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The sustainable housing question: On the role of interpersonal, impersonal and professional trust in low-carbon retrofit decisions by homeowners



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ABSTRACT

Trust is critical for facilitating energy transitions in both general and market exchange, and most particularly in consumer engagement. However, little research has been done to demonstrate how trust is established and how it influences the decision-making process of important change agents in energy transitions. On the basis of 40 in-depth interviews with homeowners who adopted a domestic low-carbon retrofit measure, this paper distinguishes three modes of trust that play a role in a retrofit decision-making process. First, interpersonal trust builds on the familiarity and social identification within social networks. Second, impersonal trust develops through certified tools and standards generated by governmental bodies and other actors perceived as independent. Finally, professional trust arises due to the perceived professional capacities and ethics of supply-side actors in the construction industry, and insulation and installation businesses. The paper demonstrates the various roles that modes of trust have in the decision-making process. Moreover, the paper shows the interaction between these different modes of trust and their mediators. Tailoring domestic low-carbon retrofit campaigns and services to different modes of trust is imperative in order to persuade homeowners to retrofit their homes, to engage with energy issues and to contribute to a transition to sustainable housing.

1. Introduction

A transition towards sustainable housing is happening all across Europe. As part of the Energy Efficiency Directive, the EU has set a target for all new buildings to approximate zero-energy by 2020 [1]. This means the existing built environment must decrease its energy demand. About 35% of the EU's buildings are over 50 years old and almost 75% of these buildings are energy inefficient [2]. As the residential sector represents a significant percentage of the total energy consumption of the built environment – 40% in the EU – a special emphasis is placed on decreasing its energy demand. A large share of these residential dwellings are owner-occupied – 69% in the EU [3] – and only 0.4–1.2% (depending on the country) of the building stock is renovated annually [2]. This indicates a very slow adoption of domestic low-carbon retrofit measures (hereafter called retrofit measures) by private homeowners and proves to be a major challenge in the transition towards sustainable housing.

Studies have shown that homeowners are reluctant to refurbish their homes for different reasons [4,5]: misunderstanding of the economic benefits [6], anxiety around not controlling the process [7] or a fear of disruption of everyday practices of homeowners [8]. Moreover, the retrofit sector is characterized by high uncertainty due to a variety of procedures, providers and products [51], uncertified supply-side

actors [9] and a lack of knowledge among professionals about how to advise the consumer [10,11]. If homeowners are interested in decreasing their energy demand by renovating their home, it is difficult for them to navigate their options: improved products enter the market on a frequent basis, (uncertified) experts generate new claims and innovative technologies develop continuously. All in all, uncertainty appears to hinder homeowners in significantly contributing to a transition towards sustainable housing.

Regarding homeowner uncertainty, many studies have pointed to the importance of “trust” in the transformation of energy systems [12,13], in citizen-consumer engagement in alternative energy [14,15] and in the promotion of energy-efficient residential buildings [16]. In accordance with these studies, this paper argues that building and maintaining trust is of particular importance in uncertain settings such as the retrofit sector. Without homeowners' trust in supply-side actors, and their products and services, the purchase and adoption of a retrofit measure is unlikely to succeed. Despite trust being critical in facilitating energy transitions in general and market exchange and consumer engagement in particular [17], insight into how trust is generated and how it influences the decision-making process of important change agents (in this case homeowners) in energy transitions is still a understudied topic [18].

Considering research from the sociology of social networks, the

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sociology of standards and standardization and the sociology of professions, combined with 40 in-depth interviews with homeowners who adopted a single domestic low-carbon retrofit measure, this paper distinguishes three modes of trust that play a role in the retrofit decision-making process: interpersonal trust, impersonal trust and professional trust. First, interpersonal trust builds on the familiarity and social identification within social networks. Second, impersonal trust develops through certified tools and standards generated by governmental bodies and other actors perceived as independent. Finally, professional trust arises due to the perceived professional capacities and ethics of supply-side actors in the construction industry, and insulation and installation businesses. The paper demonstrates the various roles that modes of trust have in the decision-making process and demonstrates the interaction between these different modes of trust and their mediators.

The paper is built up as follows: section two outlines a conceptual framework for the study of trust and retrofit within a market context. After introducing methods in section three, this framework is applied to the decision-making processes of 40 homeowners in section four. Section five relates the findings to literature and asks critical questions regarding the potential of various modes of trust in realizing a transition towards sustainable housing.

2. Background: trust and retrofit

2.1. Retrofitting as a decision-making process

Previous studies of the uptake of retrofit measures by households emphasize that it should be understood as a long-term decision-making process rather than an impulsive decision. Retrofitting is part of an ongoing practice of home maintenance and home-making and a readiness for retrofitting is created as part of this practice [19,20]. Kerr et al. [21] argue that households do not see low-carbon retrofit measures as distinctive from other home renovations and therefore offer “holistic narratives” to better understand how retrofit decisions are made. This is in line with Aune [22] who argues for the need to understand retrofitting as an ongoing process of turning a house into a home. Some researchers go so far as to qualify retrofitting as “a bundle of social practices”, demonstrating how practices of everyday life and practices of retrofitting a home are linked in myriad ways [8,23]. Understanding retrofitting as a process implies that interest in, purchase of, and installation and adoption of a retrofit measure have to be discerned as multiple, decision-making moments through which a retrofit measure is eventually considered.

