	7%
SP	14	5%
PvdA	5	2%
FvD	8	3%
GroenLinks	19	6%
Partij voor de Dieren	5	2%
CU	1	0%
Volt	6	2%
Ja21	1	0%
Denk	1	0%
50Plus	8	3%
BoerenBurgerBeweging	10	3%
Bij1	3	1%
I did not vote	11	4%
I prefer not to answer	33	11%
Other	6	2%

3.3 Measures

A questionnaire was developed to quantify the 17 constructs in this study. All constructs consisted of four items, except for intention (increasing gas prices), intention (government support), and financial ability, which all had three items. Lastly, trust in the national government consisted of five items. A 7-point Likert scale was used for measurement, ranging from strongly disagree (1) to strongly agree (7). Scales for intention – government support, intention – increasing gas prices, perceived installers' opinion, perceived knowledge of systems, and perceived inconveniences were newly created. The remaining constructs included items borrowed from previous studies:

Long- and short-term intentions were primarily based on Proudlove et al. (2020) and Yadav & Pathak (2016) and included items regarding if one wants, expects, and is willing to invest. In addition, one item was added in each construct regarding efforts to switch to sustainable heating when the old heating systems need replacing (5 and 15 years).

Attitude towards investing was primarily based on Park & Ohm (2014) and Maichum et al. (2016) and included items regarding positive feelings, if they thought sustainable heating was a good idea, and if it was desirable. One item was added to try and avoid reliability and validity difficulties and was defined as *"I find investing in natural gas-free heating for my home appealing."*

Subjective norm – social circle had two items taken from Proudlove et al. (2020) regarding family/friends. In addition, two items were added regarding one's immediate social circle.

Ability to invest had one statement borrowed from Liobikienė et al. (2021) regarding one's financial ability to invest. In addition, two items were added regarding the availability of money and if someone needs the money for something other than natural gas-free heating.

Environmental concern was based entirely on Jansma et al. (2020) and included items regarding if one cares about the environment, wants to do something about climate change, thinks society needs to do something, and the importance of using renewable energy.

Perceived environmental responsibility contained items borrowed from Zheng et al. (2020) and Wu & Yang (2018) regarding perceived sense of responsibility, having a share in fighting climate change, fighting climate change to start at oneself, and willingness to do everything one can.

Perceived environmental impact contained items borrowed from Ozaki (2011) regarding lowering air pollution, personal CO2 emissions, doing something good for the environment, and fighting global warming.

Perceived benefits were based on findings by Ebrahimigharehbaghi et al. (2019) regarding cost savings and increases in home value. In addition, two items were added regarding safety and making one's home future-proof.

Perceived comfort of living was newly constructed based on the findings of Jansma et al. (2020) regarding comfortable heating and two items regarding space and noise of systems. In addition, one item was borrowed from Gram-Hanssen et al. (2012) regarding increases in air quality.

Perceived financial costs consisted of items regarding the initial costs and the costs compared to the advantages borrowed from Engelken et al. (2018). In addition, two items were added regarding the installation costs and general expenses of sustainable heating systems.

Trust in national government was mainly constructed based on findings by Steenbekkers & Scholte (2019) regarding keeping promises and believing the government will succeed in the transition to be natural gas-free. In addition, items were borrowed from Scholte et al. (2020) and Montijn-Dorgelo & Midden (2008) regarding future governments and decisiveness. Lastly, one statement was added regarding the determination of the government to be natural gas-free by 2050. Appendix 1 shows the complete questionnaire.

3.4 Scale construction

Construction of measurement scales was done by conducting two analyses: a factor analysis to test validity and a reliability analysis for internal consistency. First, to test whether the constructs measured what was intended, a principal component factor analysis (varimax rotation) was constructed. However, some items needed to be recoded first to be positive since these were negatively asked: two items from comfort of living, one of financial abilities, and one of knowledge of systems.

The initial factor analysis contained 12 factors. However, some overlap was observed, and not all constructs seem to fit in one factor. Since the original research model included 17 constructs, a new factor analysis was constructed based on 17 factors. Based on this analysis, statements have been removed to improve the validity. (1) Attitude has been completely discarded since the construct was suspected to be a confounding variable and items fit in more than one factor. (2) One item from environmental concern and perceived environmental responsibility were deleted as well. This resulted in a new factor analysis where 14 factors loaded. However, items still seem to load in separate or combined factors. Therefore, some statements from other constructs have been removed to improve validity further. An overview of removed statements can be found below:

- Environmental concern: *"Society needs to do something about climate change"* has been removed due to it not entirely fitting since all statements in the environmental concern construct are about 'me', not about 'us'.
- Perceived environmental responsibility: *"I am willing to do what I can to fight climate change"* has been deleted since all other items were about responsibility and having a share in fighting climate change, not if one is willing to do what one can.
- Perceived behavioral control: "*The available information is difficult to understand (recode)".* This statement did not fit in any particular factor. Hence, it was removed.
- Short-term & Long-term intention: *"When my central heating needs replacing in the next 5/15 years, I plan to invest in sustainable heating".* These items loaded in different factors multiple times; therefore, these have been removed.
- Perceived benefits: *"Natural gas-free heating makes my home safer".* This item did not fit in any particular factor and was therefore discarded.

Appendix 2 shows the factor analysis. In total, six items have been removed, resulting in a factor analysis containing 15 factors. The variables of perceived financial costs and inconveniences have been combined to form 'perceived barriers'. Environmental concern and perceived environmental responsibility have been combined and created the factor 'willingness to fight climate change'. Lastly, perceived living comfort has been split into two new variables: 'perceived living comfort' and 'perceived home comfort'. Perceived living comfort fit in two factors, however, the difference in scores was big enough for further analysis. Not all factors have eigenvalues over 1. Despite this, the explained variance is roughly 84%. Therefore, the factors can be retained and used further as the proposed measurement scales. First, however, the reliability of the scales needed to be checked to ensure the scales are internally consistent by calculating Cronbach's alpha, shown in table 3. The analysis revealed that the reliability of all items is higher than .7. Thus, the measurement scales are internally consistent and, therefore, can be retained for further analysis.

Table 3: Reliability analysis

Factor	Cronbach's alpha
Intention (long term)	.93
Intention (short term)	.94
Intention (increasing gas prices)	.90
Intention (government support)	.90
Subjective norm (social circle)	.94
Subjective norm (installers)	.92
Financial abilities	.93
Knowledge of systems	.86
Willingness to fight climate change	.94
Perceived environmental impact	.91
Perceived benefits	.89
Perceived living comfort	.85
Perceived home comfort	.76
Perceived barriers	.96
Trust in national government	.88

4. Results

This section starts with descriptive statistics providing an overview of the mean results. Next, the means of behavioral intention have been compared. Third, correlations have been calculated, looking for relationships between variables. Lastly, multiple regression analysis, scrutinizing the effects of the independent on the dependent variables, has been conducted.

4.1 Descriptive statistics

Table 4 shows the means and standard deviations of the constructs. Means range between 3 and 5, measured on a 7-point Likert scale. Intention to invest in sustainable heating was measured four times: homeowners have the highest intention *while more government support is given*, rated somewhat positive. The second highest is *long-term* intention. Homeowners are neutral to somewhat positive regarding their intention to invest in the next 15 years. Surprisingly, homeowners are close to neutral regarding their intention to invest in sustainable heating *with the high natural gas prices*, rated third highest. Homeowners are the most negative about their *short-term* intention, rated somewhat negative.

Following the means for intention to invest in sustainable heating, the predictors show relatively positive results, except for subjective norm (social circle), financial abilities, perceived living comfort, and trust in the national government, which are rated negatively. However, most scores are close to neutral. The perceived benefits construct is rated relatively positive. Homeowners somewhat agree with the benefits sustainable heating brings to homes, such as costs savings, appreciation of one's home, and investment for the future. Moreover, some agreement can be found regarding the environmental impact of sustainable heating systems. However, still relatively neutral. Homeowners as well agree with the financial barriers and inconveniences that sustainable heating brings. This can be seen by financial abilities as well, which is the most negative rated predictor; homeowners have a somewhat negative view of their financial abilities to invest in sustainable heating. Interestingly, homeowners seem to not agree with comfort gains such as taking up less space and producing less noise in homes. On the contrary, home comfort is rated neutral to somewhat positive regarding improved air quality and the comfortable warming of homes. All other variables are rated neutral. Homeowners do not agree but also do not disagree.

Table 4: Mean scores

Construct	Mean	SD
Intention (long term)	4.41	1.75
Intention (short term)	3.32	1.65
Intention (increasing gas prices)	3.86	1.29
Intention (government support)	4.86	1.32
Subjective norm (social circle)	3.58	1.35
Subjective norm (installers)	4.20	1.09
Financial abilities	3.40	1.59
Knowledge of systems	4.02	1.34
Willingness to fight climate change	4.66	1.45
Perceived environmental impact	4.44	1.23
Perceived benefits	5.08	1.49
Perceived living comfort	3.48	1.13
Perceived home comfort	4.24	0.99
Perceived barriers	4.98	1.28
Trust in national government	3.96	1.16

All scales are measured on a 7-point Likert scale (1=negative / 7=positive)

4.2 Differences between variations of intention

The items of the four variations of intention to invest in sustainable heating are formulated similarly. Hence, a comparison of the means could be made by calculating 95% confidence intervals, looking for overlaps between the intervals to ensure there is (not) a difference between intention. For instance, if the confidence intervals for long- and short-term intention overlapped, no difference would exist between them. Table 5 shows the confidence intervals. Moreover, fig. 3 provides a visual overview, including the means (shown in the bars). Results confirmed that the confidence intervals do not overlap. The means are different from one another. Thus, the same intention to invest (in sustainable heating) differs depending on the situation.

