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Original research article

Who is vulnerable in regional energy transitions? An intersectional energy justice analysis of the Rotterdam-the Hague region

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ABSTRACT

A just energy transition requires not only the achievement of low-carbon goals but also the creation of fairer energy systems where special attention is given to identifying vulnerable groups and addressing the inequalities they experience. Governing energy transitions at the regional level may help formulate and implement tailored policies addressing vulnerabilities at the local level. However, there is limited understanding of the vulnerabilities that citizen groups experience in energy regions. We formulated three objectives to address this gap: I) identifying energy vulnerabilities in a regional transition context; II) understanding what citizen groups experience them and why; and III) identifying barriers that prevent policies from engaging with these groups. We applied a case-study research design to the Rotterdam-The Hague energy region in the Netherlands. Data collection involved semi-structured expert and stakeholder interviews and a review of newspaper articles and policy reports. We processed data with a thematic analysis drawing from energy justice literature and intersectionality theory. Three main energy vulnerabilities were identified: unaffordability of energy consumption, the lack of opportunity to own self-generation technology, and little to no inclusion in decision-making processes. The findings reveal five groups prone to vulnerability and the conditions that put them in a vulnerable situation, such as living in an energy-inefficient house. We conclude that regional energy transition policies should consider intersections of society while offering more support to municipalities to enable them to engage citizen groups at higher risk of energy vulnerability.

1. Introduction: Just transitions and vulnerable citizens

The transition towards low-carbon energy is embedded in an unequal socio-economic system [1]. The disproportionate accumulation of wealth and the barriers to a better quality of life that some groups face are common inequalities that also play a role in low-carbon transitions. If ignored, those inequalities could be reproduced and strengthened during and after a low-carbon transition. Therefore, energy transition agendas often seek to achieve low-carbon goals and fairer energy systems [2,3]. These types of transitions are referred to as *just transitions* [4].

Just transitions follow the principle of “leaving no one behind” [5]. This principle states that all society groups should be part of energy transitions and that special attention should be given to disadvantaged or impacted groups. Citizen participation can be considered as a means to pursue this principle and a legal right in the EU [6]. Citizens can participate in the energy transition in different ways, for example, by consuming low-carbon energy, adopting low-carbon technologies, or

partaking in decision-making. However, citizen participation has primarily been limited to a few sections of society, further reinforcing underrepresentation [7]. This calls for a need to achieve more equitable citizen participation, in which disadvantaged groups also have the right to gain access to participate actively and reap the benefits of participatory action. A distinction between citizen groups is necessary for equitable participation. However, just transition studies and policies tend to generalize citizens as one big homogenous group, overlooking the characteristics of different vulnerable groups.

One reason for such generalization is the scope of just transition frameworks. The widely applied energy justice tenet framework focuses on the fairness of energy transitions’ process, outcomes, social involvement, and past impacts [4,8,9]. Although this framework recognizes the need to discern between citizen groups, it does not help identify, describe, or understand them. To cope with this, energy justice researchers have started engaging with intersectionality theory [10,11]. This theory explains that social marginalization mainly exists when combinations of group characteristics related to marginalization are at

Abbreviations: RDH-RES, Rotterdam-The Hague energy region.

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play, such as ethnicity, class, geography, age, and gender [12,13].

Despite policies implemented to mitigate vulnerabilities, certain groups are often overlooked and, therefore, cannot sufficiently benefit from just energy transition programs or approaches. One of the reasons why just transition policies overlook vulnerable citizen groups is that they are typically defined at the national level. Policies aiming for just transitions have a high potential to be efficient in local or subnational settings [8], like in coal regions [14] or other industrial sector transitions, and therefore require tailoring to regional/local conditions [15]. For this reason, from a governance perspective - energy transition agendas can benefit from being formulated at the regional level [16,17]. Regional energy transitions refer to a sub-national energy transition strategy that typically includes more than one municipality but has a smaller scope than a province or country [18]. Since a region is situated between the national (or even provincial) and local level, it can potentially help implement national government policies while considering regional contexts, which is particularly important when discussing inter and intra-group citizen differences.

No studies have been yet conducted on regional energy transitions combining intersectional and energy justice perspectives. Therefore, this study aims to: I) identify energy vulnerabilities in a regional transition context; II) understand what citizen groups experience them and why, and; III) identify barriers that prevent policies from engaging with these groups in regional transitions.

This paper contains six sections. Section 2 presents three key theoretical concepts to this study: Energy regions, energy justice, and intersectionality. Section 3 outlines the research approach and methods, addressing how we conducted a case study in the Dutch Rotterdam - The Hague energy region (RDH-RES). Section 4 presents the results, which cover six vulnerable citizen groups, the conditions that put them at higher risk, and a reflection of how stakeholders perceive policies promoting mitigation of vulnerabilities related to energy transitions, including citizen participation. Section 5 discusses the study's results and compares them against ongoing academic debates regarding regional energy transition literature. It also provides recommendations for practitioners and policymakers in energy regions seeking to operationalize just transitions. The paper ends with conclusions and recommendations for future research in Section 6.

2. Research framework: Intersectional energy justice in regional energy governance

In this study, we use and combine theoretical concepts and frameworks to understand the phenomenon of vulnerability in regional energy transitions. They cover: I) Energy regions as a governance concept [18–22]; II) the energy justice tenet framework [9,23,24], which can help identify types of vulnerabilities; and III) intersectionality applied to energy transitions to disentangle intergroup characteristics [11,25–28].

2.1. Energy regions

An *energy region* refers to a subnational territory with institutions, structures, and policies that steer or govern a transition [22]. Energy regions provide a platform to innovate modes of governance because part of their core strategy is to pursue research and development with partners in the public and private sectors. Furthermore, these regions can also be seen as promising decentralized governance approaches to coordinate energy transition efforts between the local and national levels [18,22]. The regional level is particularly relevant regarding just transitions, as regional low-carbon transition policies have been widely implemented in Europe and other Global North contexts [15]. In the EU, regional policy programs like the Just Transition Mechanism have been enacted for coal mining and other carbon-intensive regions [5]. These regional policies are meant to help these regions overcome the challenges of transitioning away from polluting industries, for example, by providing €11.5 billion in loans to mitigate the negative socio-economic

impacts [29]. In these regions, a governance approach can be used to minimize negative impacts and decide on regional development plans [21,30].

2.2. Energy justice and vulnerability

Just transitions have been widely studied using energy justice conceptual frameworks. The most applied framework is based on three key tenets: recognition, distribution, and procedure justice [8,9]. Recognition justice focuses on identifying groups in society that are affected by energy transitions and are underrepresented in energy transition decision-making spaces. This tenet aims to find ways to avoid or correct negative impacts (e.g., energy poverty or households struggling to afford their energy bill) and the lack of representation (e.g., of minority groups). Distribution justice refers to an equitable allocation of benefits and costs of the transition. Procedure justice aims for a decision-making process that includes diverse voices of society [9]. Other energy justice tenets like epistemic, restorative, and cosmopolitan justice have been further developed and applied [31–33].