On the demand-side, homeowners have to be convinced of the necessity and utility of the retrofit measures advised, the reliability of the products and technologies used and the trustworthiness of the contractors who sell and install them [4,5]. On the supply-side, the Dutch retrofit sector involves large-sized and medium-sized insulation companies, small installation enterprises [10] as well as NGOs and governmental bodies. NGOs and governmental bodies, in their role of information providers, can inform homeowners of the necessity for decreasing their energy demand and the (technical and economic) opportunities for renovating their home. Large-sized and medium-sized insulation companies and small installation enterprises, in their role of suppliers of products and services, have to persuade homeowners to purchase, install and adopt retrofit measures. The uncertainty of this sector makes establishing trust between supply- and demand-side actors both difficult and crucial [16].

2.2. The relevance of trust

The recognition of the importance of trust has been steadily increasing within the field of energy transitions (see Section 1). In the broader sociological literature on trust, the concept has similarly been understood in relation to risk and uncertainty [24]. Sociologists argue

that trust operates to induce confidence in other actors and is a fundamental aspect of all social relationships; yet, there are various ways about how these relationships form, and about what makes someone trust someone or something [25]. In the following sections, three modes of trust are introduced through research from the sociology of social networks, the sociology of standards and standardization and the sociology of professions.

2.2.1. Interpersonal trust

Within the sociology of social networks, interpersonal communication is often portrayed as a key source of trust. This is captured in the concept of “social capital” which refers to the flow of resources through interaction in social relationships [26]. Social capital can be both a collective and an individual property [27], leading to two models of the concept. First, “collective social capital” is defined as the “face-to-face relationships [and] connections between people - social networks and the norms of reciprocity and trustworthiness that arise from them” ([28]: p. 19). It points to members of a community identifying with each other, sharing values and exchanging ideas and favors. Second, “individual social capital” refers to the “resources embedded in a social network which can be accessed and/or mobilized in purposive actions” ([27]: p. 35). It points to people asking for information or help, and using their interpersonal resources for attaining their own specific goals.

Social networks can be made up of “strong ties” and “weak ties” [29]. A strong tie is someone within a close circle of family or friends. Strong tie networks typically have a great deal of similarity and, as such, are less likely to carry new information and perspectives. A weak tie is a more tenuous relationship emerging from infrequent interaction. Weak ties are particularly valuable by providing access to new information, perspectives and experiences [30]. As the focus of this study is to understand which role different modes of trust play in inducing a transition to sustainable housing among homeowners, both strong and weak ties are operationalized as interpersonal mediators of trust, which can be deployed individually and purposively by homeowners or play a role collectively and inadvertently.

As yet, few empirical studies have pointed to the influential role of interpersonal mediators of trust for the diffusion of energy-related measures [31]. A community study of cavity wall insulation and double-glazing distribution in the Netherlands demonstrated the importance of community project groups and personal communication networks for the purpose of diffusing information [32]. Other studies on the role of collective social capital in the diffusion of renewable energy argue that interpersonal trust cannot be assured or assumed under the wide diversity of contexts, conditions and arrangements under which alternative energy systems are being pursued and practiced [33]. However, despite these studies pointing to the importance of interpersonal mediators of trust, we still know very little under which conditions these relationships form and their influence in the decision-making process regarding retrofit measures.

2.2.2. Impersonal trust

A second body of literature on the sociology of standards and standardization demonstrates that certified tools such as labels, quality marks and regulatory mechanisms exemplify objectivity. Objectivity here refers to compliances with impersonal rules and calculations in order to exclude bias and personal preferences [34,35]. Through their perceived objective nature, standards embody a second mode of trust, namely impersonal trust [36].

Standards are usually supported by external governmental bodies or independent non-governmental bodies. For instance, the International Organization for Standardization (ISO) is a global non-governmental body of which the Netherlands Standardization Institute (NEN) is a participating member. In commission of the Dutch government, the NEN decides upon the energy performance norms for Dutch buildings and sets building regulations for the Dutch construction, insulation and

installation industry. Other standards installed by various certification organizations working for the Dutch industry include quality labels for certified contractors, products or quality-assurance systems. Brunsson and Jacobsson ([37]: p. 42) argue that “although standards are often promulgated by experts, they may come to function as an alternative to expert authority – a way of embedding authority in rules and systems rather than in credentialed professionals.” These certified tools thus allow homeowners to determine, for instance, the quality of a material or technology used in a retrofit measure without mediation by professionals.

Several studies demonstrate how certified standards affect decision-making for retrofit measures. Bartiaux et al. [23] note that, in general, Danish homeowners deem an Energy Performance Certificate an insufficient source of information for low-carbon retrofit measures. Other studies suggest that online information and communication tools co-produced by authorities could help influence decision-making about energy-related measures [38,39]. Exactly how various impersonal mediators play a role in the decision-making process is a question that remains unaddressed in these studies and will be answered in this paper.

2.2.3. Professional trust

As mediating actors between possible retrofit measures and homeowners, professionals working in the construction, insulation and installation industry are a potentially highly influential group that could be regarded as a source of information and advice. A third body of literature on the sociology of professions recognizes professionals as important mediators to establish trust especially in situations where specialized knowledge is crucial [40,41]. Freidson’s “professionalism” framework summarizes a profession as an organized occupational group working in a sheltered market in which experts apply specialized knowledge obtained through professionally controlled training under protected jurisdiction, and for which entry is restricted. Professionalization of an occupation tends to result in established acceptable qualifications, one or more trade associations to recommend guidelines and to oversee the conduct and ethics of the members of the profession. This logic of professional control ascertains trust among citizens, clients or customers who make use of the knowledge and services offered by these professionals.

According to Freidson’s [41] professionalism framework, the work undertaken by professionals in the retrofit sector should be qualified as a “semi-profession”: the trade and occupation has not fully transformed itself into a profession where workers are recognized as carriers of specialized knowledge and can organize and control their own work sheltered from market logic and directives from government regulations [42]. Outsiders enter the retrofit sector regularly and set up small, temporary enterprises without properly skilled or certified professionals. In general, it remains a conservative sector in which professional ethics change slowly and unethical conduct in the form of negligence, conflict of interest and violations of professional guidelines and environmental ethics exists [43].

