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Original research article

# Energy justice and citizens' willingness to participate: A discrete choice experiment in a Mexico-United States cross-border region

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## ABSTRACT

Citizen participation in energy transitions is needed to address energy injustices. Yet, the effect of energy justice on citizens' willingness to participate remains untested. This study examines whether citizens are more inclined to participate in local energy projects that consider justice factors or not. A representative survey collected data ( $N = 768$ ) from a Mexico-US cross-border region. We applied a Discrete Choice Experiment, using a Multinomial Logit Model for aggregate preferences and a Latent Class Choice Model to identify preference variation across citizen types. Interestingly, findings show that especially vulnerable groups and youth expressed greater willingness to participate as local leaders in projects prioritizing distributional justice (i.e., targeting energy-poor households) and procedural justice (i.e., involving civil organizations and multiple governance levels in decision making). This contrasts with common assumptions that vulnerable groups are disinterested in, or insufficiently informed about, participation in the energy transition. Our findings suggest that justice-informed project design may foster broader citizen engagement. The participation, and leadership, of vulnerable groups can be enabled when formal institutions recognize and engage with existing organizations representing these groups, such as traditional Indigenous authorities.

## 1. Introduction

Transition processes toward the decarbonization of energy systems may create or exacerbate inequalities if special attention is not given to vulnerable groups experiencing energy injustices [1]. Studies have shed light on the importance of diversifying economic and decision-making power among organizations and citizens for the energy transition to address injustices [2–6]. Western countries tend to rely on formal institutions to aim to resolve socio-economic inequalities and socio-cultural tensions that emerge during the transition while addressing climate change mitigation targets; some related concepts are just transitions and energy democracy [7,8]. It is widely argued that to address energy injustices, vulnerable groups have to participate or be represented in the energy transition, as their preferences, needs, and experiences are essential to understanding injustices [8]. Conceptualizations of energy justice in decolonial contexts, like in Latin America, recognize that unsustainability and injustices have been embedded in the energy system and formal institutions since colonization times [9]; some associated concepts are energy sovereignty and autonomy [10,11].

Therefore, problematizing and addressing energy justice depends on the case context, yet both approaches recognize vulnerable groups and the moral need to repair injustices.

In the energy system, there are citizen groups that are more prone to being vulnerable [12]. Vulnerability does not equal poverty and does not have the same relationship with income [13], but it can be seen as being prone to experience energy injustices during a low-carbon transition [14,15]. Some vulnerable groups in the energy transition that have been reported are women, the rural population, children, inhabitants of small islands, immigrants, and Indigenous peoples. The involvement of vulnerable groups in energy governance has been challenging because of obstacles in the communication between decision-makers and citizens [16–18]. While it is often assumed that vulnerable groups lack the interest or capacity to participate [19], empirical evidence is limited. Understanding what motivates these groups to engage—beyond overcoming barriers—is crucial.

Citizens' perceptions of energy projects strongly influence their willingness to participate [20]. Fair and transparent project characteristics can evoke trust, a sense of ownership, and alignment with citizens'

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values, thereby fostering participation [21–23]. In particular, procedural and distributional justice—the fair allocation of benefits and inclusive decision-making—has been linked to higher social acceptance and cooperative behavior in renewable energy projects [20,24–26]. Energy citizenship frameworks conceptualize participation as a continuum of roles, from passive consumers to active prosumers and local decision-makers, emphasizing the role of agency, leadership, and collective responsibility [27–29].

Yet, no study to our knowledge has explored whether energy transition strategies that consider justice factors can improve citizens' participation in its various forms (e.g., as a consumer, prosumer or decision-maker) [27]. Thus, in this study, we answer the research question: To what extent do projects that include justice dimensions (participatory and distributional) motivate citizens to participate, or not? To address the research question, we combined a representative online sample of citizens ( $N = 651$ ) and a targeted in-person sample of vulnerable groups ( $N = 118$ ) in a Discrete Choice Experiment (DCE) study. The study in the Mexico-US cross-border region explored which citizen groups valued energy justice attributes and expressed greater willingness to participate in the energy transition.