Vulnerability is a concept used in social policy to study the drivers and experiences of disadvantage and marginalization [34]. In the context of energy transitions, energy vulnerability can be understood as the quality of the state of citizens being prone to experience energy injustices during a low-carbon transition. This concept enables the understanding of what conditions of the sociotechnical energy system [35,36] put citizens and households at higher risk of experiencing energy injustices. Energy vulnerability originates from fuel poverty studies [34,37], where vulnerable households have been identified as householders at an older age, with children, and disabled [34,38]. Other vulnerable groups described by energy justice studies include rural populations, women [7,39], Indigenous communities [40], communities close to project sites, ethnic minorities, foreign-born residents, and poor communities [41]. Several studies report a lack of tools to identify vulnerable groups and understand their differences as barriers to addressing vulnerability [7,10,34,42,43].

Drivers for energy vulnerability have been discussed. Energy vulnerability has expanded to identify drivers of energy injustices like energy poverty and lacking access to low-carbon technologies like solar panels, electric vehicles, and low-carbon heating [44–46], as well as to understand the acceptance of energy systems flexibility [42]. In the case of the Netherlands, energy vulnerability has been applied to understand households' (un)affordability of energy services and limited access to low-carbon measures [45]. Vulnerability can be driven by income level, energy prices [7], and household efficiency [34].

2.3. Intersectionality

Intersectionality theory helps understand what traits make some groups marginalized or privileged [12,47]. Al-Faham et al. (2019) have stated that oppression is created by the combination of intersectional and interlocking (macro) processes [12]. The intersectionality lens helps differentiate between and within groups and can indicate a course of action for more inclusive policies. “Black feminists” in the US used intersectionality to address how *intersections* in combination with *identity attributes* like gender and race reinforce marginalization [13,48]. Such identity attributes can be categorized, but not for quantifying groups like in surveys, but rather to identify what intersections create marginalization. This is also mentioned by Crenshaw, who argued, “Because the intersectional experience is greater than the sum of racism and sexism, any analysis that does not take intersectionality into account cannot sufficiently address the particular manner in which Black women are subordinated” [12, p. 140]. She then argued that white feminism does not cover the concerns “Black feminist” feminists have, which can be perceived as struggles faced by, for example, Global South working women.

Similarly, just energy transition policies and strategies tend to

overlook vulnerabilities that some citizen groups experience. Generally, studies on just transitions [49], energy justice [4,8], and energy poverty [50,51] refer to vulnerable and underrepresented groups and describe them in terms of their interactions with energy needs and services (e.g., low energy affordability). However, these studies fail to provide tools to identify diverse, vulnerable groups, as they have overlooked the connection between energy vulnerabilities and citizen identity attributes. A few energy justice studies have recently considered intersectionality to identify and better understand vulnerable groups' experiences [10,11,34,41,52]. A review of intersectionality and energy transitions shows how gender and equity are studied empirically in energy transitions' contexts, revealing that an intersectional lens is needed to understand how socio-cultural and economic energy systems allow the reinforcement of marginalization of certain societal groups [11]. Another review study focused on the connection between energy affordability and gender equality, revealing that contextual factors are crucial in shaping the energy-gender relationship [53].

3. Methods

We adopted a case-study research design to meet the research objective. The selected case study is the Dutch Rotterdam-The Hague energy region (RES-RDH). The research followed five steps: 1) Understanding the governance structure of the selected energy region; 2) identifying energy vulnerabilities that limit the engagement of citizen groups in the context of energy transitions; 3) identifying citizen groups that experience such vulnerabilities; 4) identifying barriers that prevent energy transition policies from achieving equitable citizen participation in the energy transition; and 5) proposing policy interventions for stakeholders to tackle vulnerabilities more effectively.

3.1. Case selection and background: The Rotterdam-the Hague energy region

The Netherlands is a pioneer in regionalizing energy transitions since the national government divided decision-making into thirty energy regions [18]. This study focuses on one of those regions, the RDH-RES, due to its relevance in the country's goal to achieve a 35 TWh generation of wind and large-scale solar parks by 2030 [18,54,55]. This region hosts twenty-one municipalities, four water boards, and the province of South Holland. It hosts a global port, two large cities, extensive greenhouse horticulture, and a densely populated residential area (RES-RDH, 2019). In 2021, RES-RDH adopted a regional energy transition strategy, RES 1.0. In doing so, the regional network of stakeholders committed themselves to generating 2.3 TWh of renewable electricity by 2030, of which the majority will be generated from solar panels installed on home rooftops.

The RES-RDH case was selected for several reasons. First, the case presents a dedicated energy region with a governance structure and regional energy transition strategy. Second, the region encapsulates a broad spectrum of urban, industrialized, suburban, and rural areas, a dense population, and is of socio-economic and political importance to the country. Third, it is the most energy-intensive region in the Netherlands. Finally, the existing literature on citizen engagement in regional energy transitions appears to overlook regions demonstrating high socio-economic and demographic diversity, such as those within RES-RDH-RES. For example, Bouma et al. (2023) and Lelieveldt & Schram (2023) analyzed smaller, sparsely populated energy regions, mainly in predominantly rural parts of the country [56,57].

In 2021, more than 600,000 people in the Netherlands were experiencing energy poverty [58]. These low-income households have difficulty covering energy expenses, which leads to inadequate housing quality and limits their ability to invest in sustainable home improvements [58]. This group is highly prevalent in the RES-RDH region compared to other country areas.

3.2. Data collection: Interviews, newspaper articles, and grey literature

Twenty semi-structured expert interviews were conducted from April to June 2023. These interviews covered a total of sixteen stakeholders from the public and semi-public sectors and four with stakeholders from civil society. In addition, three civil servants provided information via e-mail in the form of a questionnaire, which served as input to develop the interview protocols. This set of interviews provided a wide variety of stakeholders representing eleven organizations. Each interview lasted over an hour and was recorded using a phone for in-person interviews or MS Teams for online interviews. The participants used and approved a consent form, and their personal data were anonymized.

Stakeholders were initially identified using a purposive sampling method and later complemented with a snowball approach. Various stakeholder groups represented decision-makers in the RES-RDH, including municipalities, the province, and others. Another set of stakeholders represented citizens struggling with energy injustices. These stakeholders work in several different district councils of the cities of Rotterdam and The Hague, as well as in social welfare organizations ('welzijnsorganisatie' in Dutch; translation by the authors) like 'Dock' and 'Schuldhelp maatjes' where expert volunteers help citizens find solutions to financial-related or other problems [59,60]. We employed social media platforms like LinkedIn to reach the participants. A list of the stakeholder roles covered by the study is presented in Table 1. We prepared an interview protocol for decision-makers and another for citizen representatives, both in Dutch (see Appendix B).