A sociology of professions approach has previously been used to investigate professionals and their role in retrofit processes [44,45]. There are roughly three types of professional actors from the construction, insulation and installation industry who liaise directly with homeowners to identify, recommend or install retrofit measures: 1) advisors, 2) craftsmen and 3) installers involved in the repair, maintenance and improvement of existing homes. In many cases these roles merge, with installers advising on appropriate measures and then specifying, costing and implementing those measures as well. Owen et al. ([10]: 169) talk about the “unseen influence” of these professional actors and discern two aspects that can influence the retrofit process: first, their technical capacity, which enables them to identify the most appropriate solution or assimilate contextual information in order to select the most appropriate solution from the range of technically feasible solutions, and second, their non-technical capacities that enable

professionals to work effectively with homeowners to adapt to their preferences and which leads them to prioritize particular technologies in line with homeowners’ preferences. Wade et al. [45] show that professionals play a significant role in the adoption of energy-efficient measures, but how they make use of their technical and non-technical capacities is dependent on how they understand their customers. Therefore, an important question is how the construction, insulation and installation industry’s reputation as being unreliable and non-transparent in its procedures and workings [9,43] trickles down to homeowners and how this influences the mediating role of professionals in the retrofit decision-making process.

3. Methods

The concepts introduced above are applied in a study of the decision-making processes of 40 homeowner-retrofiters in the Netherlands. The aims of the study were qualitative [46]: it sought to discover *how* trust played a role in the adoption of domestic low-carbon retrofit measures purchased on the retrofit market among a target population, and to identify various modes of trust in the process.

Respondents were included on the basis of “purposive sampling” ([47]: p. 418): respondents targeted were owner-occupiers throughout various cities and villages in the Netherlands who 1) had purchased a low-carbon retrofit measure, and 2) made that purchase within six months of the study. The sampling led to an interview sample containing owner-occupiers who were 3) predominantly male, 4) predominantly above 55 years of age and 5) were predominantly highly-educated (higher vocational training or university degree) (see Table 1). The findings are therefore representative of homeowners with a medium-high socioeconomic status in countries which are subject to low-carbon retrofit policies and with a cold climate such as the Netherlands. Although it may have little relevance to groups who are markedly different from this, such as low-income and low-educated households or tenants, the target population is still relevant because Dutch (but also other EU countries’) retrofit policies and programs seem to fail to engage this group of relatively affluent and highly-educated middle-income homeowners.

Homeowners were found through the customers of various contractors in the researcher’s network. To include more respondents for the study, “snowball sampling” ([47]: p. 424) was deployed; respondents were asked if they knew of other homeowners who had just retrofitted their homes and might be interested in doing an interview. As the focus of the interviews was on reconstructing their decision-making process, it was vital that homeowners had just recently purchased or adopted a retrofit measure so that they could still recall influential considerations. Furthermore, by singling out a one-off retrofit measure, it was possible to focus on the decision-making regarding a sole measure without experiences with simultaneously adopted retrofit measures blurring the narrative. However, experiences with previously installed retrofit measures (often installed more than at least 1 year ago) were shared occasionally. The interview guide included questions about: characteristics of the dwelling and the respondent, living experience of the respondent, and the decision-making process regarding the most recent adopted low-carbon retrofit measure. The questions posed were designed to have respondents retrace the steps of the decision-making process and define which type of resources they used, in which way, why, and which types of resources they valued above other resources (see Appendix A in Supplementary material). Interviewees discussed the mediators voluntarily and were not asked directly about the various mediators of trust. Rather, they were asked which sources of information and assistance they trusted more than others and why. Furthermore, respondents were solicited to describe their retrofit experiences in their own terms, and to redefine the scope of the interview questions where appropriate. This type of in-depth, exploratory investigation is possible with a small sample where a generous amount of time is spent with each household.

Table 1
Study sample with characteristics of the 40 respondents.
(Source: www.energiesite.nl).

