Energy Research & Social Science 103 (2023) 103206

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

How policy instruments reproduce energy vulnerability - A qualitative study of Dutch household energy efficiency measures

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ARTICLE INFO

Keywords:
Energy vulnerability
Capabilities
Policy instruments
Qualitative research
Energy poverty
Energy transition

ABSTRACT

Rising energy prices threaten households' access to affordable energy services and increase the risk of energy vulnerability. One way to reduce the cost of access to energy is to implement energy efficiency measures at the household level (e.g. solar panels). However, not all households have the capacity to do this. Households that are unable to implement energy efficiency measures are vulnerable in two ways: 1) they may not enjoy the benefits of these measures (such as lower energy costs, healthier and more comfortable living conditions), and 2) they may face increasing costs due to fluctuating market prices for non-renewable energy sources or taxes on non-renewable energy sources. Although public authorities use different policy instruments to support citizens in implementing energy efficiency measures, it turns out that these policy instruments can (re)produce energy vulnerability in an uneven way. However, how exactly this happens remains unclear. The aim of this paper is to use the capability approach to identify mechanisms that explain how policy instruments (re)produce energy vulnerability. By combining three qualitative methods to analyse two Dutch neighbourhoods, this article illustrates how institutional arrangements affect capabilities unequally, depending on spatial scale, language skills, socio-economic characteristics and housing situation. Finally, it presents three subsequent mechanisms through which policy instruments may negatively affect citizens' capabilities and increase the risk of energy vulnerability: 1) by precluding citizens from relevant information about the energy transition; 2) by raising the thresholds for citizens to implement energy-efficient measures; and 3) by miscalculating policy consequences, i.e. citizens' poor anticipation of long-term policy implications, aggravated by legal and financial uncertainty or changing individual circumstances.

1. Introduction

In the Netherlands in 2022, energy prices increased by 86 % compared to the year before [1]. This development jeopardises households' access to affordable energy services (e.g., heating, cooling, cooking, drying, washing) and increases the risk of energy vulnerability. This means households will be unable to satisfy their elementary needs [2]. In fact, the number of households unable to pay their energy bills has increased from 7 % in 2020 up to 9 % in 2021 [3] and we can assume that this number will increase even further.

Increasing energy efficiency in households is one way to reduce energy costs, while simultaneously reducing greenhouse gas emissions. This can be done by implementing energy-efficient measures (e.g., home insulation, solar panels, energy-saving lamps, radiator strips) or by changing behaviour (e.g., closing doors, airing rooms). However, not every household is capable of doing this. Even before the energy crisis of 2022, it was conservatively estimated that 15 % of the Dutch homeowners would not be able to finance and implement energy-efficient measures [4]. Households that are unable to implement energy-efficient measures are vulnerable in two ways: 1) they may not benefit from the advantages of these measures (such as lower energy costs, healthier and more comfortable living conditions), and 2) they may face increasing costs due to fluctuating market prices for non-renewable energy sources, or from governmental taxes on non-renewable energy sources [5].

Public authorities use different policy instruments [6] to support citizens in implementing energy-efficient measures, such as communicative and consultative instruments (e.g., energy coaches), or financial instruments (e.g., subsidies). However, energy-related policies, regulations and procedures can also (re)produce energy vulnerability in ways

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https://doi.org/10.1016/j.erss.2023.103206
Received 19 December 2022; Received in revised form 29 June 2023; Accepted 12 July 2023
Available online 27 July 2023

that are inequitable [7], because they tend to focus on effectiveness and efficiency, neglecting distributional equity [8]. But, exactly how this happens remains unclear. The aim of this paper is to identify mechanisms that explain how policy instruments (re)produce energy vulnerability. To do so, we apply the Capability Approach (CA), a normative-theoretical approach to wellbeing and social justice originally developed by Sen [9], and later adapted by others [10,11]. As an approach focused on individual wellbeing, the CA allows us to understand how policies are taken up and used by citizens and to identify how people are unequally affected by specific institutional, political, economic and social contexts due to the interplay of personal and structural factors [12,13]. The research question of this paper is: How do energy-related policy instruments affect the ability of households to implement energy efficiency measures? This paper focuses on the retrofitting of existing dwellings and not on new construction.

There is already a large literature that takes a capability approach in the context of energy. Theoretical studies have focused on the ethical discussion conceptualising the relationship between capabilities and energy vulnerability [14,15] or energy justice [16]; or on operationalising energy justice [17,18]. We acknowledge that energy is a precondition for the realisation of basic capabilities (e.g., heating, cooking, etc.). We add to the existing literature on capabilities and energy vulnerability by focusing not primarily on these basic capabilities, but on what Smith and Seward [19] call secondary capabilities, i.e. capabilities that are seen as precursors to the realisation of basic capabilities. Namely, the capabilities to adopt energy efficiency measures that could potentially influence their energy vulnerability in the future.

Empirical studies have applied the CA in different ways to understand energy vulnerability. Bartiaux et al. [7] use quantitative data to analyse the *consequences* of energy poverty, i.e., how it affects various capabilities related to health, mobility, culture and recreational activities in Belgium. This paper, in contrast, zooms in on the structural *causes* of energy vulnerability. To explain energy vulnerability, some scholars have focused on the role of technologies, e.g., smart grid [20], off-grid [21]; the role of renewable energy projects [22–24] or grassroots initiatives [25]; the role of the economic structures, which influence the availability of financial resources [26]; or the role of (energy) policies [8,27,28], which may cause energy vulnerability due to fragmentation [29] or misrecognition of affected people [30]. This research adds to this political economy literature on energy poverty by focusing on the role of energy-related policy instruments and their interaction with other factors to identify mechanisms that (re)produce energy vulnerability.

Section 2 explains the capability approach. In Section 3, we report on a qualitative study analysing households' narratives of their experiences with the energy transition. In Section 4 we present our findings, based on which we identify three mechanisms through which policy instruments can increase the risk of energy vulnerability, which are presented in Section 5.