Table 5: Confidence intervals intention

		95% confidence interval	
Construct	Mean	Lower bound	Upper bound
Intention (long-term)	4.41	4.21	4.61
Intention (short-term)	3.32	3.13	3.51
Intention (increasing gas prices)	3.86	3.71	4.01
Intention (government support)	4.86	4.71	5.01

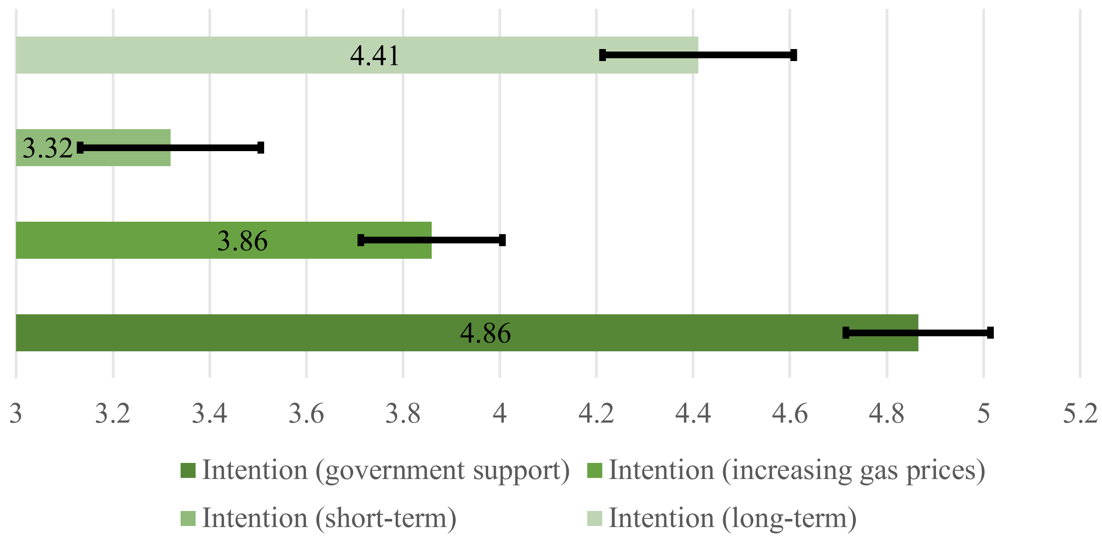

Figure 3: Means and 95% confidence intervals intention to invest in sustainable heating

4.3 Correlations

As can be seen in table 6, Pearson's r has been calculated to uncover relationships between variables. For clarity sakes, a correlation between 0 and .3 is considered weak, .3 to .5 moderate, and > .5 strong (Laerd Statistics, 2020).

The Theory of Planned Behavior constructs show significant relationships among one another; (1) Long-term intention shows a strong positive correlation with subjective norm (social circle) and subjective norm (installers). Financial abilities and knowledge of systems, on the other hand, show weak positive correlations with long-term intention. (2) The same relationships can be found for short-term intention; subjective norm (social circle) has a strong positive and subjective norm (installers) a moderate positive relationship. Financial abilities show a positive, weak correlation. Knowledge of systems, however, moderately correlates with short-term intention. (3) Intention with the increasing gas prices shows a small but positive correlation with knowledge of systems; however, negligible. Moreover, subjective norm (social circle) and subjective norm (installers) show moderate positive relationships with intention (increasing gas prices). (4) Intention with more government support shows no relationship with financial abilities and knowledge of systems. However, a moderate positive relationship can be found between subjective norm (social circle) and subjective norm (installers).

The external variables all show significant relationships with intention. As predicted, the new variable of perceived barriers strongly and negatively correlates with long-term intention. In addition, a moderate negative relationship can be seen between intention (short-term), intention (government support), and intention (increasing gas prices). Other variables show positive correlations, varying from moderate to strong. However, trust in the national government correlates weakly with intention (government support) and intention (increasing gas prices). Table 6 shows the correlations coefficients for all variables.

4.4 Predicting intention

Multiple regression analysis provides more insight into the hypotheses and the influences of the independent on the dependent variables. Four analyses will be discussed, divided into two models for each variation of intention: (1) demographic factors and (2) demographic factors + predictors. Each analysis includes a table with relevant data and a model to visualize the observed effects for added clarity. Appendix 3 shows the SPSS output for all regression analyses.

4.4.1 Predicting long-term intention

The first regression analysis regarding long-term intention can be found in table 7 and fig. 4. The demographic (first) model explains 12% of the variance. Age and the number of years when homeowners think a central heating system needs replacing are the only significant predictors. Model 2, however, explains 59% of the variance and age is as well significant alongside all predictors, except for financial abilities, perceived living comfort, home comfort, and trust in the national government. The construct of perceived benefits is most important, followed by willingness to fight climate change, perceived environmental impact, subjective norm (installers), subjective norm (social circle), perceived barriers, and knowledge of systems. Additionally, age is the second most important predictor and negatively influences intention. Hence, as people become older, long-term intention to invest in sustainable heating becomes less. The predictors explain approximately 48% of the variance (Δ adj. R^2= .477). The SPSS output can be found in appendix 3-A.

Table 6: Correlation coefficients

	Constructs	1	2	3	4	5	6	7	8	9	10	11	12	12	14	15
1	Intention (long-term)	1														
2	Intention (short-term)	.64**	1													
3	Intention (increasing gas prices)	.49**	.50**	1												
4	Intention (government support)	.55**	.52**	.61**	1											
5	Subjective norm (social circle)	.50**	.56**	.37**	.34**	1										
6	Subjective norm (installers)	.53**	.49**	.42**	.40**	.62**	1									
7	Financial abilities	.13*	.28**	.10	.06	.18**	.17**	1								
8	Knowledge of systems	.28**	.32**	.15*	.11	.30**	.15**	.03	1							
9	Willingness to fight climate change	.65**	.49**	.48**	.51**	.34**	.46**	.11	.18**	1						
10	Perceived barriers	-.50**	-.45**	-.42**	-.44**	-.29**	-.32**	-.02	-.24**	-.63**	1					
11	Perceived benefits	.66**	.52**	.47**	.54**	.46**	.56**	.07	.15**	.75**	-.57**	1				
12	Perceived living comfort	.32**	.32**	.35**	.39**	.20**	.29**	.03	.09	.47**	-.60**	.46**	1			
13	Perceived home comfort	.47**	.38**	.40**	.40**	.38**	.47**	.05	.11	.61**	-.54**	.64**	.46**	1		
14	Perceived environmental impact	.53**	.41**	.42**	.47**	.24**	.35**	.19**	.08	.73**	-.48**	.60**	.48**	.59**	1	
15	Trust in national government	.42**	.38**	.28**	.26**	.56**	.51**	.09	.13*	.46**	-.26**	.56**	.25**	.46**	.36**	1

** Correlation is sigificant at the 0.01 level (2-tailed).

* Correlation is sigificant at the 0.05 level (2-tailed).

Table 7: Regression analysis intention (long-term)

	β	t	Sig.
Model 1: Demographics			
$R^2 = .115$, $F(4,297) = 10.79$, $p < .001$			
Age	-.317	-5.79	.000
Gender	-.045	-.83	.409
Age home	.091	1.63	.104
Number of years heating system needs replacing	-.110	-1.97	.049
Model 2: Demographics + Predictors			
$R^2 = .592$, $F(15,286) = 30.15$, $p < .001$			
Age	-.213	-5.15	.000
Gender	-.019	-.50	.618
Age home	.000	.00	.997
Number of years heating system needs replacing	.015	.39	.700
Subjective Norm (Social Circle)	.138	2.50	.013
Subjective Norm (Installers)	.155	2.90	.004
Perceived Behavioral Control (Financial abilities)	.071	1.72	.086
Perceived Behavioral Control (Knowledge of systems)	.112	2.79	.006
Willingness to fight climate change	.200	2.83	.005
Perceived environmental impact	.180	3.05	.002
Perceived benefits	.221	3.31	.001
Perceived living comfort	-.095	-1.96	.051
Perceived home comfort	-.056	-1.03	.303
Perceived barriers (costs, inconveniences)	-.127	-2.28	.024
Trust in national government	-.054	-1.05	.293

a Dependent Variable: Intention (Long term)

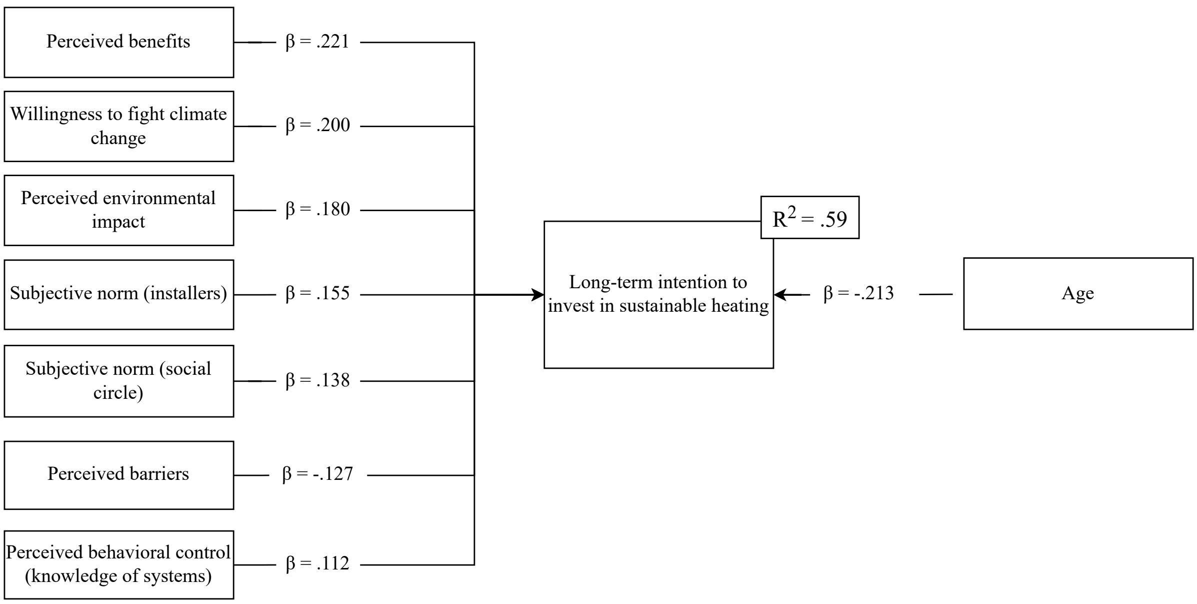

Figure 4: Factors influencing long-term intention

4.4.2 Predicting short-term intention

The next regression analysis for short-term intention to invest in sustainable heating is shown in table 8 and fig. 5. The first model explains 6% of the variance. Age of home and the number of years when homeowners think their central heating system needs replacing are significant. The second model explains approximately 48% of the variance. Hence, the predictors explain 42% of the variance (Δ adj. $R^2 = .419$). The demographic variables have become insignificant in the second model. The most important predictor is subjective norm (social circle), followed by financial abilities, perceived benefits, perceived barriers, and knowledge of systems. All other predictors are insignificant. SPSS output can be found in appendix 3-B.