Name respondent	Gender	Age	Education ^a	Type of dwelling	Date of construction	Date of purchase	Low-carbon retrofit measure	Household composition	Gas consumption in m ^{3b}	Electricity consumption in kWh ^b
Peter	m	60	high	two family house	1989	2000	floor insulation	2 adults	between 1500–2000	between 3500–4000
Rob	m	66	Low	corner house	2000	2007	pv-panels	2 adults	between 1500–2000	between 3000–3500
Lucas	m	62	high	detached house	1974	1999	pv-panels	2 adults	between 3000–4000	between 3500–4000
Jesse	m	41	high	detached house	1936	2013	cavity wall insulation	2 adults, 3 children	between 2000–3000	between 4000–5000
Marie	f	57	high	terraced house	1991	1991	floor insulation	2 adults	< 1000	< 1000
Thomas	m	47	high	corner house	1974	2008	cavity wall insulation	2 adults, 2 children	between 3000–4000	between 4000–5000
Emma	f	33	high	terraced house	1930	2012	roof insulation	2 adults, 1 child	between 2000–3000	between 3500–4000
Max	m	67	high	two family house	1999	1999	pv-panels	2 adults	between 1500–2000	between 2000–2500
Ruben	m	70	Low	two family house	1953	1991	pv-panels	2 adults	between 1000–1500	between 3500–4000
Jan	m	58	high	corner house	1956	2017	cavity wall insulation	2 adults	between 2000–3000	between 3000–3500
Jasper	m	37	high	two family house	1930	2010	pv-panels	2 adults, 2 children	between 2000–3000	< 1000
Hugo	m	78	high	family house	1969	1969	pv-panels	2 adults	between 1500–2000	between 4000–5000
Floris	m	55	high	detached house	2000	2003	pv-panels	2 adults, 1 child	between 2000–3000	between 5000 – 6000
Stan	m	66	high	terraced house	1976	2005	pv-panels	2 adults, 2 children	between 2000–3000	between 5000–6000
Richard	m	59	high	corner house	1967	2002	cavity wall insulation	2 adults, 2 children	between 3000–4000	between 4000–5000
Sophie	f	43	high	family house	1963	2015	pv-panels	2 adults, 1 child	between 1000–1500	between 2500–3000
Sara	f	53	high	terraced house	1963	1994	pv-panels	2 adults, 1 child	between 1500–2000	between 4000–5000
Willem	m	66	Low	terraced house	1964	2007	pv-panels	2 adults	between 1000 – 1500	between 2000–2500
Benjamin	m	38	high	two family house	1967	2009	roof insulation	2 adults, 2 children	between 3000–4000	between 4000–4500
Olav	m	64	high	corner house	1998	2017	pv-panels	2 adults	between 1500–2000	between 3500–4000
Patrick	m	58	Low	terraced house	1936	1983	pv-panels	2 adults, 1 child	between 2000–3000	< 1000
Nick	m	37	high	detached house	1957	2015	pv-panels	2 adults, 3 children	between 4000–5000	between 5000–6000
Ed	m	71	high	terraced house	1973	2005	pv-panels	2 adults	between 3000–4000	between 2000–2500
Olivia	f	33	Low	terraced house	1984	2007	floor insulation	2 adults	between 1500–2000	between 2500–3000
Harold	m	48	high	terraced house	1932	2004	pv-panels	2 adults, 2 children	between 2000–3000	between 4000–5000
Amber	f	49	high	corner house	1910	2015	floor insulation	1 adult	< 1000	< 1000
Rick	m	64	Low	terraced house	1963	1980	cavity wall insulation	2 adults	between 1500–2000	between 2500–3000
Louise	f	66	Low	terraced house	1973	1974	pv-panels	1 adult	< 1000	< 1000
Ronald	m	61	high	terraced house	1990	1990	floor insulation	2 adults	between 1500–2000	< 1000
John	m	63	high	detached house	1939	2002	roof insulation	2 adults	between 3000–4000	between 3000–3500
Paul	m	63	Low	terraced house	1995	1995	floor insulation	1 adult	< 1000	between 1000–2000
Eva	f	37	high	corner house	1962	2014	cavity wall insulation	1 adult, 1 child	between 2000–3000	between 3000–3500
David	m	62	high	terraced house	1960	1992	floor insulation	2 adults	between 1500–2000	between 1000–2000
Jan	m	58	high	corner house	1962	1993	cavity wall insulation	2 adults	between 1500–2000	between 3000–3500
Simon	m	59	high	detached house	1935	1985	floor insulation	2 adults	between 2000–3000	between 2500–3000
Eline	f	58	high	terraced house	1963	2008	roof insulation	1 adult, 1 child	between 1500–2000	between 2500–3000
Karen	f	54	high	detached house	1909	2016	pv-panels	2 adults, 2 children	between 4000–5000	between 5000–6000
Gijs	m	65	high	detached house	1967	1995	pv-panels	2 adults	between 2000–3000	between 4000–5000
Charlotte	f	42	high	corner house	1948	2012	cavity wall insulation	2 adults, 2 children	between 2000–3000	< 1000
Vincent	m	58	high	terraced house	1931	1998	floor insulation	2 adults	between 1500–2000	between 2000–2500

^a Low = lower secondary level or vocational education level, High = higher vocational education level or university degree.

^b On average a Dutch household with two adults annually consumes 1020 m³ gas and 2950 kWh electricity and a Dutch household with two adults and two children annually consumes 1720 m³ gas and 4600 kWh electricity.

The in-depth, semi-structured interviews of around 60–75 min. were conducted at home, recorded and transcribed ad verbatim in the period January 2016 – December 2017. The transcriptions were subsequently coded with the qualitative data analysis software Atlas.ti to find and categorize which source of information and assistance homeowners used, how they valued the sources (in relation to each other) and why they trusted the sources (more or less than others). A categorization of these sources led to an identification and analysis of the role of three mediators of trust in the decision-making process of these homeowners.

4. Results

From the retrofit narratives of 40 respondents, a typical decision-making process could be discerned which stresses the phases and issues common to most homeowners who purchase and adopt a retrofit measure via the market. This typical decision-making process is made up of four phases: 1) orientation on retrofit measures, 2) seeking customized advice and persuasion towards choosing specific retrofit measures, 3) requesting and comparing quotes and the decision towards adopting a retrofit measure and 4) implementation, evaluation and confirmation of the decision (cf. [48]). All respondents struggled throughout the process: asked to qualify their experience, respondents used terms like “unsure,” “in doubt” or “indecisive.” In general, decision-making processes towards selecting a particular retrofit measure lasted from several months to up to one year with respondents typically postponing the decision if they felt their questions could not be answered (40%), their hesitations not properly considered (30%) or if no suitable quotes and/or contractors could be found (20%). In each phase of the decision-making process, a particular issue would be foregrounded. However, which specific issues homeowners grappled with, and how, requires further exploration. This provides the focus of the following empirical sections where the role of interpersonal, impersonal and professional mediators of trust is explored in each of the four phases of the retrofit decision-making process. Table 2 summarizes the findings.