2. Conceptual approach: capability approach

To analyse householders' ability to implement energy-efficient measures (e.g., heat pumps, solar panels, etc.), the capability approach (CA) is deployed. The CA is often used to assess human well-being taking capabilities as a focus point [20]. It is a useful analytical framework for this study because it allows us to analyse (1) what people are effectively "able to do and to be" ([31], p. 94), thus being sensitive to householders' heterogeneity and idiosyncrasy, and (2) how these householders' capabilities are unequally affected by policies, regulations and procedures [12].

Key to the CA is the notion that agency is essential to achieving one's own life goals [32]. Claassen [33] argues that the scope for exercising one's agency as a person consists of an autonomy aspect and a freedom aspect: being able to reflect on the realistic possibilities one has (autonomy) and acting on the possibilities one prefers (freedom). The CA conceptualises the attainment of life goals as a process of translating *means* into *capabilities* (i.e., opportunities for valued doings and beings) and then into (achieved) *functionings* (i.e., the doings and beings the person values, such as having a good job, being happy, healthy, and well-nourished). However, this process depends not only on material means, but also on individual and structural factors that influence the conversion of these means into capabilities. These are known as *conversion factors* [31].

A person's *means* comprise both material and non-material goods and services (e.g., financial means, human capital, social capital) that are necessary to create opportunities [31,34]. *Capabilities* are the actual or real opportunities to realise given functionings, whether or not one chooses to do so at any given time [31,35]. What constitutes a capability is essentially an analytical question. The distinction between capabilities and achieved functionings depends on the potential to realise valued beings and doings and whether these are actually realised in practice [31,36]. If two people have the same set of capabilities, they may choose to translate them differently into functionings, because they may have different motivations, ideas, values and preferences about what constitutes a good life. The translation of capabilities into functionings is a constrained choice, as it is influenced by various contextual variables such as family, culture, etc. [31]. In other words, converting capabilities into functionings always takes place in a specific socio-economic and cultural context. An individual's capabilities and functionings may also be influenced by the preferences, choices or actions of others [36].

The whole set of variables that influence or moderate the conversion of opportunities into realised functionings are called conversion factors. Conversion factors can be distinguished in internal and external conversion factors. Internal conversion factors belong to the (individual or collective) agent, i.e., personal characteristics of the agent. These include health, psychological conditions, personal skills, gender, disability, reading skills, intelligence, or organisational skills [34]. External conversion factors describe the context in which the agent operates, which includes what Robeyns [31] defines as social and environmental conversion factors. Environmental conversion factors comprise the physical contexts, such as climatic conditions, geographical location and infrastructure. Social conversion factors include: (1) institutional arrangements, such as policies, legislation, procedures, policy instruments (communicative, financial, regulatory), (2) economic structures (including market mechanisms, financial system), and (3) social culture (including social networks, social norms, costumes, discrimination practices, gender roles, power relations, etc.). Access to means and configurations of conversion factors may differ between individuals and groups (see also [12]). As a result, citizens' capabilities differ, as does their risk of energy vulnerability.

Previous research has shown that energy policies can play an important role in generating energy vulnerability [8]. Following this, this paper focuses primarily on the role of policy instruments, which are conceptualised as social conversion factors belonging to the subset of institutional arrangements. We focus on (i) communicative and consultative instruments (e.g., information evenings, awareness-raising campaigns, energy coaches), (ii) financial instruments (e.g., subsidies) and (iii) regulatory instruments [6].

The concept of conversion factors reflects the dependence of individual capabilities on the social context [37]. By emphasising the importance of conversion factors, the CA recognises that material goods and services as means are important for well-being, but they are not the only factors that matter. It is equally important to analyse whether people are able to convert these means into achieved functionings if they so desire [31]. Thus, Chipango [8] points out that material means (e.g., finances or technologies) are not sufficient to understand the emergence of energy vulnerability, and that attention should be paid to factors that influence the conversion of material means into capabilities and functionings. Therefore, this paper uses a narrative approach to analyse citizens' capabilities. Capabilities are 'subjective' and depend on whether citizens are aware of their options [38]. If they are not aware of

their options or if they are aware but think that they are not feasible for them, they will not translate these capabilities into functionings. A narrative approach is therefore a sound way of analysing capabilities, as it places agents and their perceptions of their own capabilities at the centre of the research.

3. Methods

This exploratory qualitative study focuses on two neighbourhoods in two medium-sized cities in the province of Gelderland, the Netherlands. The criteria for selecting these neighbourhoods were (1) income below the national average; (2) percentage of social rentals higher than the national average; (3) no concrete plans for a collective neighbourhood heat and energy system; and (4) no previous research or social projects at the start of this study. In both neighbourhoods, there may be a disproportionate risk of energy vulnerability, primarily, because the average income (see Table 1) is below the national average of €34,000 [39,40]. Low income has been described as a source of energy vulnerability [41,42]. Second, in both neighbourhoods, the percentage of rental property (see Table 1) is higher than the national average of 28 % [43], which may influence citizens' options to implement energy-efficient measures. Third, in the two neighbourhoods, there are no concrete plans for collective neighbourhood energy systems (e.g., collective heat pumps). But given the percentage of low energy labels (see Table 1), there is a clear need to implement energy-efficient measures. It is therefore mainly up to the householders to implement individual measures (e.g., solar panels, improved insulation, LED-lamps).