The second source of data concerned newspaper articles that covered topics related to social injustices in energy transitions. Articles showing a (negative) public opinion on the energy transition were used as a proxy to identify social injustices. It should be noted that newspapers often act as an intermediary for the opinions of politicians, organizations, and citizens on climate topics [62]. A total of 36 newspaper articles published from January 2017 to May 2023 were selected for the media analysis. The newspapers comprised: "Algemeen Dagblad" and "Google News", a local and a pool of Dutch national newspapers, respectively, because of their high reach among the population. The keywords combined and used for the newspaper article selection were (translated from Dutch) "Energy transition", "energy poverty", "citizen participation", "participation", "energy inequality", "protest", "The Hague", "wind energy", "wind turbines", and "conflict". Other newspaper articles were

Table 1
List of stakeholders' roles that were interviewed.

Stakeholder role	No. of participants
Alderman ¹ Middle-large municipality	1
Consultant Province of South-Holland	1
Civil Servant Middle-large municipality	1
Civil Servant Province of South-Holland	1
Civil Servant Middle-large municipality	1
Civil Servant Middle-large municipality	1
Consultant NP RES	2
Civil Servant Large Municipality	1
Civil Servant Waterboard	1
Director Energy Cooperation	1
Alderman Middle-large municipality	1
Civil Servant Middle-large municipality	1
Alderman Middle-large municipality	1
Alderman Large Municipality	1
Civil Servant Middle-large municipality	1
Alderman Middle-large municipality	1
Employee Welfare organization	1
Alderman Middle-large municipality	1
Director Energy Cooperation	1
Total number of interviewees	20

¹ Aldermen, or *wethouders* in Dutch, refer to board members of the executive council of municipalities in charge of implementing policies on a particular topic [61].

added to the list following a snowball approach. Only articles that were written in the RES-RDH region or neighboring regions like ‘Drechtsteden’ were selected based on their relevance to this study. Additionally, grey literature, such as policy briefs and reports (e.g., RES strategy reports), was reviewed to formulate the interview protocol and connect with ongoing policy debates in the Netherlands.

3.3. Data analysis: Qualitative thematic analysis of interviews and newspaper articles

A thematic analysis of the twenty interview transcripts and thirty-six newspaper articles was conducted using a licensed version of Atlas.ti, a qualitative data analysis software [63]. Two researchers (i.e., the second and third authors of this paper) conducted two qualitative thematic analyses in parallel for the sake of robustness. One analyst started with closed themes defined by the energy justice framework, and the other with open themes defined by the data. The energy justice framework was operationalized based on the three main tenets (i.e., distribution, procedure, and recognition justice) which are introduced in Section 2.2 [9] to identify energy vulnerabilities. Each tenet was used as a theme, helping to focus the search for energy vulnerabilities: Distribution justice helped identify access to clean energy and energy affordability, procedure justice led to identifying access to decision-making spaces, and recognitional justice was later linked with intersectionality to identify and distinguish diverse, vulnerable groups. The researchers converged in their coding trees to identify energy vulnerability types. We performed a second thematic analysis of the converged coding tree by focusing on intersectionality. The coding trees are presented in Appendix A.

4. Results

A qualitative thematic analysis focused on the justice tenet framework (i.e., procedural, distributional, and recognitional justice) was applied to the stakeholder interviews and newspaper articles. This analysis helped to identify three main energy vulnerabilities. These are lack of: 1) Affordability of energy consumption, 2) the opportunity to (co-)own self-generation technologies, and 3) inclusion in decision-making processes. Although the first and second vulnerability types are related to energy accessibility, a fundamental Millennium Goal [64], these are presented separately in this analysis because they cover different types of citizen participation. Affordability of energy consumption represents a consumer role, ownership of self-generation technologies relates to a prosumer role, and inclusion in decision-making to a more deliberative form of participation [65]. We combined the tenet-based energy justice framework [9] with intersectionality theory [11,12] to understand better the groups that experience injustices. The justice framework allowed for the identification of the mentioned vulnerabilities, which are related to the distribution (affordability of energy consumption, opportunity to own self-generation technology), procedure (inclusion in decision-making processes), and recognition (three of them) tenets. However, the justice tenets cannot fully describe these energy vulnerabilities because the justice framework does not distinguish between citizen groups. Therefore, this framework was combined with intersectionality to identify different citizen groups and understand what conditions put them at higher risk of energy vulnerability.

4.1. Understanding citizen energy vulnerability

By applying intersectionality to recognition justice, we identified several energy-vulnerable groups. We considered the intersections of the RDH region’s society to identify the citizen groups prone to experiencing energy vulnerability. Based on the analysis of the newspaper articles and stakeholder interviews, we discerned five groups prone to being vulnerable: Single parents, unemployed people, elderly people,

students, and immigrants. Yet, not all of these socio-demographic groups experience energy vulnerability. When these groups present one or more vulnerability conditions, they become vulnerable to experiencing energy injustices. Such conditions for energy vulnerability include: Socio-economic aspects like income level, a household’s insulation quality, (not) having property rights; social aspects like language, time spent at home, and; others like level of interest in, knowledge of, and awareness about energy policies, and time availability. Fig. 1 shows that those citizen groups prone to vulnerability with one or more vulnerability conditions are likely to experience energy vulnerability.

4.1.1. Lacking affordability of energy consumption

Energy affordability, as a type of distributional justice, emerged as the most frequently mentioned topic in the analyzed newspaper articles and stakeholder interviews. It refers to a household’s ability to pay electricity and heating energy bills [66], perceiving households as energy consumers. Traditionally, this phenomenon has been measured in Europe as the percentage of households spending equally or more than 10 % of their income. In the RES-RDH region, an energy poverty study conducted in 2021 revealed that 9 % of households spend more than 8 % of their income on energy bills [58,66]. Big cities like Rotterdam and The Hague feature high levels of energy unaffordability among households. It was widely discussed during the interviews that low household income levels can lead to a higher risk of experiencing energy unaffordability.

As presented in Fig. 2, the lack of affordability of energy consumption was found to be related to six vulnerability conditions, such as low household energy efficiency performance. In Dutch studies, the income level and the dwelling’s energy label are considered to measure energy poverty [57]. These labels, ranking from A++++ (most energy efficient) to G (least energy efficient), consider the house’s thermal insulation, type of heating, type of water supply, ventilation system, and whether renewable energy technologies are installed [67]. Six percent of Dutch households are low-income and reside in low-degree energy-efficient dwellings labeled E, F, and G [68–70]. In the South Holland province, where the RES-RDH region is located, this figure is even higher, namely 8 %, which accounts for 133,054 households [57]. Interviewees provided insights into what groups in society experience energy unaffordability.

“Yes, social housing is quite old, and people who receive governmental support are often at home, or elderly people are retired. Yes, people who are not working, often also large families with many children in small homes [...] so all of that together does cause many people to have problems paying the energy consumption bills.” (Coach and family support worker at a welfare organization, 2023).