4.1. Orientation on low-carbon retrofit measures

Studies show that homeowners are reluctant to seriously engage with energy savings due to uncertainty about and/or unfamiliarity with financial returns or improvements in comfort [4]. Indeed, the main issue respondents (93%) addressed when reconstructing their decision-making process was that initially they were not familiar with options for retrofitting their homes energy-efficiently. A majority of 83%¹ of the respondents were specifically grappling with access to reliable information distributed by “independent” or “non-commercial” sources, “without any interest” in their decisions. One such respondent, Jan,² familiarized himself with options to insulate his corner house through inquiries to his neighbors about their experiences with adopting cavity wall insulation:

My neighbors do not have any interest in painting a rosier picture about their experience. To me, that made it trustworthy. I always think, why does someone tell something and what interest does that person have? A contractor has an interest in selling a product, and you should be more critical perhaps, but if a person without any stake in the matter comes with a good story that quickly inspires confidence. (Respondent cavity wall insulation, male, 58).

These weak ties among neighbors played a role in the first phase of the decision-making process of a majority of respondents (67%). In general, homeowners elicited information and experiences purposively from neighbors as the example above shows. However, in four instances

Table 2 Key issues and demands of homeowners, and dominant role of various mediators of trust in four phases of a retrofit decision-making process among the 40 respondents in this study. Documented percentages represent the share of respondents mentioning these mediators of trust.

	1. Orientation	2. Customized advice	3. Requesting and comparing quotes	4. Installation, evaluation and confirmation
Key Issues homeowners deal with	Not familiar with options (93%)	Overwhelmed with information (90%)	Opacity of planning, procedures and quotes (70%)	Concern about proper installation (83%)
Key demands of homeowners	Reliable information (83%)	Lack of trust in professionals (85%)	Transparency, legitimacy (70%)	Audit, check, assurance (93%)
Dominant role of interpersonal mediators of trust	To provide access to independent, non-commercial information (67%)	Oversight, compass (85%)	To share names of and experience with contractors (13%)	To verify proper installation by professionals (48%)
Dominant role of impersonal mediators of trust	To provide access to independent, non-commercial information (50%)	To verify advice from professional mediators (55%)	To represent ‘objective’ source of information on products and financial issues (53%)	To evaluate and confirm the effect of the retrofit measure (35%)
Dominant role of professional mediators of trust	No role	To deploy non-technical, adaptive capacities (45%)	To provide reliable communication on product and financial issues (40%)	To provide feedback and monitoring, which was deemed insufficient (60%)

¹ Percentages have been rounded up or down to the nearest whole number.

² Names of respondents have been changed to safeguard their anonymity.

homeowners were also spontaneously sensitized to energy issues or retrofit measures by noticing newly installed pv-panels on neighboring roofs or a contractor's van in the street and making an inquiry. In comparison, information-seeking via strong ties such as family or close friends was only undertaken by one respondent whose son had just adopted pv-panels.

In addition to these interpersonal mediators of trust, impersonal mediators were also deemed reliable sources through which to familiarize oneself with low-carbon retrofit options (50% of respondents). Informational websites of educational NGOs such as Environment Central [Milieu Centraal] and consumer organizations such as the Dutch Homeowners' Association [Vereniging Eigen Huis] were consulted by nine respondents in this phase of the process. These organizations shared research findings and information on energy performance of dwellings and household appliances through reports, information sheets and ranking tools. A standard deemed particularly insightful among homeowners making use of impersonal mediators of trust (75%) was an energy performance check of the dwelling, which compared the energy performance of the dwelling to the average energy consumption of similar dwellings with a similar household composition. For instance, for Harold, a father of two adolescent children, who he characterized as "large-scale energy consumers," the energy performance check had confirmed his suspicions on their excessive gas and electricity consumption and that incited action:

For some time I suspected our energy consumption to be rather high, so I went to this government website to find out. They had this tool there where I filled out the characteristics of our house, how many people lived here, square meters and such and then you received a report. [...] I was rather startled as our household consumed much more energy than similar households, almost twice as much! [...] Those tools don't lie and it urged me to do something about it. (Respondent pv-panels, male, 48).

Concluding, in the first phase of the decision-making process, two types of mediators were predominantly used by homeowners: interpersonal mediators in the form of weak ties among neighbors, and impersonal mediators in the form of performance standards developed, distributed and validated by government authorities and NGOs. Strikingly, a large group of these homeowners (40%) who made use of weak ties also made use of these performance standards and ranking tools, and thus deployed two modes of trust simultaneously.

4.2. Seeking customized advice

When there is increased interest in retrofit measures, homeowners seek advice tailored to their personal concerns, private energy consumption and the physical properties of their dwellings. A large majority of respondents (90%) indicated that they felt overloaded with information and stimuli during this stage, using words like "overwhelming," "challenging" and "feeling lost" to qualify their experience. A very large share of the respondents (85%) found the information both difficult to discern and act upon. This sometimes resulted in procrastination (mentioned by eight respondents). An exemplary respondent voiced these concerns by explaining he had searched for "a compass to sail on" in order to make the "right" decision regarding suitable products. Although professionals can be expected to play an important role guiding homeowners through this phase, professionals often started at a disadvantage. A majority of 85% of homeowners were hesitant towards trusting advisers and installers employed by contractors who came to inspect their homes in order to provide them with customized retrofit measures: a fair share of respondents (45%) recalled a personal experience of a renovation job gone awry. However, when these doubts were negated, homeowners stressed that professionals had deployed a non-technical, adaptive capacity (45%). This ability and willingness to assimilate contextual information and "think along" with homeowners was much appreciated because homeowners did not see it as part of the

commercial service offered by the contractors. Rather they valued it as an extra service done at the discretion of the professional. For example, Paul had been dissatisfied with the installation of cavity wall insulation in his terraced house a year earlier and was still trying to improve the thermal comfort by now purchasing floor insulation. He had been pleasantly surprised with the advice given by a professional working for a local contractor:

It was refreshing and a totally different experience than the one I had before, because he really thought along with us. He was very flexible and thoughtful. [...] He did not mind at all about telling us what we could improve, without trying to sell us anything. [...] He gave really good advice and said that we could do some kind of foil behind our radiators to establish an extra energy saving effect. That foil only costs a few euros. (Respondent floor insulation, male, 63).