We follow Zimmermann [12], who argues that qualitative research is required if one is interested in exploring the different dimensions of capabilities. To increase the validity of our findings, we aim for triangulation and combine three different methods: walk-along interviews, semi-structured interviews, and co-creative workshops. First, we conducted walk-along interviews with citizens using a narrative approach to gain insight into their experienced capabilities. A narrative methodology is particularly suited to gaining these insights as respondents talk about their aspirations, dreams, wishes and (im)possibilities [38]. It allowed us to obtain insights into the respondents' capabilities and achieved functionings and how these were influenced by the distribution of means and the configuration of conversion factors [12]. We collected 30 narratives from a diverse range of Dutch citizens between June and December 2020. Respondents were recruited by using three different methods: leaflets in every letterbox, direct approach on the street, and by snowball sampling. The text on the leaflets was in Dutch, English and Arabic. The aim was to create a wide diversity in terms of gender, age (from 25 to 85), housing situation (18 homeowners and 12 social housing tenants), but also education, profession, and family situation. Twenty-three respondents expressed an interest in participating as a result of the letterbox flyer, and seven respondents were recruited via snowballing. Everyone who expressed an interest in telling their story was invited for a walk-along interview on a day and at a time that suited them.

Following the Kvale's [44] 'traveller metaphor' of 'wandering with the respondent', we conducted walk-along interviews with the citizens. Walk-along interviews have two advantages over immobile desk-based interviews [45], which make them particularly useful for gaining insight into the CA concepts and practices of marginalised groups [46].

Table 1
Relevant neighbourhood characteristics [40].

	Neighbourhood A	Neighbourhood B
Number of inhabitants	3235	1670
Average income in Euro (in 2022)	23.900	27.400
% social renting (in 2022)	45	44
% lower educated	34,7	15,5
%Energy label (D-G) (Jan 2023)	12	46,2

First, it helps to reduce the power imbalance between interviewer and interviewee, and second, it encourages spontaneous conversation [47]. The interviews were conducted in Dutch and were all audio-recorded using a clip-on microphone attached to the interviewee's jacket. The main part of the interview developed like a mutual dialogue as the questions were open, allowing the respondent to take the in both the conversation and in the walk. This approach also allowed respondents to share their emotions, which can play an important role in energy research [48]. As the respondents' 'doings and sayings' were the starting point of the research, it depended on the respondents' story whether policy instruments played a role in their narratives. Probing questions were used to steer the interviews towards a reflection on past and present experiences and how they foresee their own future. These probing questions were also used to double check at the end of the interview whether policy instruments, such as subsidies or information evenings, played a role if they had not come up during the interview.

Second, in parallel to the interviews with citizens, we conducted semi-structured interviews with policy makers and representatives from housing corporations to receive more background on the policy instruments. These semi-structured interviews focused on the implementation approach of municipalities and housing corporations regarding the energy transition, their approaches and difficulties. We conducted six semi-structured interviews with municipal policymakers (four in total, two per city), a representative from a housing corporation and a social worker. All respondents are involved in the implementation of the energy transition and work regularly with citizens in these two neighbourhoods.

Thirdly, we organised three co-creative events (one physical in each neighbourhood, and one online session) in November and December 2021 with a total of around 40 participants. The aim of these co-creative sessions was to discuss our findings with a larger group of householders to validate whether insights gained from the individual interviews about how capabilities are affected by regulations, policies, etc., were recognized by other citizens [49]. It also gave us the opportunity to ask additional questions, and to see how representatives from the municipalities and housing corporations, and citizens reacted to each other. During the physical sessions (a winter market in front of the community centre and a clean-up day with cake and coffee afterwards), familiar faces such as a social worker created a space of trust. We brought two posters with several questions to start the conversation. As the participants were in charge of the order in which questions were asked, more sensitive questions about vulnerabilities, failures and finances could be discussed safely. For the online co-creative session, we organised a 'Game of Goose' with the housing corporation. We redesigned the board with the map of the neighbourhood and created a list of questions that go with each of the tiles. These questions followed from the previous interviews.

Despite the advantages of (the combination of) these three methods, one should bear in mind that there are some disadvantages to these methods. In our case, an issue with all three methods is the risk of 'rosy portraits' ([50], p. 65), as respondents only talk about issues they feel comfortable with and avoid discussing things they feel uncomfortable with. All the researchers involved are experienced researchers and are aware of this, but, as with other methods, the risk of socially desirable answers remains. There is also a risk of only speaking to 'key figures' in the neighbourhood. While we were able to reach the more prominent and active citizens more easily, our different strategies also resulted in respondents who stated they would normally participate in research, such as socio-economically deprived households. However, the diversity of our research on citizens with a non-Dutch background is limited, with only one respondent.

The transcripts from all three methods were analysed applying an abductive coding approach. We followed Fereday and Muir-Chocrane [51] who outlined a detailed method of analysis using a process of thematic coding that involves a balance of deductive coding and inductive coding. We used our central concepts but remained open to

new insights that emerged. The level of detail of the personal experiences shared during the interviews allowed us to delve more deeply into the capabilities and conversion factors. To emphasise and contextualise the elements from the narratives, the results refer to text fragments (quotations) rather than codes. In the first round of analysis, we focused on filtering and selecting the parts of the interviews where respondents talked about their experiences of implementing energy-efficient measures. In the second round, all researchers independently read the selected segments and manually coded the interviews using the CA concepts (incl. means and conversion factors). This was followed by a discussion of the transcript and the respondent: did we have the same idea of what kind of person the respondent was? What were the differences and similarities in the interpretation? Which (additional) passages did we consider to be interesting and why? If necessary, additional coding was formulated and applied to the different transcripts.

4. Findings: social conversion factors' influence on citizens capabilities in the energy transition

The following section discusses the role of three types of policy instruments: communicative and consultative policy instruments, financial instruments, and regulations.