“They [people experiencing energy unaffordability] are most often not sufficiently educated or do not have the time to educate themselves in making

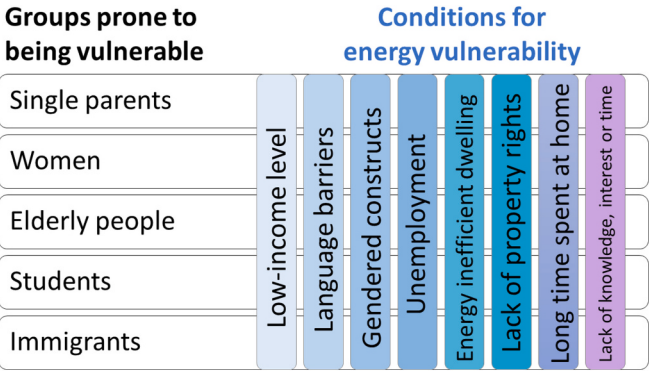


Fig. 1. Overview of intersectional energy vulnerability in the RDH-RES region. The combination of groups prone to being vulnerable (horizontal) and conditions for energy vulnerability (vertical) puts these groups at higher risk of experiencing energy vulnerability.

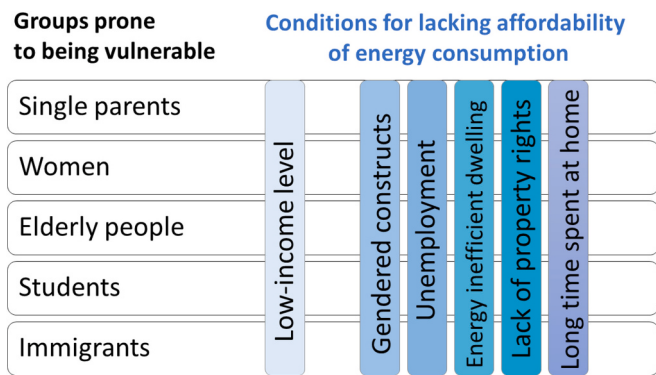


Fig. 2. Intersectionality lens applied to the lack of affordability of energy consumption. The intersection of groups prone to being vulnerable (horizontal) and one or more conditions for energy vulnerability (vertical) puts these groups at higher risk of lacking energy affordability.

[well-informed] energy decisions.” (RES-RDH decision maker, 2023).

Poor household energy efficiency performance is related to high energy consumption and hinders the fulfillment of the household’s energy services. These households can face challenges in meeting their daily expenses due to high energy costs [68,71,72]. To alleviate the financial burden, energy-inefficient dwellings can make people adopt energy-saving behaviors like switching off central heating, reducing warm showers, and limiting cooking [68,70,73–75]. Furthermore, those living in housing with poor energy efficiency performance have a high likelihood of experiencing a moist living environment, which causes fungal growth and, ultimately, health issues [73]. A quote from an interview illustrates this. According to Voermans (2023), cold and damp living conditions lead to hospital admissions, particularly for individuals under the age of eighteen with asthma-like symptoms, and in combination with financial concerns, this can cause mental health problems [75,76].

“In Winter, people do not ventilate, even less now because they are all afraid of, yes, that’s even more energy. [...] if people do not ventilate at all, it becomes very damp, and then you cannot apparently heat as good because then the air is too humid, and these are all things that people really don’t know. People think, yes, but I’m going to open, I’m just going to get cold in the house, when sometimes it’s actually good to air, especially If you have an old house without mechanical ventilation. So, I think a combo of lower prices and more economical homes and also a piece of education.” (Coach and family support worker at a welfare organization, 2023).

Spending a long time at home and living in a household with a low level of energy efficiency is a combination that can lead to energy unaffordability. Citizens who tend to spend a longer time at home are women because of the gendered construct of women being the house and family caregivers [77,78] and older adults and full-time parents. If these groups have a low disposable income and live in homes with low energy efficiency performance, they have a higher risk of experiencing energy unaffordability.

Not having property rights is another condition that puts households at higher risk of energy unaffordability. As tenants of private houses, residents do not have the power to decide whether to upgrade the house’s energy efficiency. Only private landlords, the property owners, can decide to make changes to the property. This leads to landlords withholding investments in energy performance improvements because of the so-called ‘split incentive’, which refers to tenants wanting to minimize housing costs. At the same time, homeowners aim for profit [79]. The private rental sector in the Netherlands has no obligation to improve housing energy efficiency even though the country seeks only A-D energy-labeled houses by 2030 [80]. This situation may change with the government’s measures for the built environment published in November–December 2023 [81]. Yet, these policy measures target homeowners and homeowner associations, leaving tenants without legal

resources to act. The quote from a civil servant below illustrates how lacking property rights can put citizen groups under energy vulnerability.

“We know that energy poverty is (found), particularly in those neighborhoods where there is a lot of ownership with (social) housing associations” Municipality Civil Servant, 2023).

Based on the stakeholder perceptions from the interviews, the available policy instruments to tackle energy unaffordability and energy poverty thus far fail to positively address mitigating vulnerabilities of some energy-vulnerable groups like low-income and non-Dutch speakers. The first policy discussed is personalized advice to households via energy coaches and fixers. This intervention involves professionals visiting underprivileged neighborhoods to advise households on energy-efficient behavior and energy-saving equipment like LED lights and sealing strips. These professionals can help residents understand their energy bills and acquire subsidies. However, the reach of this approach so far is limited due to a lack of human capacity required by municipalities.

Another policy addressed concerns energy allowance and loans. Energy allowances are one-time financial aid for low-income families to help them afford their energy bills. However, interviewees representing municipalities mentioned that some families (mis-)used the aid for non-energy-related purposes. Low-interest loans are other measures to help citizens invest in insulation and sustainable energy self-generation. However, low-income families do not qualify for these loans because they are considered untrustworthy. Despite the low-interest rates, some families still hesitate to access these loans because of a lack of trust, as shown in the following quote.

“Well, some distrust also gets back about the (nation-wide)’ childcare allowance affair’ (which caused widespread distrust in government in 2022 regarding national government maltreating citizens) and such that people are like. Yeah, yeah, free, but then I’ll definitely have to pay it back” (Civil servant in the RDH-RES, 2023).

As described by the quote below, the groups suffering from the unaffordability of energy.

are diverse and cannot be clustered into one homogenous group. Rather, they can be described based on the intersection of group characteristics and vulnerability conditions that create energy unaffordability. For example, some group characteristics are associated with spending long times at home, like being women or older adults. Other characteristics related to low income are being single parents or students. When these groups also experience conditions that limit their ability to live in an energy-efficient household (e.g., the dwelling’s poor energy level, low income, not having property rights or unemployment), the likelihood increases that they face energy unaffordability. Moreover, not being able to speak Dutch is an additional reason, as Dutch is the official language used with regard to how policy instrument implementation is communicated to target groups in society. This, for example, proves difficult for non-Dutch speakers who wish to apply for a subsidy or measure that comes with a tax deduction.

“So It is very complex. It is not just a group of people where you can point to it like, well, we have to do something with that. No, It is much bigger, and there are also people who live in a very large house and own it who can just about live there, [for] whatever the reason, but who do not have the money to make it more sustainable while they have a fantastic house. For some people, it’s just not feasible, so it is very diverse”. (Civil Servant Middle-large municipality, 2023).