Yet, most homeowners were cautious with professional advice and often (55% of respondents) verified it by soliciting neighbors about their experiences on the ease of the process, the technical feasibility or the necessity of a retrofit measure. Marie, for instance, was trying to find a solution for mold problems in her living room and cross-checked the advice given by a professional against her neighbor:

That guy from [the contractor] came for an inspection. What I found difficult is that sometimes you're busy or you just don't have enough energy to go and do all the research yourself or compare all the information you get. Basically, you'll just have to rely on others. I wanted to get assurance that our home would become more comfortable if we would choose PUR foam to insulate our floor, because that's what the guy advised. They would just spray it in and seal our crawlspace with PUR foam under our wooden floor. Energetically speaking it might be a good option, but I was still concerned about the mold. But Bob, my neighbor and also a technical guy, said: '[...] you shouldn't seal the crawlspace.' I was more inclined to trust Bob, because [the contractor] is out to sell whatever product as long as they sell something while Bob isn't. (Respondent floor insulation, female, 57)

In search for guidance, neighbors are a weak tie that homeowners (continue to) make use of when translating their interest in retrofitting their home into a customized plan for action. Neighbors often live in the same type of dwelling, experience similar problems in their living environment (mold, draught or heat), feel connected by proximity and are often easily relatable, as the above example shows. Furthermore, these interpersonal mediators are considered easily accessible and require minor effort for information-seeking.

Along with professional and interpersonal mediators of trust, impersonal mediators of trust were also present in this phase, but with a specific purpose: 30% of homeowners in this study used impersonal mediators of trust to verify information obtained through professional mediators of trust. Procedural regulations and certificates are validated and thermal insulation product recommendations are investigated on their design and performance standards by consulting websites of NGOs and governmental bodies. Ronald, for instance, had been going back and forth between professional advice given on thermal insulation products and expert information gathered online before making a choice for a specific product:

The guy from [a contractor] did a technical inspection and recommended Tonzon foil [insulation product] and another guy from [another contractor] recommended PUR foam. I had read some stuff online that PUR foam wasn't environmentally friendly and that a decent stench would linger in the house after installation. I started to doubt whether it was indeed the best option. Then I sought information from the Dutch Homeowner's Association. [...] They referred to research reports showing that there was evidence that it wasn't that toxic and unhealthy as was often said and managed to reassure me. And with regard to Tonzon foil, they indicated that

most probably it was good but it wasn't a certified product or anything, so that question remained somewhat unanswered. [...] In the end I didn't go for either, but went to a third contractor and asked for something else. He offered Jetspray, I checked it again online and I saw that it was much more environmentally friendly than PUR foam, less expensive than Tonzon foil and it was a certified product. Eventually, I opted for that. (Respondent floor insulation, male, 61).

Concluding, professional mediators of trust were most present in this second phase of the decision-making process due to professionals' access to expertise and information. However, professionals were fragile mediators of trust and interpersonal and impersonal mediators of trust were utilized to validate the information received through professional mediators of trust. Professionals were most successful when they deployed a non-technical, adaptive capacity.

4.3. Requesting and comparing quotes

Sorting out quotes is the most complicated phase when it comes to trusting supply-side actors. The majority of respondents (70%) were struggling with what they termed the "opaqueness" of the planning, procedures and quotes. Like the majority of respondents (58%), John contacted multiple contractors in his efforts to obtain a suitable roof insulation quote. He blamed these solicitations on the lack of transparent and accessible information on the side of contractors:

In general, I think that quotes you get from contractors and businesses are just of very poor quality. It's all about general units and sizes and such, but you absolutely do not see what exactly they charge and how many square meters of products they have calculated. Then, overhead is put over it which is completely opaque and which leads to an unreadable bid. [...] For instance, [a nationwide contractor] offered a quote for a whole new tile roof. Well, you would expect them to specify how many tiles, why these tiles et cetera. But they didn't do that. Another contractor said that it wasn't necessary to install a whole new roof. Indeed, there were bad tiles, but his advice was to replace them with second-hand tiles. But he didn't specify that in his bid as well. Look, if contractors state on their quotes that it is a provisional calculation, I don't mind, but at least tell me. If you don't disclose that information, I won't know if I might receive a bill for more or different tiles later. It is all so opaque. (Respondent roof insulation, male, 63).

Part of the decision-making process of homeowners included reflection on a proposed quote or the comparison of multiple quotes. However, due to a lack of transparency, homeowners were struggling to make the right choice. Some respondents (40%) made use of professional mediators of trust in this phase. However, most respondents (53%) did not find professional mediators of trust reliable enough. Rather, they used impersonal mediators of trust to compare quotes, verify information and check the price and quality of the products and technologies used. In this stage of the process homeowners often fell back on what they qualified as "objective" sources of information. In their choice for contractors, homeowners took into account whether the contractor was certified by governmental accreditation organizations for the building, insulation or installation industry. Issued certificates ensured that contractors adhered to performance and procedural standards. This credential offered a warranty that an installed retrofit measure and the accompanying service would meet the formal quality standards. As Ed, who was hesitating between two contractors, explained:

Next to paying attention to the quality of the pv-panels mentioned on the bid I also checked the reliability of the company itself to see if they were a certified company, because you want to have a warranty that if something goes wrong during the installation or after the installation, it will be fixed. (Respondent pv-panels, male, 71).