This study contributes to the energy citizenship literature by providing evidence suggesting that procedural and distributional justice in local energy projects may motivate widespread participation. Vulnerable groups and youth are not only highly motivated but also willing to take leading roles in local sustainability initiatives, challenging assumptions that these groups are primarily passive or constrained by energy needs [19,30]. These findings highlight the policy relevance of justice-informed engagement strategies and the importance of creating institutional platforms that enable formal participation for youth and vulnerable communities in cross-border energy transitions.

The following section presents the research framework, connecting key concepts to answer the research question: Energy justice, justice perception, level of information, and citizen participation. Section 3 describes the conducted survey with a focus on covering vulnerable groups and the applied DCE to analyze the results. Section 4 outlines the results: citizen groups reached, their answers, and the impact that the perception of fairness had on their willingness to participate. Section 5 discusses the extent to which the perception of fairness triggered equitable participation and compares the results with previous studies on triggers for participation. Finally, section 6 answers the research question, addresses limitations, and proposes a research agenda.

## 2. Research framework: energy justice and citizens' participation behavior

This framework establishes the connection between justice and citizen participation. Then the three attributes of the study are introduced: distributional justice, procedural justice (subsection 2.2), and energy citizenship roles (subsection 2.3). The effect of being informed was also measured in this study and is introduced in subsection 2.4.

### 2.1. Justice perception and citizen participation

Perceiving justice in renewable energy projects can determine people's opinions and attitudes toward projects [20]. Such perception can influence citizens' acceptance, neutrality, or opposition to energy projects, which can vary over time [23].

Some citizen groups are particularly sensitive to justice perceptions, which can influence their willingness to cooperate. According to justice sensitivity theory, individuals who perceive injustice as observers are more likely to cooperate, whereas those who perceive themselves as victims may display more self-protective or egoistic behavior [24,31]. Justice sensitivity can be triggered by making impacts on affected people visible, creating personal connections, or presenting concrete situations where inequalities are evident [32].

These insights suggest that perceptions of distributional and

procedural justice in energy projects may influence citizens' willingness to support or participate in them. In particular, individuals who perceive that benefits are fairly distributed and that decision-making processes are inclusive may be more willing to cooperate, while those who perceive injustice may be less likely to engage [20,24,31]. Based on these theoretical expectations, vulnerable or energy-poor citizens could be less likely to volunteer in energy projects if they perceive that the transition does not address their needs, although empirical evidence on this assumption remains limited.

### 2.2. Perception of distributional and procedural energy justice

Within the energy justice literature, three tenets—distributional, procedural, and recognition justice—are widely used to evaluate whether transitions are socially equitable and legitimate [25,26]. These frameworks emphasize that support for energy policies depends not only on technological or economic outcomes, but also on how benefits and burdens are allocated and how decisions are made. Recognition justice refers to the fair acknowledgment and inclusion of diverse identities, experiences, and knowledge systems, especially those of marginalized groups, in decision-making processes. Distributional and procedural justice have been shown to be central determinants of public acceptance of renewable energy projects and policies, as they shape perceptions of fairness, trust, and legitimacy in governance processes [20,25]. Building on these frameworks, this study focuses on distributional and procedural justice as key dimensions that can influence citizens' preferences regarding participation in the energy transition.

Distributional justice refers to the fair allocation of the benefits and costs of the energy transition across different social groups [26]. In energy policy contexts, concerns about distributional justice arise when subsidies, technologies, or infrastructure are not equally accessible, particularly for households affected by energy poverty or lacking reliable access to energy services [33].

Research shows that perceived distributional fairness, rather than objective outcomes alone, plays a key role in shaping public acceptance of energy policies and projects [34,35]. Individuals tend to evaluate fairness based on who receives the benefits, whether vulnerable groups are prioritized, and whether allocation rules are considered equitable or justified [34,35]. Empirical evidence from energy policy and infrastructure projects further shows that distributional arrangements that explicitly address inequality or target disadvantaged households are more likely to be perceived as legitimate and acceptable, as illustrated in studies on renewable energy support schemes and tariff redistribution policies [33,36]. To capture these considerations, this study operationalizes distributional justice as an attribute describing which groups receive clean technologies, with levels varying in the extent to which benefits are targeted toward vulnerable households or distributed more broadly across the population (see Table 5).