Table 8: Regression analysis intention (short-term)

	β	t	Sig.
Model 1: Demographics			
$R^2 = .060$, $F(4,297) = 5.77$, $p < .001$			
Age	-.093	-1.65	.101
Gender	.013	.24	.811
Age home	.124	2.17	.031
Number of years heating system needs replacing	-.194	-3.38	.001
Model 2: Demographics + Predictors			
$R^2 = .479$, $F(15,286) = 19.49$, $p < .001$			
Age	-.001	-.02	.987
Gender	.054	1.25	.211
Age home	.039	.87	.385
Number of years heating system needs replacing	-.034	-.76	.448
Subjective Norm (Social Circle)	.328	5.26	.000
Subjective Norm (Installers)	.084	1.40	.163
Perceived Behavioral Control (Financial abilities)	.163	3.52	.000
Perceived Behavioral Control (Knowledge of systems)	.127	2.80	.005
Willingness to fight climate change	.116	1.46	.147
Perceived environmental impact	.068	1.02	.307
Perceived benefits	.155	2.05	.041
Perceived living comfort	.010	.18	.855
Perceived home comfort	-.082	-1.33	.185
Perceived barriers (costs, inconveniences)	-.148	-2.35	.020
Trust in national government	-.065	-1.13	.259

a Dependent Variable: Intention (Short term)

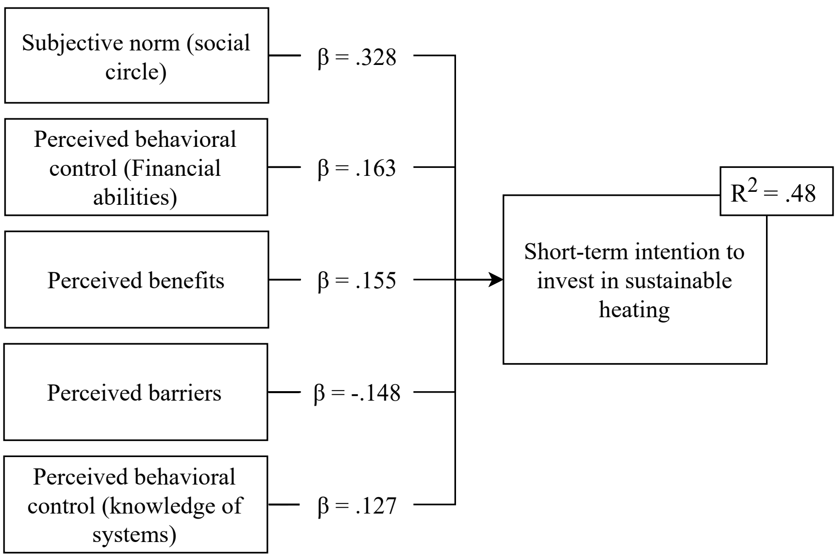

Figure 5: Factors influencing short-term intention

4.4.3 Predicting intention while gas prices are high

Third, the intention to invest in sustainable heating while gas prices are high, as shown in table 9 and fig. 7. Model 1 explains approximately 1% of the variance and age is significant. The second model, however, explains 30% of the variance with only subjective norm as a significant predictor, the most important being installers followed by one's social circle. The predictors explain 29% of the variance (Δ adj. $R^2 = .293$). No other variables are significant. SPSS output can be found in appendix 3-C.

Table 9: Regression coefficients intention (increasing gas prices)

	β	t	Sig.
Model 1: Demographics $R^2 = .009, F(4,297) = 1.66, p = .158$			
Age	-.137	-2.37	.018
Gender	.005	.08	.936
Age home	.068	1.15	.250
Number of years heating system needs replacing	.000	.01	.996
Model 2: Demographics + Predictors $R^2 = .302, F(15,286) = 9.67, p < .001$			
Age	-.059	-1.10	.273
Gender	.007	.14	.889
Age home	-.001	-.01	.991
Number of years heating system needs replacing	.087	1.66	.099
Subjective Norm (Social Circle)	.154	2.13	.034
Subjective Norm (Installers)	.169	2.41	.016
Perceived Behavioral Control (Financial abilities)	.037	.70	.487
Perceived Behavioral Control (Knowledge of systems)	.017	.32	.753
Willingness to fight climate change	.113	1.22	.222
Perceived environmental impact	.133	1.72	.086
Perceived benefits	.072	.83	.408
Perceived living comfort	.049	.78	.439
Perceived home comfort	.020	.27	.785
Perceived barriers (costs, inconveniences)	-.124	-1.69	.091
Trust in national government	-.085	-1.28	.201

a Dependent Variable: Intention (Increasing gas prices)

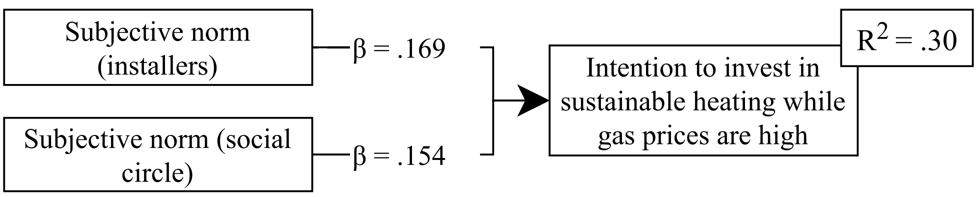

Figure 6: Factors influencing intention to invest in sustainable heating while gas prices are high

4.4.4 Predicting intention while providing more government support

Lastly, the regression analysis for intention to invest in sustainable heating while the Dutch government would give more support. As shown in table 10, age is a significant predictor in the first model, explaining 2% of the variance. As shown in fig. 7, the second model explains 35% of the variance and the perceived benefits construct is the most important predictor, followed by perceived environmental impact, trust in the national government, and subjective norm (social circle). Interestingly, trust in the national government negatively influences intention. The more one trusts the national government in facilitating the transition towards sustainable heat, the less intention one shows to invest in sustainable heating while more support and subsidies are given. The predictors explain 33% of the variance (Δ adj. $R^2 = .329$). SPSS output can be found in appendix 3-D.

Table 10: Regression analysis for intention (Government support)

	β	t	Sig.
Model 1: Demographics			
$R^2 = .024$, $F(4,297) = 2{,}83$, $p = .025$			
Age	-.142	-2.46	.014
Gender	.071	1.25	.212
Age home	.060	1.03	.303
Number of years heating system needs replacing	-.079	-1.35	.180
Model 2: Demographics + Predictors			
$R^2 = .353$, $F(15,286) = 11.95$, $p < .001$			
Age	-.033	-.63	.530
Gender	.074	1.56	.120
Age home	.010	.20	.846
Number of years heating system needs replacing	-.004	-.09	.930
Subjective Norm (Social Circle)	.147	2.12	.035
Subjective Norm (Installers)	.115	1.72	.088
Perceived Behavioral Control (Financial abilities)	-.021	-.41	.684
Perceived Behavioral Control (Knowledge of systems)	-.019	-.37	.709
Willingness to fight climate change	.083	.93	.353
Perceived environmental impact	.171	2.30	.022
Perceived benefits	.283	3.37	.001
Perceived living comfort	.089	1.47	.144
Perceived home comfort	-.061	-.88	.379
Perceived barriers (costs, inconveniences)	-.082	-1.17	.245
Trust in national government	-.159	-2.48	.014

a Dependent Variable: Intention (Government support)

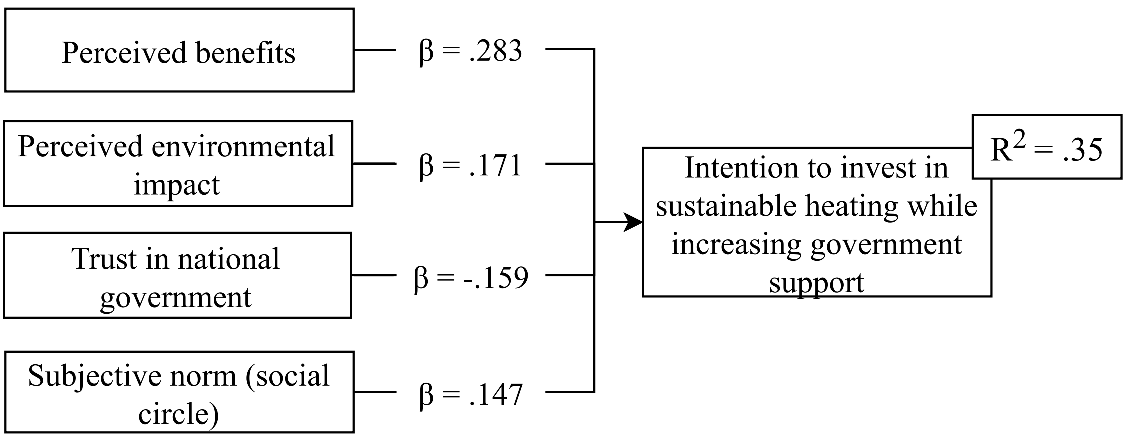

Figure 7: Factors influencing intention while increasing government support

5. Discussion & conclusion

This study aimed to understand the perceptions and intentions to invest in sustainable heating among Dutch homeowners using the Theory of Planned Behavior as a theoretical basis. By conducting a survey, intention, subjective norm, perceived behavioral control, and influential beliefs were measured. Below, the main findings of this study will be discussed first. Next, limitations will and propositions for future research will be addressed. Finally, this section ends with practical implications following the findings.

5.1 Main findings

The findings show that the same intention (to invest in sustainable heating) differs significantly depending on the situation. Four variations of intention were researched; homeowners have a somewhat positive perception of their intention to invest in sustainable heating while the government gives more support, which is rated highest. As second highest, long-term intention seems to be neutral to somewhat positive. Interestingly, as the third highest, the increasing gas prices do not have a substantial effect on intention. It does result in a higher intention to invest in sustainable heating at this moment in time, however, still rated neutral. Lastly, homeowners have a somewhat negative perception of their intention to invest in the short-term. Since the four situations were asked similarly, 95% confidence intervals could be calculated to determine if there was a difference; no overlap was observed. Hence, the intention to invest in sustainable heating is different depending on the situation.

The main question of this research was: ***"Which factors influence Dutch homeowners' intention to invest in sustainable heating?"*** The regression analysis revealed differences in the factors predicting intention. The constructs of the Theory of Planned Behavior (TPB) proved to be important. Interestingly, one's social circle is significant in all four variations of intention. When friends, family, or other important people think one should invest in sustainable heating, and one expects them to do the same, his/her intention to invest in sustainable heating will be higher in the long-term, short-term, while gas prices are high, and while more support is given by the Dutch government. While scores were relatively negative, however, close to neutral, one's social circle is essential. These findings are in line with studies regarding renewable energy usage in general (e.g., Chen et al., 2016; Halder et al., 2016; Irfan et al., 2020). Likewise, installers' opinions are important, especially in the long-term and while gas prices are high. Installers are sources of information and have been proven to influence intention in the past. However, installers must have a favorable opinion for them to advise accordingly (Freyre et al., 2021; Owen & Mitchell, 2015; Rai et al., 2016). Hence, it might be that homeowners are advised to wait longer to invest since installers may not trust the technology yet. Moreover, installers of heating systems are important in times of high natural gas prices. This as well can be explained by the fact that installers of heating systems can advise on possible cheaper alternatives to natural gas heating. Future studies should uncover if installers advise to invest in sustainable heating now that the gas prices are high, or if the advice is to invest in the long term.