4.1.2. Lacking the opportunity to (co-)own self-generation technologies

In the RES-RDH region, some citizen groups are restricted from owning clean energy technologies like solar panels and heat pumps for self-consumption purposes. This is another type of distributional (in) justice. Lacking the opportunity to (co-)own clean-energy technology is an energy vulnerability type from an energy prosumer perspective because it can create more inequality and restrict vulnerable citizens in the way they can participate in the energy transition [82]. Lacking

access to self-generation technologies jeopardizes citizens' right to become energy prosumers and their desire to reduce one's carbon footprint.

The RES-RDH region hosts community energy initiatives and projects where residents, businesses, and organizations collaborate to invest, install, and own renewable energy technologies in their locality. These local-ownership projects can give partial or complete control to citizens and businesses to financial participation via shares or bonds. Members of these projects, that is, citizens who own self-generation technologies, have the opportunity to participate in planning, landscape integration, and revenue allocation and can benefit from lower energy bills.

However, many households do not have the opportunity to participate in community energy projects nor to access clean-energy self-generation technologies. Four groups lacking the opportunity to (co-)own self-generation technologies were found, who experience one or more of the four vulnerability conditions described in Fig. 3. = One of the main concerns found in the newspaper articles analyzed concerned residents' struggles to afford clean energy technology due to a low disposable income. Self-generation technologies such as heat pumps and solar panels are currently too expensive for many citizens. Residents who are more well-off generally benefit more from the energy transition than those with less disposable income.

Yet, focusing only on the disposable income level is not sufficiently specific to identify nor broad enough to cover all citizens with limited access to clean-energy technologies. According to the results of the analysis of the interviews and newspapers, single parents, students, and older people are prone to having a low disposable income. Moreover, lacking property rights also impedes tenants from investing in and installing clean energy technologies, as well as not speaking Dutch because residents can find it more challenging to access information about subsidies and how to apply for them. If the groups shown in Fig. 3 intersect any of the vulnerability conditions, they are likely to face this energy vulnerability type.

"Well, it is indeed often the less affluent households anyway. It's (especially) the households that may not be able to speak the language. It's households that, yes, have other problems on their plate, making it less interesting for them that they have him as the priority. So, It's very complex. It's not just a group of people where you can point it out, but we need to do something with that." (Alderman of a municipality in RDH, 2023).

Municipal policies aim to promote citizens' financial participation. Some municipalities in the RDH region offer citizens subsidies and the opportunity to invest in specific energy projects, benefit from their investments and participate in the decisions of the projects. Although this mechanism supports the development and operation of energy initiatives, the stakeholders interviewed acknowledged that many citizens cannot invest because of financial constraints, not having property

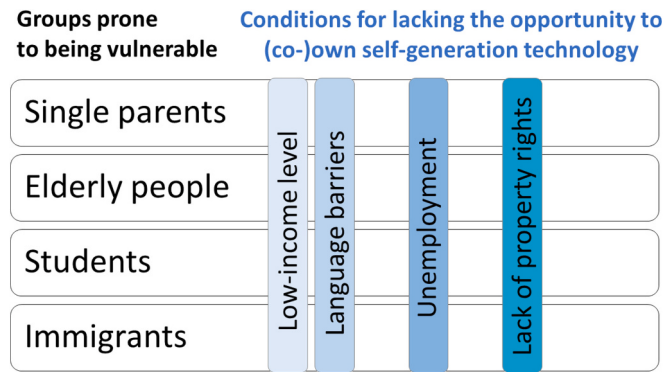


Fig. 3. Intersectionality lens applied to the lack of opportunity to (co-)own self-generation technology. The intersection of groups prone to being vulnerable (horizontal) and conditions for energy vulnerability (vertical) puts these groups at higher risk of lacking the opportunity to (co-)own self-generation technology.

rights or language barriers.

4.1.3. Lacking inclusion in decision-making processes

The third energy injustice that we identified is associated with procedural justice: A lack of decision-making inclusivity, as presented in Fig. 4. Several entities play a role in the RES-RDH- decision-making. We find municipal councils, councilors, alderpersons, City mayors, and citizens among these. For example, the energy transition regional energy strategy plan (RES 1.0) was approved by municipal councils, Provincial States, and general boards of the water authorities [83]. Yet, the RES-RDH organization stresses that it is the responsibility of the parties involved themselves to engage with residents and local stakeholders in undertaking this process [84], which shows that social engagement is not organized nor prioritized by the energy region. Public hearings and other citizen involvement initiatives are organized at the municipal level, which become integral to the decision-making process. For example, the council establishes general policies like environmental regulations and energy targets in a wind park project. The alderperson prepares the groundwork, including details about the proposed wind farm project. Citizens can then raise their opinions and concerns during the public hearing. Yet, this citizen participation approach does not allow a two-way and long-term exchange of information and opinions. Moreover, this approach lacks transparency in how public opinions are considered or not in the decisions, and it lacks fairness because citizens engage in conversations only after the projects have been defined.

From the newspaper article analysis, we noticed that stakeholders at both the regional and local levels mentioned the lack of citizen participation in the energy transition decision-making process. The newspaper articles highlight that even when citizen participation exists, it is often unclear how input is utilized, and there are concerns about the government neglecting to engage with hard-to-reach groups.

We identified four vulnerability conditions addressing decision-making inclusivity that five groups tend to experience as presented in Fig. 4. The first pertains to low disposable income because it also reduces citizens' time to engage in energy transition discussions. Lack of knowledge, interest, or time from either citizens or decision-makers also limits the inclusion of citizen groups in the decisions. Previous studies have highlighted that mostly male citizens participate in meetings, which points out the importance of gender. Moreover, not speaking Dutch is considered a big limitation since it is the official language of how citizens are invited and where meetings are held. Lastly, traditional gendered constructs of women as stay-home caregivers, who have experienced political discrimination throughout generations, limit female involvement in public decision-making spaces [85]. Therefore, women raised with traditionally gendered constructs and who are also prone to other vulnerability conditions like low-disposable income or lack of time are less likely to have access to decision-making spaces.

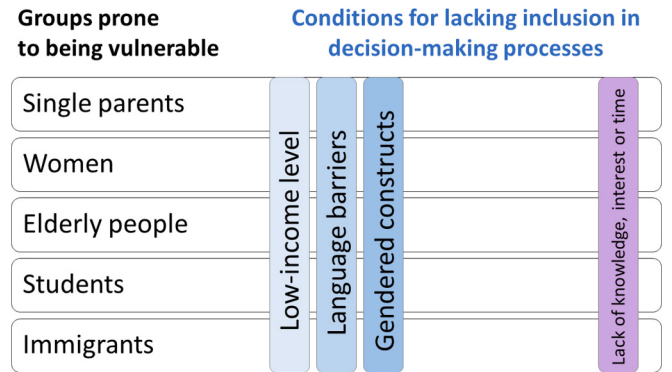


Fig. 4. Intersectionality lens applied to the lack of inclusion in decision-making processes. The intersection of groups prone to being vulnerable (horizontal) and conditions for energy vulnerability (vertical) puts these groups at a higher risk of being excluded from decision-making processes.