The role of neighbors was less pronounced in this phase, although 13% of respondents did ask neighbors for their experiences with a certain contractor to imbue confidence for their own choice. However, homeowners who relied on their social networks for suggested contractors did not find it necessary to verify the quotes through impersonal mediators of trust.

Concluding, the opaqueness experienced by homeowners due to a lack of professional trust resulted in relying on impersonal mediators of trust when comparing quotes. Impersonal mediators of trust are deemed objective and reliable in opposition to professional mediators of trust whose information needs to be assessed and verified. In finding contractors and comparing their quotes, homeowners relied much less on interpersonal mediators of trust.

4.4. Implementation, evaluation and confirmation of the decision

Once the retrofit installation is completed, the next step of the homeowner's process involves evaluating both the overall satisfaction of the installation and the accuracy of its results. Notably, a large majority of homeowners (83%) questioned the proper installation of unseen insulation products or quickly installed retrofit measures. Insufficient evaluation of the installed retrofit measure by contractors was something most respondents (60%) identified as a concern. Richard, who retrofitted the cavity walls of his home with thermal insulation, questioned its functionality:

The only thing that I worry about is that there hasn't been a control check after the installation. I can't look into the cavity wall, so I have no clue whether it actually functions. I wonder whether it does. (Respondent, cavity wall insulation, male, 59).

Richard's concerns follow those respondents who also deemed the post-installation service lacking or insufficient. A minority of respondents (35%) returned to impersonal mediators of trust to confirm whether the retrofit measure actually decreased their energy demand or generated solar power. Jan, who also opted for cavity wall insulation and had initially asked his neighbors for advice, was now considering an additional energy performance certificate-audit:

I guess the aftersales service, that's what I missed. The contractor said he'd be back for a check-up but it didn't happen. Perhaps his business went into bankrupt or something else? I have no clue. [...] I was thinking of having an energy consultant come over and check it in order to get a proper energy performance certificate or go to the energy service of the municipality. I mean then you know for sure whether it has been done correctly and actually works. (Respondent cavity wall insulation, male, 58).

A slightly larger group of respondents (48%) conferred with their social networks, often including neighbors, in order to process the overall experience and verify whether it was, as one homeowner remarked, "a normal way of doing things".

Concluding, due to insufficient evaluating by contractors in this phase of the process, impersonal and interpersonal mediators of trust played a significant role in helping to assure homeowners of the proper installation of retrofit measures and its proper effects.

5. Discussion and policy implications

The discussion now returns to the paper's earlier focus on how three modes of trust do not exclude each other, but are interrelated and might play a relatively more influential and/or beneficial role than other modes of trust in specific phases of a retrofit process.

5.1. The strength of interpersonal trust

The findings demonstrate that interpersonal mediators of trust play an important and beneficial role in each phase of the retrofit process as

evaluative judgments by homeowners' social networks (including friends, neighbors and acquaintances) mitigate the uncertainty around energy-related renovations. The empirical finding that interpersonal trust affects more than just information-related issues adds to McMichael and Shipworth [31] who suggest, but not empirically show, that information is just one element within a decision-making process. Homeowners in the presented study processed the information and used it to validate whether a retrofit measure suited their home, their financial situation or relieved their worries about thermal discomfort or health issues (i.e. mold). Homeowners often have little knowledge about the process of installing a retrofit measure and feel vulnerable; thus, for reassurance, they seek out similar experiences from trusted sources.

Furthermore, this study shows that particularly *evaluation and confirmation* of the retrofit measure is important, and that (re)assurance about the installation is sought among neighbors and is vital to the eventual adoption of the retrofit measure. This is concurrent with ([49], p. 142) who indicate that “people adopt innovations only after their effectiveness has been demonstrated through the experience of friends and acquaintances.” Indeed, sharing common retrofitting experiences with peers was a coping mechanism for homeowners when dealing with the uncertainty about the effectiveness of the retrofit measure and in efforts to confirm their decisions. This could lead homeowners to embrace the retrofit measure as a good choice despite a decision-making process characterized by doubt. This (re)assurance is primarily mediated through “weak ties” [29] that are mostly individually and purposively deployed by homeowners. Neighbors predominantly make up this “individual social capital” [27] of homeowners, perhaps not surprisingly as they live in the same type of dwellings and often live the same lifestyles due to socio-economic homogeneity of neighborhoods [50]. These findings support studies showing the importance of local communities [33] for influencing energy consumption norms and practices. Because the findings show that homeowners prefer to deploy these resources individually and purposively as well, policy makers and supply-side actors should look beyond merely facilitating collective approaches to retrofit by neighborhood. Rather, they should design space within these approaches to directly and purposively target the needs of homeowners with the help of their social networks.

5.2. The frailty of professional trust

The findings show professionals play an important role in retrofit decision-making processes, both by influencing which retrofit measures homeowners select and which methods of installation they prefer. However, the findings also show that professionals are frail mediators of trust, often featuring as “barrier rather than as enabling mediator” ([11]: 1029, see also [8]). Poor consumer experience due to unreliable planning, careless workmanship and lack of post-installation inspection gives the industry a bad reputation among homeowners. A majority of the respondents reflected upon the industry as an opaque and poorly regulated one, which affected homeowners' trust in professional's capacities. In the orienting phase of the decision-making process, professional information is often dismissed because the industry is perceived to be motivated by profit and displays poor work ethics. This also made homeowners hesitant to trust professionals' advice in comparing quotes. Instead, the majority of respondents relied on impersonal mediators of trust, which were deemed more objective and thus trustworthy. Professionals are thus perceived as a “community of professional practice” [45], but share a collective disreputable identity. Notably, homeowners in this study did not make any difference between types of professionals: whether an adviser, installer or craftsman working for a nationwide contractor or a local installation firm, they are all deemed representatives of the construction, insulation and installation industry and thus they are judged accordingly.