The next predictor of the TPB, perceived behavioral control, is significant as well, especially regarding the long- and short-term intention. Financial abilities are only important in predicting short-term intention. As second strongest, it is a vital predictor. Naturally, homeowners intending to invest in sustainable heating in the short term must have the ability to pay for the systems. These findings are in line with Liobikienė et al. (2021), who found financial abilities to have the second strongest effect as well on intention to use renewable energy. This study has strengthened these findings by arguing that financial ability becomes (more) significant as the intended time of investment in sustainable heating becomes less in years. However, future studies should uncover if and in what matter this factor becomes stronger in time. The next construct of perceived behavioral control, knowledge of systems, is the least important predictor of long- and short-term intention. However, in both cases it shows that knowledge is significant, supporting the study by Ozaki (2011), who found an initial correlation between the access of information and adoption intention of green tariffs.

The regression analyses revealed differences in the beliefs influencing intention as well. First, environmental beliefs seem to be primarily predicting long-term intention. Homeowners willing to fight climate change and with a positive perception of the environmental impact of sustainable heating are more inclined to invest in the long term. Previous studies found similar results, namely Broers et al. (2019) and Grębosz-Krawczyk et al. (2021), who found that perceptions of environmental concern and environmental responsibility are important factors to consider in the adoption process of renewable energy and consideration of energy renovation measures. In addition, while more government support increases intention significantly, the impact of sustainable heating on the environment is important as well and by influencing this, the intention to invest will be even higher. Claudy et al. (2013) revealed that the environmental benefits of renewable energy (reducing pollution/greenhouse gasses) are an important reason for the adoption of solar panels. The present study expands these findings in the context of sustainable heating, however, did not consider these factors as reasons for adoption.

Second, personal benefits such as cost savings, appreciation of home value, and future-proof benefits are essential in the long-term, short-term, and while providing more government support. In fact, in the long term and while providing more support, benefits are the most vital in predicting intention. In the short term, it is the third most important (after financial abilities and one's social circle). The difference in importance might be explained by the fact that in the short-term, financial matters are becoming more important and homeowners talk more about the investment with their social circle. Nevertheless, the findings are in line with Claudy et al. (2013) and Ebrahimigharehbaghi et al. (2019), stating that personal financial benefits are the most important drivers and reasons for adoption. This study expands these findings by proving that benefits are more important in the long-term than in the short-term, and, again, proving that just offering more financial support is not the only measure to increase investment intention.

Third, the proposed barriers such as the costs of sustainable heating and inconveniences during installation (time, arrangements, effort, disruptions) all prove to negatively affect intention. More specifically, long- and short-term intention. The high initial and installation cost of sustainable heating, as well as inconveniences during installation, are major barriers in forming an intention to invest among homeowners. This is in line with various studies such as Aravena et al. (2016), Engelken et al. (2018), and Karytsas (2018), whom all found barriers such as costs and inconveniences to negatively influence intention to purchase renewable energy systems and hinder the installation of heat pumps. Another negative predictor in the case of long-term intention is age. As people age, their long-term intention to invest in sustainable heating will become lower. This highlights that the younger generation might be the one to (eventually) invest.

Lastly, an interesting finding of this study is the negative influence of trust in the national government. The more people trust (future) governments to stand behind the policy to be natural gas-free by 2050, think it will succeed, and be decisive enough to facilitate the transition to sustainable heat, the less intention one shows to invest while more support and subsidies are given. These findings are contradictory to Jansma et al. (2020), who found a positive influence of trust in municipalities on attitude towards becoming natural gas-free. This might be explained by the fact that as homeowners trust the government more while it provides more support, they expect them to act first and provide homeowners with information or sustainable heating systems in general. This is supported by Scholte et al. (2020), who argued that people wait for the government to provide more information before considering sustainable heating. This study, however, did not consider this and future studies should confirm why this negative influence exists.

All in all, previous studies are not always in line with the current findings depending on intention variation. Only *hypothesis 2a*: *one's social circle positively influences intention*, is fully supported, in line with Chen et al. (2016), Halder et al. (2016), Irfan et al. (2020), and Ozaki (2011). This emphasizes the social aspect of the Dutch transition towards becoming natural gas-free. Additionally, this study found not only intention to invest in sustainable heating to differ significantly depending on the situation, but that the factors influencing the situations vary as well. Future studies should uncover why these differences exist. Therefore, a framework has been developed (fig. 8), showing which factors predict intention to invest in sustainable heating and which predictors are more important. Moreover, the framework shows that certain factors are influential in one variation of intention, but not in another. Even if the same intention is predicted; intention to invest in sustainable heating.

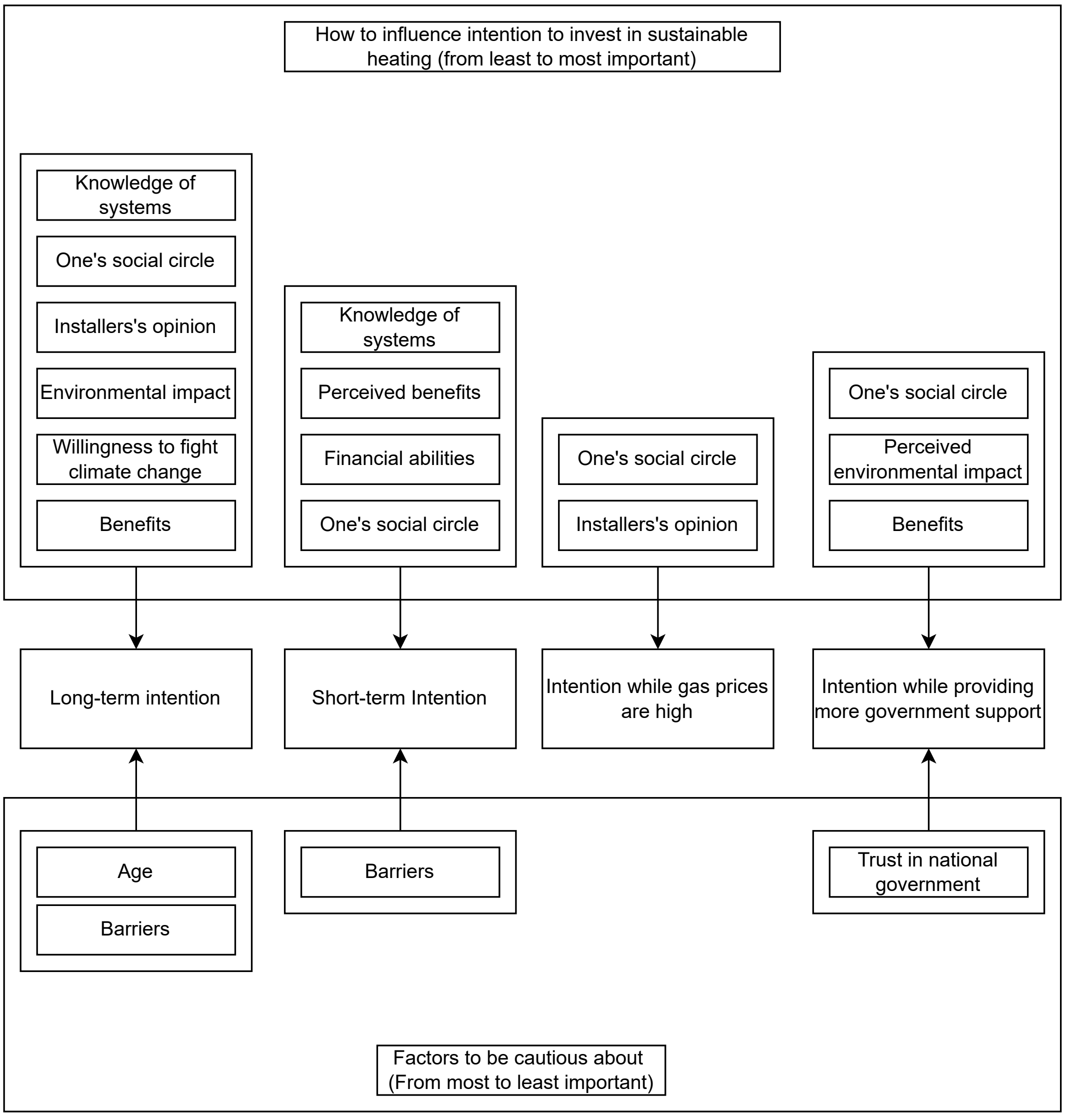

Figure 8: Framework to increase the intention to invest in sustainable heating among Dutch homeowners

5.2 Limitations and future research

This study is not without its limitations. First, the sample size of 302 respondents is not enough to say something about the whole population of The Netherlands. Therefore, these results should be taken with some caution. Future studies should confirm the results of this study with a bigger sample.

Second, while it has been proven that intention often leads to actual behavior, this study did not measure if – in the context of investing in sustainable heating – this is the case. Future studies should test if the intention to invest in sustainable heating led to investments.

Third, while apartment owners have been included in this study, it is mainly not the decision of the owner of an apartment – instead of the complex as a whole – to invest in sustainable heating. These have not been considered in this study. Therefore, future research should consider this. For instance, perceptions of 'VvE's' (or owners associations) in apartment buildings might provide valuable insights into the intention of these actors to invest in sustainable heating.

Fourth, this study did not consider if homes were, for instance, well-insulated or already had renewable energy systems installed. Comparing poorly and well-insulated homes or no sustainable measures vs. sustainable measures could provide valuable insights. Future studies should differentiate between this.

Lastly, this study did not consider the intention of landlords/ladies or housing corporations. Future studies should look towards landlords/ladies and housing corporations as well.

5.3 Practical implications

This study provides the Dutch government with several insights regarding homeowners' perceptions of investing in sustainable heating, as shown in the framework in fig. 8. First, this study emphasizes the social aspect of the transition towards becoming natural gas-free. Therefore, the government should stimulate homeowners to encourage friends, family, or other important people to invest in sustainable heating. Make expectations known. This way, perceptions of social influences increase and, thereby, the intention to invest in the next five years, 15 years, while gas prices are high and when more government support is given. Likewise, installers' opinions are important in influencing long-term intention and intention while gas prices are high. The government should make sure the opinions of installers are favorable, convince them of the usefulness and necessity of sustainable heating.

Second, homeowners need to have the ability to invest in sustainable heating as well. More specifically, financial aspects and knowledge of systems. Financial ability to invest is vital in the short term. The government should make sure homeowners have the financial resources to invest. Bringing the initial costs down through (more) research towards the systems itself or by providing other financial support will result in homeowners being more able to afford sustainable heating systems and therefore create a higher intention to invest in the next five years. Likewise, homeowners need to be able to search for and have enough information available by which a decision for a certain system can be made. The national government should provide sufficient sources of information.