One crucial distinction made by the majority of municipalities is the involvement of citizens in energy transitions and their inclusion in the RES decision-making processes. This differentiation is important because while the government encourages citizen participation in the energy transition by adopting more sustainable behaviors and technology, citizen participation in public decision-making is scarce. One reason is that governments lack knowledge on how to engage citizens in decision-making. Another reason is that most local government civil servants find that the decision-making process regarding the design of energy systems is considered “too abstract” and think that citizens do not want to be involved.

Municipalities employ several measures to engage citizens and encourage participation in energy transitions. The first measure corresponds to information sharing. Municipalities employ various communication channels such as newspapers, flyers, websites, social media platforms, and public stands. Local governments share information about upcoming energy projects and policies through these channels with citizens. By engaging in conversations with citizens, authorities seek their opinions and perspectives, which can be utilized as input for policy making. Another measure used concerns running advisory councils. Some municipalities have established advisory councils for decision-makers and civil servants regarding energy-related matters. In this way, civil servants indirectly represent citizens' opinions in decision-making. However, there is a concern that several groups in society are inadequately represented or reached by civil servants. Moreover, whereas the afore mentioned measures are rather successful in achieving communication in one direction - i.e., from the municipalities to the citizens - as described in the quote below, they are less successful in enabling deliberation to encourage any meaningful discussions.

“Yes, we started last year with a group of energy ambassadors. I think they went to a total of 1,700 households and installed energy-saving measures or gave information about them. More than 70% of the residents where they've been pictured off of the households they've been in. And that's just because we've put a lot of time into it, so not ringing the doorbell once, but knowing after that come again and not yet come again the week after and then put a bill in the box and the neighbors' question of you know who that's and we're really trying to actively those people. [...] Personalized approach, that's just very important.” (Alderman of a municipality in RDH, 2023).

4.2. Barriers to addressing or mitigating the identified energy vulnerabilities

The thematic analysis of stakeholders' perceptions and policy briefs helped identify four barriers that (‘RES’) decision-makers in energy regions, mainly municipalities, face when implementing energy transition policies seeking citizen participation.

The first mentioned barrier refers to municipalities' limited (financial) capacity. The national government is the main funding body that distributes resources to municipalities. However, no national program is dedicated to addressing energy injustices or vulnerabilities of the mentioned citizen groups. Energy vulnerabilities are not evenly distributed among municipalities but rather concentrated in some neighborhoods, such as neighborhoods with mostly social housing. This translates into bigger barriers for some municipalities, which do not necessarily match certain municipality's availability of resources and decrease their capability to act.

Furthermore, the method used to allocate financial means to municipalities is changing, as the national government increasingly provides SPUKs (subsidies specific benefits), which can only be used for specific instances and earmarked purposes. This limits the maneuvering space of municipalities in addressing energy injustices. In addition to financial constraints, lack of manpower capacity, particularly within municipalities, represents another barrier. Engaging citizens in decision-making regarding the energy transition and addressing energy unaffordability by the existing communication mechanisms (e.g., providing

advice and organizing thermal insulation programs for households) demands manpower, which is scarce in most municipalities, especially in small and medium-sized ones. Moreover, effective engagement strategies tailored to each community require customized approaches.

Another barrier that municipalities face is a lack of data about vulnerable groups. The analysis of the interviews revealed that municipalities face difficulties in spatially identifying the groups at higher risk of energy vulnerability. Municipalities lack access to adequate data, particularly concerning energy-vulnerable residents, as highlighted by a previous in Utrecht, the Netherlands [86]. They heavily rely on the data provided by TNO (The Netherlands Organization for Applied Scientific Research) to identify, locate, and address vulnerable groups in society.

Furthermore, municipalities and citizens often have limited understanding and awareness about just transitions. This challenge lies in two key aspects. First, there is limited awareness among both citizens and the government regarding energy justice. The municipality's understanding of just transitions tends to be limited, stressing energy affordability, leaving clean-energy accessibility and decision-making inclusivity aside. Second, citizens are often unaware of municipalities' policies to mitigate energy unaffordability, like subsidies and thermal insulation programs. Similarly, citizens are commonly uninformed about channels for engaging in participation. In addition, many exercise a general distrust of the government, which also contributes to limited awareness or interest in energy transition projects. In the cases of wind farms, citizens have shown interest, and sometimes opposition, when farms are developed nearby [87]. There are many reasons citizens do not participate, as illustrated by the quote below.

“Again, there are various reasons. Some people just don't want to participate because they think it's nonsense. Some people are 80 (and think) it will take my time [...]. Some people who just don't speak the language, and then they just don't manage to get in [...] It can also have to do with people who just distrust the government and are like. Yeah, it is all fine and dandy, but I just don't want you guys in there.” (Alderman of a municipality in RDH, 2023)

5. Discussion: Establishing an intersectional energy vulnerability analysis approach

Our study agrees with previous energy poverty and justice studies in the Netherlands, which identified similar conditions and household characteristics for energy vulnerability (see Fig. 1). These conditions include insufficient income, lack of property rights, dwellings' energy efficiency quality [45,58,88], gender [89], and language barriers [45]. Living in social housing [58,88] was also found, but we did not include it in Fig. 1 because of its interdependencies with a low household income and lack of property rights. Other conditions that our study did not identify are living in densely populated areas [88,90] and under-consuming households [58,88], possibly because of our coverage of municipalities (see Appendix B). Our study also confirms the prevalence of certain characteristics among the groups that experience energy vulnerability in the Netherlands: Gender identity, single-parent families, age, employment status, family size, and disability [89]. This study did not reveal the last two characteristics. Other group characteristics we identified are students and immigrants, possibly because of the high percentage of students and expats in the RDH region.

The conceptual and methodological gap this study addressed in intersectional energy studies is the description of vulnerable group characteristics and a method to identify them. Previous studies describe vulnerable groups in terms of overlapping categories like group needs [34], capabilities [39,42], and characteristics like gender, race, and class [11]. We described these groups based on two dimensions to make the approach more operationalizable: 1) Groups prone to vulnerability and 2) vulnerability conditions. This is an important distinction because it allows one to disentangle the complexity of intersectional energy vulnerability. Previous studies stated that the causes of energy poverty are a combination of energy prices, building stock infrastructure, and

socio-economic and demographic factors [34,89]. Although this conceptualization is comprehensive, it does not prove practical when it comes to identifying the groups who experience energy poverty. Similarly, focusing on group characteristics can lead to the conclusion that one should look for gender, power, ethnicity, and class to identify vulnerable groups [10,27,89]. However, families could meet these socio-economic and demographic characteristics yet still not experience energy vulnerability, for example, because they live in a high-performance, energy-efficient house. That is why we believe that our distinction between groups prone to vulnerability and vulnerability conditions is a step towards building policy-making tools to identify and target vulnerable groups.

The empirical gap in intersectional energy studies we addressed is the skewed selection of communities near the development of energy projects [11]. Our focus on general citizens, regardless of their location, makes our findings more applicable to other regions, going beyond NIMBY framings and the limited citizen representation of community energy projects.