Procedural justice refers to the fairness of decision-making processes, including the degree to which different actors are represented, included, and able to influence outcomes [26]. In the context of environmental and energy governance, perceived procedural fairness has been shown to influence trust in institutions, perceived effectiveness of policies, and willingness to accept collective decisions [37,38]. Perceptions of fairness depend on who participates in decision-making, how transparent the process is, and whether stakeholders feel adequately represented [39].

In the energy transition, procedural justice is closely related to concepts such as energy democracy and energy sovereignty, which emphasize inclusive governance and the involvement of citizens, civil society, and public institutions in shaping energy systems [5,10]. Different configurations of actors across governance levels may therefore lead to different perceptions of legitimacy and acceptance of energy policies [6,27]. To capture these considerations, this study operationalizes procedural justice as an attribute describing which actors decide how clean technologies are allocated, with levels varying from decisions

made by government institutions to those involving civil organizations and multiple governance levels (see Table 5).

### 2.3. Energy citizenship roles

Citizen participation in the energy transition has been conceptualized through frameworks that describe how individuals engage with energy systems at different levels of involvement. Early work distinguishes between consumer-oriented and participatory narratives, where citizens may act as energy users, prosumers, or active participants in collective decision-making processes [27–29]. In the consumerist perspective, participation mainly occurs through individual behavior, such as adopting energy-efficient technologies or reducing energy demand [40,41], whereas more active roles emerge when citizens become involved in energy generation, community initiatives, or local projects [42,43]. These frameworks provide a foundation for understanding participation in terms of the role citizens take in the energy system, from passive consumption to local collective action.

More recent energy citizenship frameworks expand this perspective by conceptualizing participation as a continuum that includes rights, responsibilities, and agency in a just and sustainable energy transition. Citizens are characterized not only by their energy behaviors but also by their collective engagement, leadership in community projects, and influence on governance processes [44–46]. These approaches emphasize that participation differs not only in effort but also in the degree of responsibility and decision-making power citizens assume.

Drawing on this literature, this study operationalizes preference for participation as a survey attribute (see Methods section) with levels representing increasing involvement, from no participation to individual behavioral change and leadership in local energy initiatives (see Table 1).

### 2.4. Level of knowledge and social acceptance

The relationship between citizens' level of knowledge and their acceptance of renewable energy projects is complex and context-dependent: greater factual understanding and energy literacy often increase perceived benefits (e.g., climate mitigation, local economic gains) and thereby support, but detailed knowledge can also highlight trade-offs (e.g., land-use impacts, noise, procedural shortcomings) that reduce acceptance unless accompanied by fair decision-making and trust in authorities. Empirical reviews and case studies show that knowledge improves acceptance when it is paired with transparent processes, perceived distributive benefits, and opportunities for meaningful local participation [47]. Conversely, low knowledge sometimes coexists with high stated support (social desirability or abstract environmental attitudes) yet hides vulnerability to local opposition when projects become concrete. In particular, a comprehensive review of 25 European case studies found that the dissemination of information and transparent communication by project developers strongly correlate with higher local acceptance of renewable energy projects [47]. Moreover, several studies emphasize that beyond mere awareness, trust in responsible actors and opportunities for public participation significantly shape whether knowledge translates into acceptance [23,48]. Systematic frameworks of social acceptance show that awareness and knowledge remain central dimensions, but they interact with perceived

**Table 1**  
Levels of the attribute type of participation and related literature.

Levels	Related energy citizenship roles
No participation	Non-engaged / passive citizen [27,41]
Sustainable behavior at home	Consumer / behavioral citizen [28,43,44]
Local leader in project	Collective / governance / political citizen [29,42,45,46]

fairness, risk-benefit assessments, and community engagement processes [49]. In this study, the effect of knowledge was operationalized through a treatment-control design, in which the treatment group received an introductory text on energy, sustainability, and justice topics prior to the choice tasks, while the control group did not. Differences in stated preferences between these groups allow assessment of whether greater knowledge or justice framing shifts citizens' participation preferences.