Third, environmental beliefs are essential in creating an intention to invest in sustainable heating among homeowners, especially in the long term. The perception of the impact of sustainable heating on the environment is important in creating an intention in the long-term and while providing more government support. Make homeowners more aware of the reduction in greenhouse gasses, air pollution, and give them the feeling they do something good for the environment by investing. Emphasize the broader context of investing in sustainable heating on climate change and the positive impact of the systems. Likewise, homeowners' willingness to fight climate change is essential for creating a long-term intention. The national government should put more emphasis on climate change and its consequences to try and make homeowners more concerned. Moreover, homeowners need to get a sense of responsibility to do something about climate change. The national government needs to make sure homeowners have a perception of their share in fighting climate change, that it starts with them, and that they have a responsibility.

Fourth, the national government should put more emphasis on the personal benefits of sustainable heating. Homeowners intending to invest in the long-, short-term, and while providing more government support are influenced by their perception of personal benefits such as cost reductions, appreciation of home values, and the idea of making one's home future-proof. Therefore, the government should make homeowners (more) aware of the benefits sustainable heating brings.

Lastly, the government must watch out for or minimize perceptions of beliefs that result in a lower intention to invest in sustainable heating. The most dangerous is the perception of barriers such as the high initial and installation costs and inconveniences during installation (disruptions in one's home, effort and time needed, arrangements). The costs need to go down in order to minimize the negative effect on homeowners' long- and short-term intentions. Government bodies should work on this. Next, while inconveniences might not be able to be overcome in its entirety, the government could minimize them. For instance, make the application for subsidies easier, reducing the time it takes to arrange the investment and installation of heating systems. Finally, homeowners who trust the government to facilitate the gas transition will have a lower intention to invest when more government support is given. Policymakers should not hold homeowners' hands and give a perception that the government will do everything for them. They need to make decisions of their own to make the gas transition work. Finally, since age is a significant barrier to long-term intention, policymakers should focus (more) on the younger generations, where generally, intention to invest in sustainable heating is higher. However, this is a long-term plan, and the focus should not be on the younger generations only.

5.4 Conclusion

Nowadays, sustainable heating is essential in transitioning to a society free of natural gas. Starting from now, the government plans to be completely natural gas-free by 2050. Homeowners need to invest in systems, however, their intention to invest is not so easily defined. Differences exist depending on the situation. Homeowners do not expect to invest in the short term. Likewise, the high natural gas prices do not seem to make a huge difference; homeowners are still neutral. Only in the long-term (close to neutral) and while more support is provided by the Dutch government (somewhat positive), intention to invest in sustainable heating is looking more favorable. This study found factors that predict the intention to invest in sustainable heating. However, predictors vary depending on the intention variation. A framework has been developed based on empirical findings showing how intention can be predicted in specific ways (one variation of intention) or more broad ways (multiple variations of intention). Lastly, the findings resulted in multiple implications that the government could use, thereby utilizing the framework to improve homeowners' perception of beliefs that influence intention. This study provided more insights into what Dutch homeowners drive to transition towards a natural gas-free society and uncovered that intention (and its predictors) can differ depending on the situation in the context of investing in sustainable heating.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology & Health*, *26*(9), 1113–1127. https://doi.org/10.1080/08870446.2011.613995

Akroush, M. N., Zuriekat, M. I., al Jabali, H. I., & Asfour, N. A. (2019). Determinants of purchasing intentions of energy-efficient products. *International Journal of Energy Sector Management*, *13*(1), 128–148. https://doi.org/10.1108/IJESM-05-2018-0009

Alam, S. S., Nik Hashim, N. H., Rashid, M., Omar, N. A., Ahsan, N., & Ismail, M. D. (2014). Small-scale households renewable energy usage intention: Theoretical development and empirical settings. *Renewable Energy*, *68*, 255–263. https://doi.org/10.1016/j.renene.2014.02.010

Aravena, C., Riquelme, A., & Denny, E. (2016). Money, comfort or environment? Priorities and determinants of energy efficiency investments in irish households. *Journal of Consumer Policy*, *39*(2), 159–186. https://doi.org/10.1007/s10603-016-9311-2

Boot, P. (2021). *Nederland heeft een nieuw gasbeleid nodig*. https://www.pbl.nl/blogs/nederland-heeft-een-nieuw-gasbeleid-nodig

Broers, W. M. H., Vasseur, V., Kemp, R., Abujidi, N., & Vroon, Z. A. E. P. (2019). Decided or divided? An empirical analysis of the decision-making process of Dutch homeowners for energy renovation measures. *Energy Research & Social Science*, *58*, 101284. https://doi.org/10.1016/j.erss.2019.101284

CAN Europe. (2021). *High electricity prices, the links to fossil gas and the need to shift to 100% renewables and reduce energy demand*. https://caneurope.org/high-electricity-prices-links-fossil-gas-need-shift-to-renewables/

Chen, C.-F., Xu, X., & Frey, S. (2016). Who wants solar water heaters and alternative fuel vehicles? Assessing social–psychological predictors of adoption intention and policy support in China. *Energy Research & Social Science*, *15*, 1–11. https://doi.org/10.1016/j.erss.2016.02.006

Chung, J.-B., & Kim, E.-S. (2018). Public perception of energy transition in Korea: Nuclear power, climate change, and party preference. *Energy Policy*, *116*, 137–144. https://doi.org/10.1016/j.enpol.2018.02.007

Claudy, M. C., Peterson, M., & O'Driscoll, A. (2013). Understanding the attitude-behavior gap for renewable energy systems using behavioral reasoning theory. *Journal of Macromarketing*, *33*(4), 273–287. https://doi.org/10.1177/0276146713481605

de Vries, G., Rietkerk, M., & Kooger, R. (2020). The hassle factor as a psychological barrier to a green home. *Journal of Consumer Policy*, *43*(2), 345–352. https://doi.org/10.1007/s10603-019-09410-7

Dunlap, R., & Jones, R. (2002). Environmental concern: Conceptual and measurement issues. In R. Dunlap & W. Michelson (Eds.), *Handbook of Environmental Sociology* (pp. 482–542). Greenwood Press.

Ebrahimigharehbaghi, S., Qian, Q. K., Meijer, F. M., & Visscher, H. J. (2019). Unravelling Dutch homeowners' behaviour towards energy efficiency renovations: What drives and hinders their decision-making? *Energy Policy*, *129*, 546–561. https://doi.org/10.1016/j.enpol.2019.02.046

Engelken, M., Römer, B., Drescher, M., & Welpe, I. (2018). Why homeowners strive for energy self-supply and how policy makers can influence them. *Energy Policy*, *117*, 423–433. https://doi.org/10.1016/j.enpol.2018.02.026

Fishbein, M., & Ajzen, I. (2011). *Predicting and changing behavior*. Psychology Press. https://doi.org/10.4324/9780203838020

Freyre, A., Cozza, S., Rüetschi, M., Bürer, M., Sahakian, M., & Patel, M. K. (2021). How to improve effectiveness of renewable space heating programs by better understanding homeowner—installer interactions. *Energies*, *14*(15), 4625. https://doi.org/10.3390/en14154625

Gemeente Enschede. (2020). *Transitievisie warmte Enschede 2020: De mening van Enschedeers*.

Gram-Hanssen, K., Christensen, T. H., & Petersen, P. E. (2012). Air-to-air heat pumps in real-life use: Are potential savings achieved or are they transformed into increased comfort? *Energy and Buildings*, *53*, 64–73. https://doi.org/10.1016/j.enbuild.2012.06.023

Grębosz-Krawczyk, M., Zakrzewska-Bielawska, A., Glinka, B., & Glińska-Neweś, A. (2021). Why do consumers choose photovoltaic panels? Identification of the factors influencing consumers' choice behavior regarding photovoltaic panel installations. *Energies*, *14*(9), 2674. https://doi.org/10.3390/en14092674

Halder, P., Pietarinen, J., Havu-Nuutinen, S., Pöllänen, S., & Pelkonen, P. (2016). The theory of planned behavior model and students' intentions to use bioenergy: A cross-cultural perspective. *Renewable Energy*, *89*, 627–635. https://doi.org/10.1016/j.renene.2015.12.023

Hammingh, P., Daniels, B., Koutstaal, P., & Menkveld, M. (2021). *Klimaat- en energieverkenning 2021*. https://www.pbl.nl/sites/default/files/downloads/pbl-2021-klimaat-en-energieverkenning-2021-4681.pdf

Hassandra, M., Vlachopoulos, S. P., Kosmidou, E., Hatzigeorgiadis, A., Goudas, M., & Theodorakis, Y. (2011). Predicting students' intention to smoke by theory of planned behaviour variables and parental influences across school grade levels. *Psychology & Health*, *26*(9), 1241–1258. https://doi.org/10.1080/08870446.2011.605137

Haytko, D. L., & Matulich, E. (2010). Green advertising and environmentally responsible consumer behaviors: Linkages examined. *Journal of Management and Marketing Research*, *1*, 2–11.

He, Q., Zhao, H., Shen, L., Dong, L., Cheng, Y., & Xu, K. (2019). Factors influencing residents' intention toward green retrofitting of existing residential buildings. *Sustainability*, *11*(15), 4246. https://doi.org/10.3390/su11154246

Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). Dimensions of national cultures. In *Cultures and organizations: Software of the mind* (3rd ed., pp. 53–88). McGraw-Hill.

Huijts, N. M. A., Molin, E. J. E., & Steg, L. (2012). Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. *Renewable and Sustainable Energy Reviews*, *16*(1), 525–531. https://doi.org/10.1016/j.rser.2011.08.018

Irfan, M., Zhao, Z.-Y., Li, H., & Rehman, A. (2020). The influence of consumers' intention factors on willingness to pay for renewable energy: A structural equation modeling approach. *Environmental Science and Pollution Research*, *27*(17), 21747–21761. https://doi.org/10.1007/s11356-020-08592-9

Jabeen, G., Yan, Q., Ahmad, M., Fatima, N., & Qamar, S. (2019). Consumers' intention-based influence factors of renewable power generation technology utilization: A structural equation modeling approach. *Journal of Cleaner Production*, *237*, 117737. https://doi.org/10.1016/j.jclepro.2019.117737

Jansma, S. R., Gosselt, J. F., & de Jong, M. D. T. (2020). Kissing natural gas goodbye? Homeowner versus tenant perceptions of the transition towards sustainable heat in The Netherlands. *Energy Research & Social Science*, *69*, 101694. https://doi.org/10.1016/j.erss.2020.101694

Joshi, Y., & Rahman, Z. (2019). Consumers' sustainable purchase behaviour: Modeling the impact of psychological factors. *Ecological Economics*, *159*, 235–243. https://doi.org/10.1016/j.ecolecon.2019.01.025

Karytsas, S. (2018). An empirical analysis on awareness and intention adoption of residential ground source heat pump systems in Greece. *Energy Policy*, *123*, 167–179. https://doi.org/10.1016/j.enpol.2018.08.001

Karytsas, S., & Theodoropoulou, H. (2014). Public awareness and willingness to adopt ground source heat pumps for domestic heating and cooling. *Renewable and Sustainable Energy Reviews*, *34*, 49–57. https://doi.org/10.1016/j.rser.2014.02.008

Kim, H., Park, E., Kwon, S. J., Ohm, J. Y., & Chang, H. J. (2014). An integrated adoption model of solar energy technologies in South Korea. *Renewable Energy*, *66*, 523–531. https://doi.org/10.1016/j.renene.2013.12.022

Konisky, D. M., Milyo, J., & Richardson, L. E. (2008). Environmental policy attitudes: Issues, geographical scale, and political trust. *Social Science Quarterly*, *89*(5), 1066–1085. https://doi.org/10.1111/j.1540-6237.2008.00574.x

Korcaj, L., Hahnel, U. J. J., & Spada, H. (2015). Intentions to adopt photovoltaic systems depend on homeowners' expected personal gains and behavior of peers. *Renewable Energy*, *75*, 407–415. https://doi.org/10.1016/j.renene.2014.10.007

Koster, R. (2021). *Stijging van 17,50 euro: grootste energiebedrijf maakt tarieven 2022 bekend*.