4.1. Communicative and consultative policy instruments

Municipalities and housing corporations are the two public actors most frequently mentioned by the respondents with regard to the Dutch energy transition. Municipalities coordinate the local energy transition in the built environment, in close cooperation with housing corporations, which own in Gelderland 26.8 % [52] of the rental property and that need to make investments to achieve energy-neutrality by 2050. Both actors use different policy instruments to support citizens in implementing energy-efficient measures. A frequently used instrument is to raise awareness and educate citizens about different options to implement such measures or to adapt their behaviour. They provide information in the form of flyers, websites, or organise information evenings where different measures (e.g., solar panels, insulation, heat pumps) or financing possibilities (e.g., subsidies, loans) are presented. These municipal events were attended by around 30 people out of a population of 2500. Diversity was limited, however, as the participants were mainly middle-income, highly educated Dutch people interested in the topic. The municipal policymakers seem to accept that "*the reality is that we cannot reach everyone*". During the co-creative sessions, citizens confirmed that they felt that the municipality was not there for them: "*we never see the people from the municipality or the housing association*". The municipality explains that this is due to limited resources: "*we just don't have the money*" (interview policymakers municipality, 2021). This may be seen as an indication of the municipalities limited capabilities to organise inclusive public engagement processes. It may also be seen as an example of street-level injustice [53]: as civil servants implementing policies have a high degree of discretionary power, the implementation of (public engagement) policies is influenced by prioritizations of civil servants, based on their prejudices and perceptions. This may ultimately lead to the exclusion of some groups, if officials refrain from appropriate engagement activities.

As a result, some citizens are unaware of their options in the energy transition. For example, not all citizens are aware of subsidies for energy efficiency measures, as many homeowners stated: "*I don't know of any subsidies*" and therefore cannot benefit from them. This lack of awareness was also evident during the co-creative sessions, where many people heard for the first time that the municipality was offering a €50 voucher to invest in small-scale energy efficiency technologies such as draught excluders, radiator foils and LED light bulbs. This suggests that the issue is not simply the availability of resources or money, but that municipalities and housing corporations do not always sufficiently provide the enabling context for citizens to obtain and use these resources. This is typically indicative of a suboptimal conversion process: although (limited) means are indeed available, citizens are contextually unable to convert them into the capability to be energy efficient, because they are simply unaware of their realistic options.

Looking at the communication provided, it is noticeable that the local authorities communicate in Dutch. The policy of the housing cooperation even states that information to their tenants should only be provided in Dutch: "*Because our tenants live in the Netherlands, we expect them to learn the language. The citizens who cannot do that (yet), can often ask for help from family members, neighbours and friends.*" (Interview housing corporation, 2021). However, in the city of neighbourhood A, 32.8 % of the citizens have a migration background and in the city of neighbourhood B, 26.5 %. These figures are in line with the Dutch average: around 26 % of the total population is considered to have a migration background [54]. Migrant citizens may be heavily dependent on the support of their family or friends for such language issues as social cultural conversion factors. The interview with the housing corporation shows that professionals are somewhat aware of the actual situation behind the front doors, but they put the responsibility on their tenants:

> "*If you come across a household where no one speaks Dutch at all* […] *then someone just has to ask that family to bring in an interpreter* […] *Isn't that a bit of a responsibility if you live in the Netherlands that you make sure you know the language for when you get important papers etc.*"

This raises the question of how far does professional responsibility goes. Depending on the answer to this question, this example may be seen as another example of street-level injustice [53], as it dismisses the professional responsibility to ensure access to information for every tenant, i.e. hampering institutional conversion factor. This hampering conversion factor means that it is now up to the tenants' individual conversion factor (i.e., language mastery) and social-cultural conversion (i.e., the idea that family helps each other) to get access to information. Obviously, this potentially introduces a consequent cluster of individual hindrances related to one internal conversion factor, in case language mastery.

Not all citizens have a sufficient command of Dutch to understand the content of the information provided. This includes citizens whose first language is not Dutch, but also Dutch citizens with low literacy levels. First, during the co-creative sessions, a man with close ties to the Moroccan community stresses that "*people don't know about these services* [*e.g., energy coach, subsidies*] *or don't understand them. These people don't speak the Dutch language and don't know about these possibilities*." He emphasises repeatedly that "*the language barrier is a big problem*" in communicating about these services. Second, the provided information is not accessible to people with low literacy levels. For example, when the municipality gave citizens a voucher to spend on energy measure in their houses, a respondent in the co-creative session stated:

> "*That* [*voucher*] *assumes that everyone can read the text, if you are talking about low literacy, then you can get that letter in your mailbox but it will just as quickly be thrown away with the old newspapers because you have no idea what it says.* […] *And* [*in the community centre*] *you see a lot of people who are dealing with low literacy.*"

In fact, 2.5 million people over the age of 16 in the Netherlands are illiterate [55]. Broers et al. [56] also highlighted the role of illiteracy as an internal conversion factor in reproducing energy vulnerability. Additionally, providing *written* information does not seem to be the most impactful way of communication for all citizens. A social worker explains: "*People don't really read it* [*leaflets and other material*] *when it arrives in their letterbox. They throw it away. It needs to be communicated in a different way*". Even digitally delivered information, such as a QR code, may not be suitable for everyone. A citizen active in Neighbourhood A shared:

"*There are a lot of older people here who don't understand how it works* [*with the QR code*]. [*They come to me and ask:*] '*But how does it work? I don't know all that.*' *That is often the problem.* […] *There are also a lot of people who don't have access to the internet, or don't understand all that*".

These findings underscore how hindering internal conversion factors related to communication can severely limit the expansion of energy efficiency capabilities, as it deprives (digitally) illiterate or non-Dutch-speaking citizens of opportunities that literate or Dutch-speaking citizens can actually benefit from.