We consider that the applied theoretical framework and the methodology can be applied to other contexts where there are energy transition policies aiming for citizen participation, and they have a subnational governance layer that covers a manageable number of municipalities. This is the case in most European countries because of the phenomenon of regionalization and the availability of regional developing funds, which promote regional initiatives [91,92]. Similarly, the findings on vulnerable groups and barriers can be used as a reference for future studies in other Dutch or Western urbanized regions, as some overlapping vulnerable groups have been previously reported [93].

5.1. Policy recommendations

5.1.1. Representation in decision-making

Following Crenshaw's intersectionality rationale [48,94], to address energy vulnerabilities, it is necessary for the participation and leadership of representatives of the intersectional groups that are currently marginalized by the sociotechnical energy system. The National Program of Regional Energy Strategies (NP RES) recognizes that besides financial participation, citizen participation in decision-making is necessary for social acceptance, especially to avoid opposition [95]. Although NP RES offers tools for municipalities and RESs to carry out citizen participation, there is a lack of citizen involvement and, therefore, a lack of representation of vulnerable groups in the RESRDH regions and municipalities' decision-making process [96]. In this region, citizen participation has been limited to top-down information dissemination activities.

The representation of vulnerable citizens is needed at the municipality level, and all vulnerability issues among municipalities are needed in the RES. A study in the province of Gelderland (another region in the country) also reported that municipalities struggle to reach diverse groups in the events they organize [45]. According to Riverland region administrators, an effective way to achieve inclusion is not about including as many people but rather as many opinions and perspectives as possible [96]. Two-way communication spaces in municipalities where citizen representatives and stakeholders can co-create pathways to address energy vulnerabilities are needed. An effective but time-consuming avenue to initiate the engagement of diverse citizens is door-by-door communication, as reported by some municipalities in the RES-RDH. Other regions like Arnhem-Nijmegen have engaged university students in sustainability projects, investing resources in long-term communication platforms [96]. However, if there is distrust, the communication process can be mediated or conducted by a third party with access to vulnerable communities like social work agencies and welfare organizations. Alternative ways have been proposed, such as narrative creation workshops with residents in the Drenthe-RES, sustainability projects with university students in the Arnhem-Nijmegen region [96], and using online platforms because of their potential to

be less time-consuming and reach out to young people [97].

According to the NP RES, a measure that can potentially help municipalities address the lack of access to clean energy technologies is to have clear agency when pursuing local ownership [98]. The NP RES has the goal of meeting the (national) Climate Agreement goal by achieving 50 % local ownership of solar and wind energy, where implementation is the responsibility of municipalities [95]. One of the challenges that municipalities face is the lack of clarity on how to achieve local ownership. For this, the NP RES states that local ownership should be part of municipal policy, with established goals and obligations, so that there is clarity about the roles and contributions to the energy transition. This is, however, only an initial step, as civil servants need more preparation to understand the topic, its challenges, and how to organize regional energy strategies. Representing vulnerable groups at the municipality level is key to overcoming the barriers that prevent some citizens from participating in local ownership projects.

5.1.2. Targeted policies

Energy transition policy measures tend to overlook the citizen groups at higher risk of energy vulnerability. We discussed several policy measures, including energy advice to households, energy allowance and loans, subsidies for self-generation projects, and information dissemination and public hearings organized by municipalities. These policies are blind to specific groups of vulnerable citizens. This finding agrees with previous qualitative studies in the Netherlands, which revealed that mechanisms aiming to address household energy vulnerability are largely unknown by the groups that commonly experience it [45,99,100]. In accordance with our findings, Kaufmann et al., (2023) state that policy instruments (e.g., focused on energy efficiency, subsidies, and financial aid) can fail to reach some groups because of language barriers, not being legally eligible to access energy efficiency measures, and not being able to afford the loan after receiving it (Ibid). Therefore, there is a need for energy transition policy measures to consider particular vulnerability conditions that prevent vulnerable groups from participating in the policy programs.

Applying an intersectionality lens to citizen participation in energy policies can be both practical and effective. First, applying an intersectionality energy justice lens to a qualitative case study analysis with stakeholder and citizen participation helps identify several vulnerable groups and the policy instruments that overlook these groups. The intersectional nature of energy vulnerability should not be understood as a continuum where the more conditions, the more vulnerability because some vulnerability conditions can be more relevant than others. Therefore, the list of vulnerability conditions should be used for qualitative and descriptive purposes instead of quantitative interpretations. With this information, policy and decision-makers can focus on the revealed intersectional groups, meaning they can zoom into the five groups prone to being vulnerable and who also have one or more vulnerability conditions. Reaching a representative sample of vulnerable groups in the analysis is necessary to avoid overlooking groups. Since a team of two researchers working full time for three months and one supervisor were enough to cover several municipalities in this study, we think that a small team can make a representative study of one region. Therefore, we do not say that issuing one tailor-made policy per vulnerable group is necessary, but applying an intersectional justice lens can make existing policies sensible to vulnerable groups.

5.1.3. Strengthening municipalities' capacities

Municipalities have been responsible for addressing energy vulnerability in the Netherlands. Most interviewed municipal agents considered this topic to lie within the municipality domain. At the same time, they considered that their capabilities were oversaturated, so they were not able to reach out to vulnerable groups. We reported four main barriers municipalities face when implementing policies pursuing citizen participation in the transition: Limited (financial and human) capacities, lack of data and knowledge about vulnerable citizen groups,

limited understanding and awareness about what just transitions mean, and political instability around energy projects. These findings are, to a certain extent, generalizable to other regions in the Netherlands, as they have been observed in geographically different regions like Arnhem-Nijmegen, Drenthe, among others [45,96,101]. Therefore, local governments are in need of more human capital, resources, and capacity [101].

Most municipalities need more expertise and staff, especially in the implementation phase of energy counters, fixers, and insulation campaigns. Similarly, they report a lack of expertise in the planning and development of district heating networks. During the interviews, many municipalities expressed interest in citizen participation but lacked expertise on the topic. We suggest that instead of relying on consultancy firms for this, municipalities could hire citizen participation experts and work more closely with social workers who are knowledgeable about vulnerable groups.

5.1.4. The role of energy regions

Other barriers that impede the alleviation of energy vulnerability are a predominantly top-down governance approach and the limited agency of energy regions. In the Netherlands, energy transition policies are not framed as striving to reach just transition goals, but some aim to (partially) contribute to this by stressing citizen participation. These policies have been defined at the national level and implemented by municipalities. Most RESs, like the RES-RDH region, have followed a predominantly top-down oriented approach, with the exception of the five pilot regions [102], despite the fact that energy regions were designed to function as a link between municipalities and the central government. RES' objective is to contribute to the national 35 TWh goal, and they have some room to decide relatively autonomously how to design and implement a strategy despite being highly dependent on national government policy support frameworks.