Kumar, V., Syan, A. S., & Kaur, K. (2022). A structural equation modeling analysis of factors driving customer purchase intention towards solar water heater. *Smart and Sustainable Built Environment*, *11*(1), 65–78. https://doi.org/10.1108/SASBE-05-2020-0069

Laerd Statistics. (2020). *Pearson's product moment correlation*. Statistical Tutorials and Software Guides. https://statistics.laerd.com/statistical-guides/pearson-correlation-coefficient-statistical-guide.php

Liobikienė, G., Dagiliūtė, R., & Juknys, R. (2021). The determinants of renewable energy usage intentions using theory of planned behaviour approach. *Renewable Energy*, *170*, 587–594. https://doi.org/10.1016/j.renene.2021.01.152

Mahapatra, K., & Gustavsson, L. (2007). Innovative approaches to domestic heating: Homeowners' perceptions and factors influencing their choice of heating system. *International Journal of Consumer Studies*, *32*(1), 75–87. https://doi.org/10.1111/j.1470-6431.2007.00638.x

Maichum, K., Parichatnon, S., & Peng, K.-C. (2016). Application of the extended theory of planned behavior model to investigate purchase intention of green products among Thai consumers. *Sustainability*, *8*(10), 1077. https://doi.org/10.3390/su8101077

Malik, C., & Singhal, N. (2017). Consumer environmental attitude and willingness to purchase environmentally friendly products: An sem approach. *Vision: The Journal of Business Perspective*, *21*(2), 152–161. https://doi.org/10.1177/0972262917700991

Milieucentraal. (2018). *Warmtepomp: Waar let ik op als ik offertes wil aanvragen?*

Milieucentraal. (2021). *Stappenplan aardgasvrij wonen*. https://www.milieucentraal.nl/energie-besparen/aardgasvrij-wonen/stappenplan-aardgasvrij-wonen/

Montijn-Dorgelo, F. N. H., & Midden, C. J. H. (2008). The role of negative associations and trust in risk perception of new hydrogen systems. *Journal of Risk Research*, *11*(5), 659–671. https://doi.org/10.1080/13669870801967218

Murphy, L. (2014). The influence of energy audits on the energy efficiency investments of private owner-occupied households in The Netherlands. *Energy Policy*, *65*, 398–407. https://doi.org/10.1016/j.enpol.2013.10.016

Murphy, L. (2016). *Policy instruments to improve energy performance of existing owner occupied dwellings: Understanding and insight*. https://doi.org/10.7480/isbn.9789492516183

NOS. (2021). *Duurdere producten door hogere energieprijzen: "het is serieus."* https://nos.nl/artikel/2399971-duurdere-producten-door-hogere-energieprijzen-het-is-serieus

NVDE. (2021). *Inventarisatie gevolgen hoge aardgasprijs in duurzame energiesector*. https://www.nvde.nl/wp-content/uploads/2021/11/rapportage-Inventarisatie-gasprijs-12-nov-1.pdf

Owen, A., & Mitchell, G. (2015). Outside influence – Some effects of retrofit installers and advisors on energy behaviours in households. *Indoor and Built Environment*, *24*(7), 925–936. https://doi.org/10.1177/1420326X15600775

Owen, A., Mitchell, G., & Gouldson, A. (2014). Unseen influence—The role of low carbon retrofit advisers and installers in the adoption and use of domestic energy technology. *Energy Policy*, *73*, 169–179. https://doi.org/10.1016/j.enpol.2014.06.013

Ozaki, R. (2011). Adopting sustainable innovation: What makes consumers sign up to green electricity? *Business Strategy and the Environment*, *20*(1), 1–17. https://doi.org/10.1002/bse.650

Palm, J. (2018). Household installation of solar panels – Motives and barriers in a 10-year perspective. *Energy Policy*, *113*, 1–8. https://doi.org/10.1016/j.enpol.2017.10.047

Park, E., & Ohm, J. Y. (2014). Factors influencing the public intention to use renewable energy technologies in South Korea: Effects of the Fukushima nuclear accident. *Energy Policy*, *65*, 198–211. https://doi.org/10.1016/j.enpol.2013.10.037

Proudlove, R., Finch, S., & Thomas, S. (2020). Factors influencing intention to invest in a community owned renewable energy initiative in Queensland, Australia. *Energy Policy*, *140*, 111441. https://doi.org/10.1016/j.enpol.2020.111441

Qiu, Y., Wang, Y. D., & Wang, J. (2017). Soak up the sun: Impact of solar energy systems on residential home values in Arizona. *Energy Economics*, *66*, 328–336. https://doi.org/10.1016/j.eneco.2017.07.001

Rai, V., Reeves, D. C., & Margolis, R. (2016). Overcoming barriers and uncertainties in the adoption of residential solar PV. *Renewable Energy*, *89*, 498–505. https://doi.org/10.1016/j.renene.2015.11.080

Reindl, K., & Palm, J. (2021). Installing pv: Barriers and enablers experienced by non-residential property owners. *Renewable and Sustainable Energy Reviews*, *141*, 110829. https://doi.org/10.1016/j.rser.2021.110829

Rezaei, R., & Ghofranfarid, M. (2018). Rural households' renewable energy usage intention in Iran: Extending the unified theory of acceptance and use of technology. *Renewable Energy*, *122*, 382–391. https://doi.org/10.1016/j.renene.2018.02.011

Rijksoverheid. (2021). *Kabinet verlaagt energiebelasting en stelt extra geld voor isolatie beschikbaar*. https://www.rijksoverheid.nl/onderwerpen/energie-thuis/nieuws/2021/10/15/kabinet-verlaagt-energiebelasting-en-stelt-extra-geld-voor-isolatie-beschikbaar

Scholte, S., Kluizenaar, Y. de, Wilde, T. de, Steenbekkers, A., & Carabain, C. (2020). *Op weg naar aardgasvrij wonen*. https://www.scp.nl/binaries/scp/documenten/publicaties/2020/05/25/op-weg-naar-aardgasvrij-wonen/Op+weg+naar+aardgasvrij+wonen.pdf

Steenbekkers, A., & Scholte, S. (2019). *Onder de pannen zonder gas?* https://www.scp.nl/binaries/scp/documenten/publicaties/2019/09/05/onder-de-pannen-zonder-gas/Onder+de+pannen+zonder+gas.pdf

United Nations. (2015). *What is the Paris agreement?* https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

Van Gerven, M., & Akimoto. (2018). *Wat de woningbezitter betaalt als we stoppen met aardgas*.

Wilson, C., Crane, L., & Chryssochoidis, G. (2015). Why do homeowners renovate energy efficiently? Contrasting perspectives and implications for policy. *Energy Research & Social Science*, *7*, 12–22. https://doi.org/10.1016/j.erss.2015.03.002

Wu, B., & Yang, Z. (2018). The impact of moral identity on consumers' green consumption tendency: The role of perceived responsibility for environmental damage. *Journal of Environmental Psychology*, *59*, 74–84. https://doi.org/10.1016/j.jenvp.2018.08.011

Xie, W., Chen, C., Li, F., Cai, B., Yang, R., Cao, L., Wu, P., & Pang, L. (2021). Key factors of rural households' willingness to pay for cleaner heating in hebi: A case study in northern China. *Sustainability*, *13*(2), 633. https://doi.org/10.3390/su13020633

Yadav, R., & Pathak, G. S. (2016). Young consumers' intention towards buying green products in a developing nation: Extending the theory of planned behavior. *Journal of Cleaner Production*, *135*, 732–739. https://doi.org/10.1016/j.jclepro.2016.06.120

Yazdanpanah, M., Komendantova, N., & Ardestani, R. S. (2015). Governance of energy transition in Iran: Investigating public acceptance and willingness to use renewable energy sources through socio-psychological model. *Renewable and Sustainable Energy Reviews*, *45*, 565–573. https://doi.org/10.1016/j.rser.2015.02.002

Yee, C. H., Al-Mulali, U., & Ling, G. M. (2021). Intention towards renewable energy investments in Malaysia: Extending theory of planned behaviour. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-021-15737-x

Zheng, G.-W., Siddik, A. B., Masukujjaman, M., Alam, S. S., & Akter, A. (2020). Perceived environmental responsibilities and green buying behavior: The mediating effect of attitude. *Sustainability*, *13*(1), 35. https://doi.org/10.3390/su13010035

Appendices

Appendix 1: Questionnaire design (English translation)

Appendix 2: Factor analysis SPSS output

Appendix 3: SPSS output multiple regression analyses

APPENDIX 1: Questionnaire design (English translation)

Table 1: Questionnaire design

Construct	Item	Scale
Intention (Long term)	1) I want to invest in natural gas-free heating within 15 years	1 = Strongly disagree
	2) I expect to purchase natural gas-free heating within 15 years	7 = Strongly agree
	3) I am willing to get natural gas-free heating within 15 years	
	4) If my heating system needs replacing within 15 years, I plan to switch to natural gas-free heating	
Intention (Short term)	1) I want to invest in natural gas-free heating within five years	1 = Strongly disagree
	2) I expect to purchase natural gas-free heating within five years	7 = Strongly agree
	3) I am willing to get natural gas-free heating within five years	
	4) If my heating system needs replacing within 5 years, I plan to switch to natural gas-free heating	
Intention (Government support)	1) If the government provides more support, I plan to invest in natural gas-free heating	1 = Strongly disagree
	2) If the government provides more subsidies, I expect to purchase natural gas-free heating	7 = Strongly agree
	3) If the government provides tax reduction, I am willing to get natural gas-free heating	
Intention (Increasing gas prices)	1) If the gas prices continue to rise, I intend on getting natural gas-free heating	1 = Strongly disagree
	2) If my contract with my energy supplier becomes more expensive, I am willing to get natural gas-free heating	7 = Strongly agree
	3) If taxes on gas will rise, I expect to purchase natural gas-free heating	
Attitude	1) I have a positive feeling towards switching to natural gas-free heating for my home	1 = Strongly disagree
	2) Natural gas-free heating for my home is a good idea	7 = Strongly agree
	3) It is desirable to get natural gas-free heating for my home	
	4) I find it appealing to invest in natural gas-free heating for my home	