To compensate for difficulties, citizens use formal and informal social networks, which vary in form and character. Formalised neighbourhood groups are subsidised by the municipality. In such groups, citizens get together to repair broken household items, play cards, organise events, etc. During these meetings, citizens regularly exchange positive and negative experiences on how to save energy. However, these groups have been criticised because they may not give an equal voice and opportunity to all citizens, but may favour assertive citizens, as one respondent explained: "*Yes, we have a platform in the neighbourhood. But the people there* […] *only cared about getting subsidies for their own personal interests and not for the interests of the neighbourhood.* […]." Hence, formalised, local networks may help to increase some citizens' capabilities but not others, which might contribute to an unequal development of capabilities (see also Brummel [57] on the unequal benefits of formal neighbourhood groups). Additionally, municipal funding for local neighbourhood groups has decreased in recent years, which hinders this social conversion factor and increases power imbalances between citizens because of the lack of a municipal mediator. According to a citizen: "*The municipality disbanded* [*subsidies for*] *a lot of neighbourhood groups this year and the year before.* […]. *We still have a group but it is not operational.*"

Citizens also use informal social networks. Social relations can act both as social capital, i.e., as a means of access to others that can provide concrete support, and as social conversion factors because they reinforce reciprocal processes in a local culture of social interaction and (neighbourly) support (see also [25]). As a citizen explained:

"*People know us and contact us for help and questions.* […] *We like to help them.* [*Last time, someone contacted us because she had*] *no one who can* [*install a draft strip*]. *A lot of single people* [*contact us*]. […] *I do not have enough time to help all my neighbours*."

Informal opportunities are organised by citizens themselves and not supported by the municipality. Social media is playing an increasing role for digitally literate citizens to partly overcome some of the communication difficulties. TikTok, for example, was suggested as a means of communication that relies less on written text and is already very popular in the Moroccan community. A citizen summarised the advantages as follows: "*information can be shared in different languages so that people who do not use paper also see the information.* […] *it is important to make sure that people can also recognise themselves* [*and their culture*] *in the videos.*" For energy saving and sustainable intervention, Facebooks groups are very popular to share experiences and ask for advice. A respondent in neighbourhood B started a Facebook Group for sharing experiences at a neighbourhood level:

We launched a Facebook group last week, and people are joining it now. We want to try to encourage people to insulate their homes, to install solar panels, to make their homes more sustainable. […] *the idea that you have a list of contractors and companies that do a good job. So that you can also refer people to trustworthy contractors*

- Homeowner, neighbourhood B

In short, although energy efficiency measures are indeed available resources, if communication about them is lacking, citizens may not be able to consciously consider them and consequently convert them into actual functionings. Nevertheless, social networks offer opportunities to compensate for the lack of access to information, but their accessibility and impact vary depending on the type of social network.

4.2. Financial policy instruments

To increase citizens' capabilities to implement energy-efficient measures, municipalities also provide financial instruments, but mainly for homeowners. During the research period, these included, for example, the National Heat Fund (*Nationaal Warmtefonds*), which provides loans to homeowners, the Home Energy Saving Subsidy (*Subsidie Energiebesparing Eigen Huis*), which provides subsidies for energy advice and insulation measures; or a VAT refund for homeowners who invest in solar panels. This is as a response to the prevailing narrative that implementing energy-efficiency measures is expensive.

In general, not many respondents made use of financial support, even though it was generally considered to be beneficial as one homeowner (neighbourhood B) shared his view: "*You can reclaim your VAT. Yes* [*we did it for the solar panels*]. […] *it's 20 %, so it's still a lot of money.*" This financial support is seen as beneficial:

"*If you live on a small budget, then investments have to pay for themselves within a year, the energy transition does not happen within a year* […]. *But that means you have to have a* [*financial*] *buffer, and so, the subsidies from the municipality, they help.*"

However, citizens benefit differently from financial instruments and several mechanisms stand out.

First, homeowners' access to municipal subsidies differs per municipality. This is because the municipalities apply for funds from the national government (e.g., Program: *Aardgasvrije wijken, or Volkshuisvestingsfonds*). Through tailor-made programmes, local governments receive money that they can transfer to their citizens in the form of subsidies. However, this leads to differences between municipalities themselves. In our study, it turned out that one of the two municipalities had a subsidy for homeowners, while the other did not. As it turns out municipalities have to go through an application procedure, which demands prior investments as a municipal policymaker explains:

We do not have unlimited resources, so national funding is crucial for us. […] [*However*], *the application is complicated. Too complicated* [*because of the requirements*] […] *Then we are not a priority area.* […] *Municipality X is a priority area, they have a higher probability of receiving money even before the actual application process has started.*

– Policymaker neighbourhood A, 2021

The capability of homeowners to implement energy-efficient measures is therefore spatially uneven due to the structure of the national funding programmes, which provide unequal opportunities for municipalities to access these funds. This shows how householders' capabilities depend on other actors' capabilities to create the necessary means for them (i.e., how successful their municipal policy makers are in applying for funding), and whose capabilities are in turn influenced by national policies that act as macro-level social-institutional conversion factors. This illustrates the complexity and interdependence of various actors' capabilities, which complements the findings of Griewald and Rauschmayer [58].

Second, another point concerning the financial instruments is that not every citizen meets the requirements for municipal subsidies or bank loans. For example, a tenant angrily explained how he was not eligible for a mortgage because he receives social welfare benefits: "*I was rejected because I receive social benefits, how is that possible? But then I think, how on earth is it possible to have a more stable income than my benefit?*." A similar problem arises for homeowners: for example, the National Heat Fund offers loans to homeowners, but they only qualify for the loan if they have a permanent work contract with an average salary and if they have no personal loans or child support of more than €250 per month (see also

[59]). Thus, the regulations and procedures of financial instruments enhance some homeowners' capabilities, but also exclude other homeowners who are less financially secure. It is often socio-economically deprived householders, who would need subsidies. For example, citizens who cheaply buy property with a low energy label, often struggle to invest in energy-efficient measures if they do not meet the requirements (Interview municipality, 2021). Although municipalities are not allowed to issue loans, some municipalities try to compensate for this shortcoming by setting up a fund to enable low-income households to apply for a low-interest, long-term loan (e.g., '*futureproof housing loans*'). However, this fund only extends the capabilities of homeowners in that particular municipality, thereby exacerbating existing geographical inequalities.