This frailty of professional trust is a problem as it obstructs a smooth decision-making process of homeowners. However, a large minority of respondents (45%) indicated that when professionals deployed “non-

technical” and “adaptive capacities” [10], their help and advice was appreciated and trusted. This raises questions about the roles assigned to professionals working in the construction, insulation or installation industry. There are new developments of strategic intermediary organizations trying to “design trust” among homeowners in the Netherlands [16] which are promising. Professionals working for these intermediaries give extra attention to those aspects of the job deemed non-technical and more adaptive to contextual information.

5.3. The interaction of various modes of trust and the pervasiveness of impersonal trust

Findings from the presented study show that various modes of trust interact with each other in the decision-making process for retrofit measures. This is due to the fact that homeowners are, in essence, searching for cogent advice, reliable products and credible contractors when considering how to integrate retrofit measures into their everyday lives (see also [7,21]). If, for instance, they do not trust the advice given by their contractor, they will seek (re)assurance somewhere else to quell feelings of doubt and uncertainty. In this way, trust is constantly under construction and homeowners seek various mediators, performing various modes of trust, in order to build it. Two interactions are worth discussing.

First, some mediators of trust are more suitable than others at intercepting uncertainties about particular retrofit issues. Whenever respondents had doubts about specific products and technologies advised by professionals, they deferred to impersonal mediators of trust such as certificates, standards of use, and test reports by NGOs and authorities. This is in agreement with Wilson et al. [4] who argue that quality assurance and certification schemes improve trust in contractors. However, if there was uncertainty about the suitability of a particular product for their needs, the respondents relied upon their interpersonal network for reassurance. This also occurred if there were doubts and questions about the whole retrofit process. In practice, however, these uncertainties co-exist, meaning that impersonal and interpersonal mediators complement each other in the decision-making process.

Second, because professional trust is rather frail, homeowners default to two other modes of trust when seeking information or advice provided by professionals. Homeowners either verified through their interpersonal networks whether a contractor has delivered exceptional work in the past (or chose their contractors through their interpersonal network), or turned to the internet to check a contractor's credentials. Thus interpersonal and impersonal mediators of trust often verify and audit professional mediators of trust. This shows that standards become most important where professions have a reputation for being unreliable and non-transparent in its procedures and workings (cf. [35]) or where interpersonal mediators of trust are in short supply.

Studies investigating the role of trust in facilitating energy transitions tend to focus on modes of trust separately, but the findings presented here shows that investigating the interrelation of modes of trust is needed to better understand the dynamics of decision-making processes with regard to retrofitting and energy-related measures. The presented findings indicate that for a large-scale transition to sustainable housing to succeed it is crucial that in the process of implementation via the market, impersonal and interpersonal mediators of trust are properly (made) available in order to mitigate the frailty of professional trust among homeowners. This is especially critical when energy-related measures pertain to the intimacy of domestic settings, such as domestic low-carbon retrofit measures.

6. Conclusion

The presented study operationalizes the purchase of a one-off domestic low-carbon retrofit measure by private homeowners as a decision-making process with four phases and many considerations. Trust has been recognized as an important mediating factor in this process.

The findings in this paper show that trust between homeowners and supply-side actors of information, products and services is influenced by three modes of trust. First, interpersonal trust builds on the familiarity and social identification present in social networks. Second, impersonal trust develops through certified tools and standards generated by governmental bodies and other actors perceived as independent. Finally, professional trust arises due to the perceived professional capacities and ethics of supply-side actors in the construction industry, and insulation and installation businesses. In their effort to encourage the uptake of domestic low-carbon retrofit measures by homeowners, policy makers and supply-side actors can make use of these modes of trust. The presented study reveals that these modes of trust exist concurrently and their importance differs for specific phases of a retrofit process. It is imperative that the correct policy measures and market tools are deployed at particular stages of a decision-making process in order for the decision-making process to lead to the adoption of a retrofit measure, and thus be successful.

First, the study demonstrates that interpersonal mediators of trust pervade the entire decision-making process in an attempt by homeowners to eliminate uncertainty. Homeowners relied on the knowledge and experience available through their social networks. Thus, these interpersonal mediators of trust are well positioned to encourage interest in energy-efficient renovation, provide advice and ensure buy-in of a retrofit measure. Second, the construction, insulation and installation industry and the professionals working within it are seen as sharing a collective identity with a feeble reputation. A majority of respondents reflected upon the industry as poorly regulated and lacking transparency, which functions as a barrier in the decision-making process. Thus, frail professional trust indicates that professionals are not necessarily the most effective avenues for the dissemination of information on low-carbon retrofit measures. Third, findings show that various mediators of trust interact with each other. Interpersonal and impersonal mediators of trust complement each other and they often verify and audit professional mediators of trust. Therefore, it is vital that information is made available from a wide variety of resources during the entire decision-making process.

This study gives rise to a number of questions for future research. First, it is important to analyze successful and less successful energy policies aimed at low-carbon retrofit of the home in order to identify whether the lack of specific mediators of trust can explain differences in uptake or buy-in. Second, while this study was aimed at owner-occupied dwellings, it is important to also study retrofit processes for other types of housing structures (most notably social housing projects) where the role of mediators of trust might be very different. Finally, it is important to investigate which mediators are most suited to push homeowners to eventually purchase consecutive low-carbon retrofit measures in an attempt to further improve the energy-efficiency performance of their homes and eventually realize a transition to sustainable housing.

Declarations of interest

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Appendix A. Supplementary data

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