Table 1 (continued)

Construct	**Item**	**Scale**
Subjective norm (Social circle)	1) My family/friends think I should switch to natural gas-free heating	1 = Strongly disagree
	2) I expect family/friends to invest in natural gas-free heating	7 = Strongly agree
	3) My immediate social contacts think that I should switch to natural gas-free heating	
	4) I expect my immediate social contacts to invest in natural gas-free heating	
Subjective norm (Installers)	1) In my opinion, installers of heating systems have a positive feeling towards natural gas-free heating	1 = Strongly disagree
	2) I think that installers of heating systems would advise me to switch to natural gas-free heating	7 = Strongly agree
	3) Installers of heating systems find natural gas-free heating a good idea	
	4) Installers of heating systems think that natural gas-free heating works well	
PBC (Ability to invest)	1) I have the financial availability to invest in natural gas-free heating	1 = Strongly disagree
	2) I have the money to invest in natural gas-free heating	7 = Strongly agree
	3) I need the money I would have to spend on natural gas-free heating for other things	
PBC (perceived knowledge systems)	1) I have sufficient knowledge about the possibilities of natural gas-free heating in my home	1 = Strongly disagree
	2) there is enough information available about the possibilities of natural gas-free heating in my home	7 = Strongly agree
	3) I know what needs to happen to make natural gas-free heating possible	
	4) The information about natural gas-free heating is difficult to understand	
Environmental concern	1) I am worried about climate change	1 = Strongly disagree
	2) I want to do something against climate change	7 = Strongly agree
	3) Society needs to do something about climate change	
	4) I find it important to use sustainable energy, such as solar- or wind energy	

Table 1 (continued)

Construct	Item	Scale
Perceived financial costs	1) The purchase costs for natural gas-free heating are very high	1 = Strongly disagree
	2) The installation costs for natural gas-free heating are very high	7 = Strongly agree
	3) Natural gas-free heating costs a lot of money compared to the advantages it gives	
	4) In general, natural gas-free heating is an expensive investment	
Perceived inconveniences	1) Major renovations are needed for the installation of natural gas-free heating	1 = Strongly disagree
	2) Installing natural gas-free heating takes a lot of time	7 = Strongly agree
	3) A lot needs to be arranged to get natural gas-free heating installed	
	4) Installing natural gas-free heating takes a lot of effort	
Perceived benefits	1) Natural gas-free heating leads to cost savings on my utility bill	1 = Strongly disagree
	2) Investing in natural gas-free heating leads to the appreciation of homes	7 = Strongly agree
	3) Natural gas-free heating makes my home safer	
	4) Natural gas-free heating is future proof	
Perceived comfort of living	1) Natural gas-free heating heats homes comfortably	1 = Strongly disagree
	2) Natural gas-free heating takes up a lot of space	7 = Strongly agree
	3) Natural gas-free heating produces a lot of noise	
	4) Air quality in homes will be improved due to natural gas-free heating	

Table 1 (continued)

Construct	Item	Scale
Perceived environmental impact	1) By investing in natural gas-free heating I do something good for the environment	1 = Strongly disagree
	2) Natural gas-free heating leads to less air pollution	7 = Strongly agree
	3) Through natural gas-free heating I will lower my CO2 emissions	
	4) By investing in natural gas-free heating I do something against global warming	
Trust in the gas transition	1) the national government will adhere to promises to be natural gas-free by 2050	1 = Strongly disagree
	2) Future governments will stand behind the transition to be natural gas-free	7 = Strongly agree
	3) The national government is decisive enough to facilitate the transition to be natural gas-free by 2050	
	4) The Netherlands will succeed and will be natural gas-free by 2050	
	5) The national government is determined to be natural gas-free in 2050	
Perceived environmental responsibility	1) Fighting climate change starts with me	1 = Strongly disagree
	2) Fighting climate change is my responsibility as well	7 = Strongly agree
	3) I have a share in fighting climate change	
	4) I am willing to do everything I can to fight climate change	

APPENDIX 2: Factor analysis SPSS output

Statements	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
INCON - Het installeren van aardgasvrije verwarming kost veel tijd	-0.852														
COST - De installatiekosten voor aardgasvrije verwarming zijn erg hoog	-0.847														
INCON - Er moet veel geregeld worden om aardgasvrije verwarming geïnstalleerd te krijgen	-0.842														
INCON - Het installeren van aardgasvrije verwarming kost veel moeite	-0.818														
INCON - Er zijn ingrijpende verbouwingen nodig voor het installeren van aardgasvrije verwarming	-0.816														
COST - De aanschafkosten voor aardgasvrije verwarmingssystemen zijn erg hoog	-0.801														
COST - Over het algemeen is aardgasvrije verwarming een dure investering	-0.793														
COST - Aardgasvrije verwarming kost veel geld vergeleken met de voordelen die het met zich meebrengt	-0.756														
RESP - Tegengaan van klimaatverandering is mede mijn verantwoordelijkheid		0.729													
RESP - Klimaatverandering tegengaan begint bij mijzelf		0.689													
EC - Ik maak me zorgen over de klimaatverandering		0.683													
RESP - Ik heb een aandeel in het tegengaan van klimaatverandering		0.64													
EC - Ik vind het belangrijk om gebruik te maken van duurzame energie, zoals zonne- en windenergie		0.604													
EC - Ik wil iets tegen klimaatverandering doen		0.564													
GOV - De landelijke overheid zal zich houden aan haar belofte om aardgasvrij te zijn in 2050			0.78												
GOV - Het gaat Nederland lukken om gestelde doelen te behalen en aardgasvrij te zijn in 2050			0.772												
GOV - Toekomstige regeringen zullen achter de transitie naar aardgasvrij blijven staan			0.757												
GOV - De landelijke overheid is besluitvaardig genoeg om de transitie naar aardgasvrij te bewerkstelligen			0.744												
GOV - De landelijke overheid is vastberaden om in 2050 aardgasvrij te zijn			0.647												
SJ2 - Volgens mij staan CV-installateurs positief tegenover aardgasvrije verwarming				0.821											
SJ2 - CV-installateurs vinden aardgasvrije verwarming een goed idee				0.819											
SJ2 - Ik denk dat CV-installateurs mij zouden adviseren om over te gaan op aardgasvrije verwarming				0.761											
SJ2 - CV-installateurs denken dat aardgasvrije verwarming goed werkt				0.733											
SJ1 - Mijn familie en/of vrienden vinden dat ik moet overgaan op aardgasvrije verwarming					0.857										
SJ1 - Mijn directe omgeving vindt dat ik moet overgaan op aardgasvrije verwarming					0.826										
SJ1 - Ik verwacht dat familie en/of vrienden gaan investeren in aardgasvrije verwarming					0.772										
SJ1 - Ik verwacht dat mijn directe omgeving gaat investeren in aardasvrije verwarming					0.768										
ENVIMP - Met aardgasvrije verwarming zorg ik voor minder luchtvervuiling						0.806									
ENVIMP - Door middel van aardgasvrije verwarming verlaag ik mijn persoonlijke CO2-uitstoot						0.798									
ENVIMP - Door te investeren in aardgasvrije verwarming doe ik iets tegen de opwarming van de aarde						0.719									
ENVIMP - Door te investeren in aardgasvrije verwarming doe ik iets goeds voor het milieu						0.663									
PBC_FA - Ik heb het geld om aardgasvrije verwarming te nemen							0.954								
PBC_FA - Ik heb de financiële ruimte om te investeren in aardgasvrije verwarming							0.95								
PBC_FA - Het geld dat ik voor aardgasvrije verwarming kwijt zou zijn, heb ik nodig voor andere dingen (RECODE)							0.875								
INT4 - Als de belasting op gas gaat stijgen, verwacht ik aardgasvrije verwarming aan te schaffen								0.847							
INT4 - Als mijn nieuwe energiecontract duurder wordt bij verlenging, ben ik bereid aardgasvrije verwarming te nemen								0.824							
INT4 - Als de gasprijs verder stijgt, ben ik van plan aardgasvrije verwarming te nemen								0.681							
INT3 - Als de overheid meer steun biedt bij de aanschaf van aardgasvrije verwarming, ben ik van plan om te investeren									0.792						
INT3 - Als de overheid meer subsidie geeft, verwacht ik aardgasvrije verwarming aan te schaffen									0.768						
INT3 - Als de overheid belastingverlaging geeft, ben ik bereid aardgasvrije verwarming te nemen									0.747						
PBC_KNOW - Ik weet wat er moet gebeuren om aardgasvrije verwarming in mijn woning mogelijk te maken										0.883					
PBC_KNOW - Ik weet voldoende over de mogelijkheden van aardgasvrije verwarming voor mijn woning										0.871					
PBC_KNOW - Er is genoeg informatie beschikbaar over de mogelijkheden van aardgasvrije verwarming voor mijn woning										0.824					
INT2 - Ik verwacht binnen vijf jaar aardgasvrije verwarming aan te schaffen											0.774				
INT2 - Binnen vijf jaar wil ik investeren in aardgasvrije verwarming											0.747				
INT2 - Ik ben bereid binnen vijf jaar aardgasvrije verwarming te nemen											0.728				
INT1 - Ik verwacht in de komende 15 jaar aardgasvrije verwarming aan te schaffen												0.725			
INT1 - Binnen 15 jaar wil ik investeren in aardgasvrije verwarming												0.678			
INT1 - Ik ben bereid binnen 15 jaar aardgasvrije verwarming te nemen												0.67			
BENEFIT - Investeringen in aardgasvrije verwarming leiden tot een waardestijging van mijn huis													0.632		
BENEFIT - Aardgasvrije verwarming leidt tot besparingen op mijn energierekening													0.592		
BENEFIT - Aardgasvrije verwarming is een investering voor de toekomst													0.404		
COL - Aardgasvrije verwarmingssystemen nemen veel ruimte in beslag (RECODE)	0.419													0.764	
COL - Aardgasvrije verwarmingssystemen produceren over het algemeen veel geluid (RECODE)	0.409													0.736	
COL - De luchtkwaliteit in huis wordt verbeterd door aardgasvrije verwarming															0.737
COL - Aardgasvrije verwarming verwarmt huizen op een comfortabele manier															0.561

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 9 iterations.