Third, during the co-creative sessions, another risk was raised in relation to timing. Homeowners can often only apply for the subsidy after they have completed the investments in energy-efficient measures. This means that there is a risk that homeowners might not receive the subsidy and will have to bear the costs themselves, e.g., because it turns out that they are not eligible for the subsidy after all, they have missed the deadline because the construction work took longer to complete, or the fund is already depleted. A lack of understanding of the subsidies, which may be considered a typical internal conversion factor, can cause problems in the long run. This might increase energy vulnerability in two ways: Either because citizens make the investments in anticipation of financial support from the subsidy, but do not receive it, and now face financial deficits because of the high investments. Or because citizens refrain from making investments in energy-efficient measures at all because they fear the risk and uncertainty (see the notion of capability security as elaborated in [60]).

Finally, at the level of the agent, citizens need to be able to understand the requirements and application procedures to take advantage of the subsidies. Homeowners need to have several internal conversion factors in place to apply for subsidies and use them in practice, such as knowledge, time, patience, and assertiveness to understand and manage the procedures. The lack of such internal conversion factors may be a reason why citizens do not apply for these subsidies. As already mentioned above, to access the €50 voucher (provided by the municipality for small-scale energy-efficiency investments) a QR-code had to be scanned. However, not everyone was able to do this. As a resident explained, "*I don't understand it and I have no internet.*" Citizens also complained that the voucher could only be spent in small, unknown web shops, rather than in the larger, well-known construction markets where they could physically go. Similarly, during the co-creative sessions, a homeowner who had made his house energy-neutral explained that he had not applied for any subsidies because he expected that it would be too complicated. On top of that, citizens may misunderstand the procedures and do not apply for subsidies because they assume that accepting subsidies will make them ineligible for social benefits. As a social worker explained, "*People are afraid because they assume they will get a reduction in their social benefits*". These examples illustrate how, although subsidies are available to increase the means, they are not used because of a subjective assessment or a pessimistic expectation that these are not being realistic opportunities. As this is a process in which citizens apply self-limitation, this acts as an internal conversion factor: they limit their own capabilities because they have doubts about whether the choices are realistic.

To compensate for these difficulties, citizens can use different approaches to save costs. For example, they may collaborate with neighbours when renovating their homes in order to save money, as this respondent from neighbourhood A illustrates: "[*The neighbour*] *came with a cheap offer* [*for solar panels*]. *If you have the money, you say* '*I'll join in*' [*and we'll share the transport costs*]. *That will bring benefits*". Citizens also share their experiences with contractors and recommend the most reliable ones, as we have already seen in the example of the Facebook Group for contractors in neighbourhood B. Another respondent explained:

> "*We chose a smaller company* [*to install solar panels*]. *They come right over with a technical guy, so you don't have to sign the offer before they come over, you know. So it's just a little bit more accessible* [*and safer*]."

Again, the social-cultural conversion factor of providing a trustworthy service is used to overcome difficulties.

Citizens also combine their social capital with internal conversion factors to negotiate for building materials from other construction sites in the neighbourhood, as a citizen explained:

> *The housing corporation was changing the windows* [*to improve insulation*]. *We had just bought a new house with rotten windows. As the whole row of houses had standard windows, we asked if we could get some of their old but still reasonable windows, as they were still better than ours.* […] *We asked one of the workers* '*How much will we have to pay for them?*' [*and they replied*] '*Well, cake.*' *Right, they come and sit here on a Friday afternoon and eat cake.*
>
> – Homeowner, neighbourhood A, 2020

Thus, our findings show that financial instruments may provide citizens with the necessary means to expand their energy efficiency capabilities, but that the actual availability or access to these means is highly dependent on contextual conversion factors, such as the municipality they live in or the contingencies with different types of financial measures or policies. Also internal conversion factors related to the uncertainty of some of these measures induce self-limiting mechanisms in citizens. However, citizens combine internal conversion factors and social capital to find alternative ways to save costs or to obtain these means at the community level to expand capabilities.

4.3. Regulations

Another category of institutional conversion factors is the role of regulations. For example, the capability of homeowners to implement energy-efficient measures is limited and made more costly by regulations for monumental buildings, i.e., buildings that are under special protection because of their historical or socio-cultural value:

> *This whole row* [*of houses*] *is monumental. That requires all kinds of extra safeguards to ensure that the monumental status of the property is preserved.* […] *which makes insulation measures even more expensive, because you have to make all kinds of provisions and choices to match. This makes the investments quite expensive for the occupant or owner.*
>
> - Homeowner, neighbourhood B, 2020

Apart from the extra construction costs, homeowners of monumental houses need to apply for costly permits:

> *If you want to install solar panels on your roof, you must apply for a permit, because you are making some changes to the house. If I apply for a permit to install solar panels on a monument like this, it will cost me 500 euros in administrative fees. You can almost buy one solar panel for 500 euros. So that's already one solar panel less given my budget.*
>
> - Homeowner, neighbourhood B, 2020

The municipality reacted to this situation by adapting the regulations to increase the homeowners' capabilities to implement energy-efficient measures, as the respondent further explains: "*Fortunately, an alderman realised that it is an impeding factor. She says:* "*In this case we exempt you from the obligation to pay legal costs, but you still have to apply for a permit.*""

This quote shows that conversion factors are dynamic over time and can negatively or positively affect citizens' capabilities. Even though homeowners no longer have to apply for a permit or pay an administrative fee anymore, homeowners of monumental buildings still face a number of restrictions: they have to apply for a permit for the solar panels, for example, because the solar panels should not be visible from the public road. This illustrates how regulations affect homeowners' capabilities in different ways.