The RES-RDH region has remained distanced from energy vulnerability issues. Energy vulnerability and citizen participation topics were not even mentioned in the strategic governing document of the RDH region, the so-called 'RES1.0 RDH', despite the region being densely populated and home to an above-average rate of energy poverty [58,103]. This is striking because other energy regions in the country, like the West-Brabant-RES, are less densely populated have a lower rate of energy poverty, and still address citizen participation in their strategic 'RES1.0' document. This is why we cannot generally conclude that all energy regions are ready to address energy vulnerability; they need prior knowledge, experience, and (political) interest in this topic. Still, we can anticipate that if focused on energy vulnerability and justice, energy regions could strengthen municipalities' efforts.

A potential measure for energy regions (i.e., 'RES regions') to help municipalities is the capacitation of civil servants on energy vulnerability topics. The NP RES provides support to municipalities by offering a range of communicative policy instruments. For example, webinars are organized to show municipalities how they can develop local policies to pursue goals like local ownership in solar or wind projects [98]. Since January 2023, the National Local Heat Transition Program was launched to provide funding to regions (total budget: €9 million annually) to support municipalities [104]. Through this program, RESs were involved in sharing knowledge and good practices on initiatives to municipalities within the region via official websites, helpdesks, and social media, as well as by organizing thematic meetings. The focus of this program was to accelerate and scale the sustainable heat transition. Although this information has been valuable for preparing civil servants, they also require training on addressing energy vulnerability. Addressing energy vulnerability requires a joint effort between decision-makers, academia, social workers, and citizens. The RES can lead this joint effort, not with individual municipalities, but with representatives of each municipality to promote cross-learning and synergies.

From an energy justice and multi-level governance perspective, municipal cooperation is needed to promote a fair distribution of costs

and benefits, and energy regions can be the intermediates for this cooperation. The energy region can have an overview of energy justice issues and inequalities between municipalities in the region. For example, residents of the City of Wassenaar may be more privileged than in Rotterdam or The Hague because Wassenaar has more financial capabilities and policy agencies due to the high tax income paid by wealthy citizens. With energy regions as intermediates, policies could be tailored to local contexts. For example, energy regions could inform policymakers about municipalities' needs, capacities, and potential municipality pairing for cooperation. Then, policies could allocate resources for regions to enable the sharing of manpower, knowledge, and household data between paired municipalities to ultimately identify and engage with vulnerable households.

5.2. Limitations and future research

The interviews and newspaper articles of this case study may not necessarily offer a representative view of the public opinion in the RES-RDH region. We cannot state that the identified group characteristics and vulnerability conditions are the only or most representative of the region. However, our findings coincide with previous Dutch case studies [45,58,88,89]. The conclusions presented would highly benefit future research employing a representative survey that manages to engage with hard-to-reach groups, including the groups identified in this study in the list of municipalities of Appendix B.

Given our time constraints, we used Microsoft Teams and Word to transcribe interviews. This could have altered the meaning of some paragraphs, as the software separates sentences. However, to mitigate this, we followed good practices and procedures for thematic analyses [105]. For example, two researchers coding interview transcripts in parallel found similar interpretations. Moreover, peer debriefing was applied throughout the data treatment and analysis process to assure sound coding practice and inter-coder reliability.

Future intersectional energy justice studies can apply our framework (Fig. 1) in different contexts to understand the role of context and analyze the framework over time to assess policy effectiveness. Energy justice can have different meanings other than the three identified vulnerabilities. For example, Mejía-Montero et al. 2023 focused on individual and collective views on justice in Zapotec Indigenous communities in Southern Mexico, where wind turbines have been installed. Their study reveals the importance of including care of birds and bats and a more collective ownership model in the concept of energy justice [10]. We think special focus must be given to municipalities hosting large-scale energy projects like wind farms in the Netherlands and elsewhere. Another study combined feminist gender studies with socio-technical transition frameworks to study the evolution of just transitions over time in Kenya, Canada, and Spain [27]. This study conceptualizes just transitions in terms of the diversity of perspectives incorporated in the transition [27]. We recommend that future longitudinal studies apply our framework along the energy transition stages to assess the progress of just transitions. Furthermore, future studies can combine qualitative with quantitative approaches [106] to provide a more comprehensive overview of intersectional energy injustices.

6. Conclusion: Towards the operationalization of just transitions

We conducted a case study in the Rotterdam-Den Haag energy region (RES-RDH) to: I) Identify energy vulnerabilities in a regional transition context, II) understand what citizen groups experience them and why, and III) identify barriers that prevent policies from engaging with these groups in regional transitions. We met these objectives by analyzing stakeholders' interviews and newspaper articles with a qualitative thematic analysis drawing from theoretical perspectives on intersectional energy justice and governance. First, the findings show that citizen groups can be vulnerable in the energy transition context in three main

ways: i) By being unable to afford energy bills; ii) by lacking access to clean-energy technologies, and; iii) by not being included in public decision-making processes. Second, the groups prone to being vulnerable share one or more vulnerability conditions (see Fig. 1). Third, we overview the barriers to engaging vulnerable groups in Section 4.2 and suggested policy recommendations to address them: A representation of vulnerable citizens in decision-making, designing intersectional energy policies targeting vulnerable groups, strengthening of municipalities, and a more active role of energy regions. These empirical findings can be considered to some extent generalizable to other Dutch and Western urbanized regions (formal and informal), as similar vulnerability issues and groups have been reported [93].

Our findings contribute to just transitions literature by presenting a case that confirms that citizen groups do not experience the costs and benefits of energy transitions equally. This supports the statement by Dubois & Meier (2016) that energy transitions are embedded in an unequal socio-economic system [1]. An energy justice and intersectional lens in governance is required to identify and address inequality in energy transitions. Therefore, we suggest that future studies and policies focus on operationalizing just transitions and consider societal intersections. For example, we think including vulnerable tenants and homeowner groups is necessary when evaluating the effectiveness of policies (e.g., focused on regulating the energy level of dwellings). Without an intersectional perspective, energy policies will continue to overlook the groups at higher risk of vulnerability.

Based on our results, we recommend municipalities engage with vulnerable groups by visiting them at home while sharing information in native languages (i.e., also in languages used by minorities), as this method has proven effective. Then, two-way communication methods like transdisciplinary tools [107] could be considered to foster participation and cross-learning with citizens. For example, municipalities could invite citizen representatives to jointly create a rich picture consisting of a drawing of the problem framing, which can help reach a shared understanding of the problem in a group setting [108]. External parties like social work agencies and welfare organizations may be helpful in cases where citizens lack trust in the government by intermediating discussions between citizens and the government. Although these organizations are already present in countries like the Netherlands, they need more outreach. Finally, regional governance can coordinate cross-municipal collaboration to exchange expertise, capabilities, and other (human and material) resources.

CRediT authorship contribution statement

Amanda Martinez-Reyes: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Syben Wolters:** Methodology, Investigation, Data curation. **Olaf Luijk:** Methodology, Investigation, Formal analysis, Data curation. **Özge Okur:** Writing – review & editing, Supervision. **Thomas Hoppe:** Writing – review & editing, Supervision, Methodology.

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Declaration of competing interest

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.erss.2024.103859>.

Data availability

Data will be made available on request.

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