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	21.12	37.714	37.714	21.12	37.714	37.714	7.702	13.753	13.753
2	5.476	9.778	47.492	5.476	9.778	47.492	4.107	7.333	21.087
3	3.144	5.614	53.106	3.144	5.614	53.106	3.937	7.031	28.117
4	2.97	5.304	58.411	2.97	5.304	58.411	3.848	6.872	34.989
5	2.447	4.369	62.78	2.447	4.369	62.78	3.779	6.748	41.737
6	2.135	3.813	66.593	2.135	3.813	66.593	3.63	6.483	48.22
7	1.573	2.809	69.402	1.573	2.809	69.402	2.769	4.944	53.164
8	1.448	2.586	71.987	1.448	2.586	71.987	2.635	4.705	57.869
9	1.174	2.096	74.083	1.174	2.096	74.083	2.561	4.573	62.442
10	1.155	2.063	76.146	1.155	2.063	76.146	2.524	4.507	66.949
11	0.964	1.721	77.866	0.964	1.721	77.866	2.502	4.468	71.417
12	0.943	1.684	79.55	0.943	1.684	79.55	2.456	4.386	75.803
13	0.851	1.52	81.071	0.851	1.52	81.071	1.556	2.778	78.581
14	0.808	1.443	82.514	0.808	1.443	82.514	1.471	2.627	81.208
15	0.646	1.153	83.667	0.646	1.153	83.667	1.377	2.459	83.667

Extraction Method: Principal Component Analysis.

APPENDIX 3: SPSS output multiple regression

APPENDIX 3-A: SPSS output multiple regression intention long-term

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.356a	0.127	0.115	1.64228
2	.783b	0.613	0.592	1.11482

a Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home
b Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home, COl1, PBC2_MEAN, PBC1_MEAN, GOV, ENVIMP, SN2_MEAN, COSTandINCON, COl2, SN1_MEAN, BENEFIT, ECandRESP

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	116.435	4	29.109	10.793	.000b
	Residual	801.035	297	2.697		
	Total	917.471	301			
2	Regression	562.025	15	37.468	30.148	.000c
	Residual	355.445	286	1.243		
	Total	917.471	301			

a Dependent Variable: INT1_MEAN
b Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home
c Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home, COl1, PBC2_MEAN, PBC1_MEAN, GOV, ENVIMP, SN2_MEAN, COSTandINCON, COl2, SN1_MEAN, BENEFIT, ECandRESP

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-4.26	6.867		-0.62	0.536
	Age	-0.045	0.008	-0.317	-5.793	0
	Gender	-0.151	0.182	-0.045	-0.827	0.409
	Age home	0.006	0.003	0.091	1.63	0.104
	Amount of years heating system needs replacin	-0.047	0.024	-0.11	-1.974	0.049
2	(Constant)	1.732	4.868		0.356	0.722
	Age	-0.03	0.006	-0.213	-5.148	0
	Gender	-0.063	0.127	-0.019	-0.5	0.618
	Age home	8.82E-06	0.002	0	0.004	0.997
	Amount of years heating system needs replacin	0.007	0.017	0.015	0.385	0.7
	SN1_MEAN	0.179	0.072	0.138	2.504	0.013
	SN2_MEAN	0.248	0.085	0.155	2.9	0.004
	PBC1_MEAN	0.078	0.045	0.071	1.724	0.086
	PBC2_MEAN	0.146	0.052	0.112	2.794	0.006
	ECandRESP	0.241	0.085	0.2	2.827	0.005
	ENVIMP	0.256	0.084	0.18	3.052	0.002
	BENEFIT	0.259	0.078	0.221	3.312	0.001
	COl1	-0.146	0.075	-0.095	-1.958	0.051
	COl2	-0.099	0.096	-0.056	-1.033	0.303
	COSTandINCON	-0.173	0.076	-0.127	-2.276	0.024
	GOV	-0.081	0.076	-0.054	-1.054	0.293

a Dependent Variable: INT1_MEAN

APPENDIX 3-B: SPSS output multiple regression analysis intention (short-term)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.269a	0.072	0.06	1.59995
2	.711b	0.505	0.479	1.19034

a Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home
b Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home, COl1, PBC2_MEAN, PBC1_MEAN, GOV, ENVIMP, SN2_MEAN, COSTandINCON, COl2, SN1_MEAN, BENEFIT, ECandRESP

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	59.106	4	14.777	5.772	.000b
	Residual	760.276	297	2.56		
	Total	819.382	301			
2	Regression	414.145	15	27.61	19.486	.000c
	Residual	405.237	286	1.417		
	Total	819.382	301			

a Dependent Variable: INT2_MEAN
b Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home
c Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home, COl1, PBC2_MEAN, PBC1_MEAN, GOV, ENVIMP, SN2_MEAN, COSTandINCON, COl2, SN1_MEAN, BENEFIT, ECandRESP

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-10.094	6.69		-1.509	0.132
	Age	-0.012	0.008	-0.093	-1.647	0.101
	Gender	0.043	0.178	0.013	0.24	0.811
	Age home	0.007	0.003	0.124	2.167	0.031
	Amount of years heating system needs replacing	-0.078	0.023	-0.194	-3.377	0.001
2	(Constant)	-4.597	5.198		-0.884	0.377
	Age	0	0.006	-0.001	-0.017	0.987
	Gender	0.17	0.136	0.054	1.254	0.211
	Age home	0.002	0.003	0.039	0.87	0.385
	Amount of years heating system needs replacing	-0.014	0.018	-0.034	-0.76	0.448
	SN1_MEAN	0.401	0.076	0.328	5.256	0
	SN2_MEAN	0.128	0.091	0.084	1.397	0.163
	PBC1_MEAN	0.17	0.048	0.163	3.521	0
	PBC2_MEAN	0.157	0.056	0.127	2.803	0.005
	ECandRESP	0.132	0.091	0.116	1.456	0.147
	ENVIMP	0.092	0.089	0.068	1.024	0.307
	BENEFIT	0.171	0.084	0.155	2.052	0.041
	COl1	0.015	0.08	0.01	0.183	0.855
	COl2	-0.137	0.103	-0.082	-1.33	0.185
	COSTandINCON	-0.19	0.081	-0.148	-2.347	0.02
	GOV	-0.092	0.082	-0.065	-1.132	0.259

a Dependent Variable: INT2_MEAN

APPENDIX 3-C: SPSS output multiple regression analysis intention (increasing gas prices)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.148a	0.022	0.009	1.28659
2	.580b	0.336	0.302	1.07987

a Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home
b Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home, COl1, PBC2_MEAN, PBC1_MEAN, GOV, ENVIMP, SN2_MEAN, COSTandINCON, COl2, SN1_MEAN, BENEFIT, ECandRESP

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.014	4	2.753	1.663	.158b
	Residual	491.625	297	1.655		
	Total	502.639	301			
2	Regression	169.13	15	11.275	9.669	.000c
	Residual	333.509	286	1.166		
	Total	502.639	301			

a Dependent Variable: INT4_MEAN
b Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home
c Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home, COl1, PBC2_MEAN, PBC1_MEAN, GOV, ENVIMP, SN2_MEAN, COSTandINCON, COl2, SN1_MEAN, BENEFIT, ECandRESP

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-1.73	5.379		-0.322	0.748
	Age	-0.014	0.006	-0.137	-2.372	0.018
	Gender	1.10E-02	0.143	0.005	0.08	0.936
	Age home	0.003	0.003	0.068	1.154	0.25
	Amount of years heating system needs replacing	9.53E-05	0.018	0	0.005	0.996
2	(Constant)	1.7	4.716		0.36	0.719
	Age	-6.00E-03	0.006	-0.059	-1.098	0.273
	Gender	0.017	0.123	0.007	0.139	0.889
	Age home	-2.63E-05	0.002	-0.001	-0.011	0.991
	Amount of years heating system needs replacing	0.027	0.016	0.087	1.656	0.099
	ECandRESP	0.101	0.083	0.113	1.223	0.222
	SN1_MEAN	0.148	0.069	0.154	2.13	0.034
	SN2_MEAN	0.2	0.083	0.169	2.413	0.016
	PBC1_MEAN	0.03	0.044	0.037	0.696	0.487
	PBC2_MEAN	0.016	0.051	0.017	0.315	0.753
	COSTandINCON	-0.125	0.074	-0.124	-1.694	0.091
	BENEFIT	0.063	0.076	0.072	0.829	0.408
	COI1	0.056	0.072	0.049	0.775	0.439
	COI2	0.026	0.093	0.02	0.274	0.785
	ENVIMP	0.14	0.081	0.133	1.724	0.086
	GOV	-0.095	0.074	-0.085	-1.283	0.201

a Dependent Variable: INT4_MEAN

APPENDIX 3-D: SPSS output multiple regression analysis intention (government support)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.192a	0.037	0.024	1.30376
2	.621b	0.385	0.353	1.06131

a Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home
b Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home, COl1, PBC2_MEAN, PBC1_MEAN, GOV, ENVIMP, SN2_MEAN, COSTandINCON, COl2, SN1_MEAN, BENEFIT, ECandRESP

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.261	4	4.815	2.833	.025b
	Residual	504.839	297	1.7		
	Total	524.1	301			
2	Regression	201.953	15	13.464	11.953	.000c
	Residual	322.147	286	1.126		
	Total	524.1	301			

a Dependent Variable: INT3_MEAN
b Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home
c Predictors: (Constant), Amount of years heating system needs replacing, Gender, Age, Age home, COl1, PBC2_MEAN, PBC1_MEAN, GOV, ENVIMP, SN2_MEAN, COSTandINCON, COl2, SN1_MEAN, BENEFIT, ECandRESP

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-0.176	5.451		-0.032	0.974
	Age	-0.015	0.006	-0.142	-2.464	0.014
	Gender	0.181	0.145	0.071	1.251	0.212
	Age home	0.003	0.003	0.06	1.031	0.303
	Amount of years heating system needs replacing	-0.025	0.019	-0.079	-1.345	0.18
2	(Constant)	1.546	4.635		0.334	0.739
	Age	-0.003	0.006	-0.033	-0.629	0.53
	Gender	0.188	0.121	0.074	1.559	0.12
	Age home	0	0.002	0.01	0.195	0.846
	Amount of years heating system needs replacing	-0.001	0.016	-0.004	-0.088	0.93
	SN1_MEAN	0.144	0.068	0.147	2.118	0.035
	SN2_MEAN	0.14	0.081	0.115	1.715	0.088
	PBC1_MEAN	-0.017	0.043	-0.021	-0.407	0.684
	PBC2_MEAN	-0.019	0.05	-0.019	-0.373	0.709
	ECandRESP	0.075	0.081	0.083	0.929	0.353
	ENVIMP	0.183	0.08	0.171	2.299	0.022
	BENEFIT	0.251	0.074	0.283	3.367	0.001
	COl1	0.104	0.071	0.089	1.465	0.144
	COl2	-0.081	0.092	-0.061	-0.881	0.379
	COSTandINCON	-0.084	0.072	-0.082	-1.165	0.245
	GOV	-0.18	0.073	-0.159	-2.478	0.014

a Dependent Variable: INT3_MEAN