Although these rules apply to everyone, some people may be able to compensate for them with beneficial internal conversion factors such as creative skills, legal expertise or financial competence, but not everyone will be able to do so. The following quote from an architect and homeowner illustrates how homeowners with specific knowledge and expertise can compensate for these restrictions:

> *Well, I have to do the insulation from the inside* (…) *I still have doubts about that, or pyrite, that's an oil-based product but the insulation value is so high that you have that environmental impact out pretty quickly. And because of that, you don't lose a lot of space in the room. Because if you did that with natural products, for example, then you would have to go for such a thick package, that it would make your living room a lot smaller. So that's always a compromise.*
>
> – Homeowner, neighbourhood B, 2020

Safety regulations would also increase the costs, but some citizens choose not to comply with these regulations, as illustrated by the following homeowners who renovated their kitchen and switched to induction cooking:

> *If you take all the safety measures, you have to replace the entire fuse box and get more power, because if we turn everything on at the same time the municipal plug will pop out. The probability of everything being on at the same time is zero, so yeah, when are you going to do that. But if you did, it would be very expensive.*
>
> – Homeowner, neighbourhood A

With respect to tenants, their capabilities to implement energy-efficient measures are strongly influenced by the procedures and regulations of the housing corporations, thus reflecting a strong influence of institutional conversion factors. One tenant explains how he lives in a poorly insulated flat and has to use blankets to compensate for the turned down heating. He tried to improve his situation by contacting the housing corporations, but they explained that they comply with the current energy label, i.e., national institutional conversion factor. The housing corporation had insulated the roof to achieve the energy label, but not the walls of the lower floors. This has financial consequences for the tenants in certain parts of the block: because he lives on the ground floor and only the roof has been insulated, he does not benefits from a lower energy bill and his rent keeps rising. He was unable to influence the housing corporations: "*He* [*representative housing corporation*] *gave me all kinds of excuses why they wouldn't improve the insulation of the wall.*" The housing cooperation fulfils its legal obligation, but the tenant might still be energy vulnerable and has few options to change his situation. A further example of tenants' limited capabilities to implement energy-efficient measures due to institutional conversion factors, is that they are not allowed to put solar panels on their roofs, even at their own expense, as the house is, of course, not their property.

The options available to tenants to compensate for these regulations appear to be quite limited, at least among the respondents. Some opted for choosing a frugal lifestyle to compensate for increasing energy-related costs, but some are quite desperate, as this tenants' quote illustrates:

> "*How can I reduce my energy consumption any further? I don't have a car, I separate everything, I try to watch my heating costs.* […] *I'm human too.* […] *What else can I do to be even more energy efficient?* […] *Now it's the housing association's turn.*"

In summary, regulations are institutional conversion factors that work out differently for different individual households. Thus, if they are no continuously evaluated for negative outcomes and acted upon accordingly by institutions and organisations, they are likely to act as conversion factors that have unequal effects in improving households' energy efficiency capabilities. Further, if the institutional actors applying these regulations do not use their discretion to apply the rules based on individual situations, they may reproduce energy vulnerability, as it will be these individual cases in particular situations that will keep falling off the wagon. This would require institutions to consciously approach regulations as targeted instruments (i.e. means and conversion factors) to achieve better energy efficiency in individual households.

5. Conclusion

This paper analysed how policy instruments, conceptualised as social conversion factors, affect individuals' capabilities to implement energy-efficient measures potentially increasing the risk of energy vulnerability. The Capability Approach (CA) helped to identify how and through what mechanisms citizens are unequally affected by policy instruments, in particular as factors that hinder the conversion of means into capabilities and, in turn, into functionings.

By showing how the design of energy-related policy instruments can exacerbate energy vulnerability, this paper contributes to research on the political economy of energy poverty, which analyses how structural factors can exacerbate energy vulnerability [26,29,30]. It also contributes to the literature on just, low-carbon transformations. While some scholars have disentangled complex interactions between sectors to understand the inequities of transformations, e.g. energy and transport poverty [30,61], energy and water poverty [62]; or analysed global unequal processes of resource extraction [63], this paper disentangles transformations at the local level, starting with the individual. The literature on energy citizenship argues that there is a shared responsibility between governmental authorities and citizens in achieving these transformations, with the former being responsible for creating the structural opportunities [66]. By analysing citizens' capabilities, our study shows that creating these opportunities through policy instruments can increase social inequalities. This is particularly the case when policies focus mainly on achieving the technical goal of energy neutrality, neglecting differentiated solutions (see also [64]).

We identified and empirically substantiated three subsequent mechanisms through which policy instruments may increase the risk of energy vulnerability by negatively affecting citizens' capabilities: 1) by *precluding* citizens from relevant information about the energy transition; 2) by *raising the thresholds* for citizens to implement energy-efficient measures; and 3) by *miscalculating* policy consequences, i.e., citizens' poor anticipation of long-term policy implications, aggravated by legal and financial uncertainty, or changing individual circumstances. All three steps need to be overcome to avoid energy vulnerability. These mechanisms can cumulate, interact, or operate in isolation: citizens who are not precluded may still face raised thresholds that prevent them from implementing energy-efficient measures, and citizens who have managed to avoid the first two mechanisms, might still miscalculate policy consequences leading to increased energy vulnerability in the future. A simplified overview of the link between policy instruments and mechanisms is given in Table 2.

First, citizens with a lower mastery of the Dutch language (e.g., migrants or people with low literacy levels), i.e., internal conversion factors, are at risk of being *precluded* from the energy transition, as the authorities seem to provide information mainly in Dutch. This means that these citizens do not have access to the appropriate technical, financial and legal information, because they do not understand the information material provided and therefore cannot start to think about it or put it into practice. Subsequently, they are unable to take advantage of opportunities to implement energy-efficient measures, leaving them exposed to rising energy prices and potential energy vulnerability. This mechanism works to reduce the autonomy-aspect of agency [33]: because some residents effectively do not have sufficient and understandable information about the objectively available opportunities, it is made difficult for them to weigh these options and determine their preference. This leads to increasing inequality, as other residents may have sufficient and understandable information allowing them to exercise their autonomy.

Table 2
Summary on how policy instruments affect citizens capabilities through three mechanisms.

Mechanisms policy instruments	Precluding	Raising threshold	Miscalculating consequences
Communicative	Citizens with limited Dutch language skills (internal conversion factor) may not be able to access information on energy-efficiency options; or the availability of subsidies/ financial support	Decreasing options for informal information sources (formalised neighbourhood networks)	Unclear or incomplete information may lead to faulty interpretations and expectations by citizens
Financial	Citizens may face difficulties understanding the requirements and application procedures of financial instruments, which may discourage them from applying.	Citizens who do not fulfil pre-requirements of loans or subsidies (e.g., certain minimum income, no debts) are not eligible for financial instruments; Citizens living in a municipality that is not eligible for a national funding scheme do not have access to certain financial instruments and face higher costs	Citizens who may have made financial investments in energy-efficient measures might find themselves in debt due to changes in: eligibility criteria for subsidies, availability of financial instruments or personal circumstances (e.g., loss of job, sickness)
Regulatory	Citizens may face difficulties in understanding regulations (e.g., buildings codes and restrictions), which may discourage them from taking action	Homeowners may face increased costs due to building regulations requiring additional technical measures (e.g., monumental buildings); Regulations (e.g., procedures housing corporations) may deny tenants the right to implement certain energy-efficient measures	Unexpected and unintended cumulative effects of policies and intersection of exclusionary regulations may aggravate inequalities

Second, even if citizens have access to information and are able to reflect on their options in the energy transition, institutional conversion factors sometimes raise the threshold for implementing energy-efficient measures by making them more difficult and costly, or even impossible. The examples of tenants illustrated their lack of influence on how housing corporations implement energy-efficient measures leaving them with sub-optimal solutions (e.g., not being able to install solar panels). Another example is the possibility to get financial support such as subsidies and loans to implement energy-efficient measures, which seems to exclude certain householders if they do not meet the pre-requirements. It seems that particularly householders that are already socio-economically disadvantaged are not eligible for certain subsidies. This is in line with findings of another study, which found that 80 % of the €750 million that the government paid out to householders under climate policy in 2017 went to richer householders and only 20 % to economically deprived householders [65]. In other words, the current institutional conversion factors seem to aggravate disadvantages stemming from economic structures, such as welfare policies or the financial sector.

This second mechanism effectively limits the freedom aspect of agency for some households in the sense that it prevents or reduces their opportunities to act on their preferences (see [33]). Thus, they either may or may not be able to adequately weigh up their options, but once they have chosen an option (e.g. to apply for a subsidy), they may not qualify for it, if they do not meet the legal requirements. However, these thresholds do not affect all households in the same way. As these thresholds are related to either available resources or conversion factors, they can exploit actual pre-existing differences in such resources or conversion factors between different individuals. This could lead to increased inequality in the population as a result of the implementation of energy measures.

Third, if citizens are able to invest in energy-efficient measures by taking advantage of subsidies or loans, i.e., if they are not affected by the first two mechanisms, there may be a third mechanism, the miscalculation of policy consequences, which may lead to a problematic situation. For example, homeowners who may have invested in energy-efficient measures and expected to receive a subsidy may face financial problems if they are no longer considered eligible for the subsidy due to changing circumstances. Changes in the homeowners' personal circumstances (accident, loss of job, health issues) could make it difficult for them to repay the loans they used to invest in energy-efficient measures. In some (worst) cases, they may be forced to sell their property with a debt, which could jeopardise citizens' retirement plans. Regulations and procedures do not seem to anticipate such personal changes, and tend to focus only on the topical issue at hand. If civil servants, housing corporation employees or social workers are not alert to such undesired effects, or are unable to act to mitigate their consequences or to support citizens in doing so, the unintended negative consequences of the regulations as a whole may ultimately outweigh the intended specific and beneficial ones.

Thus, while these householders may not be at risk of becoming energy vulnerable in the present, the complex dynamics of the institutional conversion factors may push them in that direction in the future. In other words, they may have the capability to implement energy-efficient measures in the present, but these might change over time, due to possible future changes in policy and in internal conversion factors. The inability to anticipate and prepare for these changes might increase the risk of energy vulnerability.

Apart from these mechanisms that potentially exacerbate energy vulnerability, our research also provided some indications on how citizens attempt to circumvent these mechanisms. We found that internal conversion factors (e.g., skills, assertiveness) and networks, conceptualised as social capital, in combination with supportive social cultural conversion factors (e.g., a culture of helping and supporting each other) can play an important role. These conversion factors are dynamic and influenced, in turn, by institutional conversion factors (e.g., the dissolution of neighbourhood groups). At the same time, new technologies (e.g., social media) can offer alternatives to strengthen these conversion factors. However, different citizens will have different opportunities to benefit from these developments (e.g., digitally illiterate citizens may benefit less from social media).

This research disentangles the interaction and interdependence of institutional conversion factors, illustrating the complexity of energy vulnerability. Our research provides in-depth empirical insight into the findings of other studies [5], which argue that current policies and regulations are not evenly enabling householders that are energy vulnerable and may even aggravate energy vulnerability in the future. This research illustrates how institutional arrangements unequally affect capabilities expansion, and hence may increase the risk of energy vulnerability for some citizens. Further research could focus on disentangling the workings of a particular mechanisms in more detail, or on the role of one issue (e.g., language), and then pay much more attention to how to these mechanisms are circumvented. As the risk of energy

vulnerability has been increased with the Russia-Ukraine conflict, new empirical research could analyse this new situation.

Declaration of competing interest

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

Data availability

Data will be made available on request.

Acknowledgement

The authors would like to thank the respondents of this research for their contribution and the anononymous reviewers for their constructive feedback.

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