## 3. Methodology

### 3.1. Case study description

Our case study is located in the cross-border region between Baja California, Mexico, and Southern California, United States (US), as shown in Fig. 1. This case is of particular interest for studying the relationship between citizen participation and energy justice because citizen participation in energy-related topics in this cross-border region is scarce, and yet, numerous citizen groups struggle with energy services, as explained in Section 3.2.1.

Citizen involvement in energy projects could potentially advance the low-carbon transition in this region. The region shows potential to develop a cross-border regional energy transition. Besides its interconnections in terms of migration, trading, businesses, and culture, this region is interconnected through gas pipelines and electricity transmission lines for exports and imports [50]. This region is fascinating to study as a potential energy region because Southern California and Baja California have a history of international environmental protection agreements, especially on the topics of water, energy, air, and waste management [51]. There are two 230 kV electricity interconnections with a total capacity of 800 MW and natural gas pipelines with a total rate of 23.4 MSm<sup>3</sup>/d between California and Baja California, as shown in Fig. 2. Electricity generation in California comes from 48.6% of renewable energy sources, of which 46% is imported [52]. In Baja California, electricity consumption in 2023 was 16 TWh, with a local generation of 15.3 TWh, out of which 13.9% comes from renewable energy sources (geothermal 12.5%, wind 0.6%, and solar 0.8%) [53]. There is technically-proven renewable energy potential, which requires the development of policy and market support [54].

Citizen participation in energy projects in the cross-border region is limited to one-way communication approaches (i.e., informing). In Mexico, citizen participation is not mandatory for all projects or stages [23,55]. It is formally organized as a public consultation as part of the Environmental Impact Assessment only if the consultation has been requested shortly after the energy project has started [56]. Similarly, in the US, citizens are involved during the public hearing and review of Environmental Impact Statements, which are not required for all projects [57].

### 3.2. Data collection: online and in-person survey

To answer the research question (*to what extent do projects that include justice dimensions (participatory and distributional) motivate citizens to participate, or not?*), we combined two data collection methods, an online and an in-person questionnaire. The questionnaire details are presented in Appendix A. We used the same questionnaire for both Spanish and English samples, which we designed in Qualtrics XM, an online licensed platform to design surveys. We exported and printed the questionnaire for the in-person sample. This questionnaire follows the structure of a choice experiment in which respondents participate in either a control or treatment group. The control group answered the survey without a detailed introduction, whereas the treatment group received an introduction on energy, sustainability, and justice topics. After excluding speeders (i.e., those who took less than four minutes to complete the survey) and incomplete surveys, the response time was between 5 and 20 min. In the online sample, the average was 7.4 min for the treatment

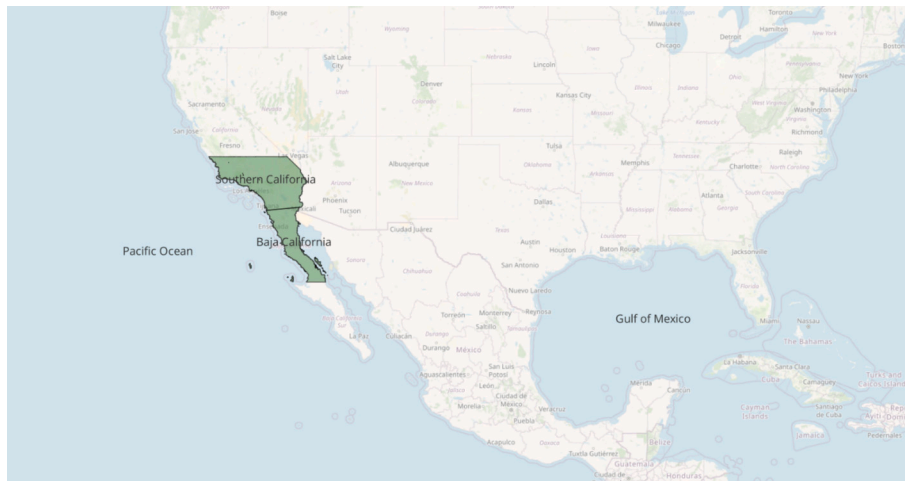


Fig. 1. Aimed area for the survey (respondent's place of residency). Baja California, Mexico, and Southern California, US.

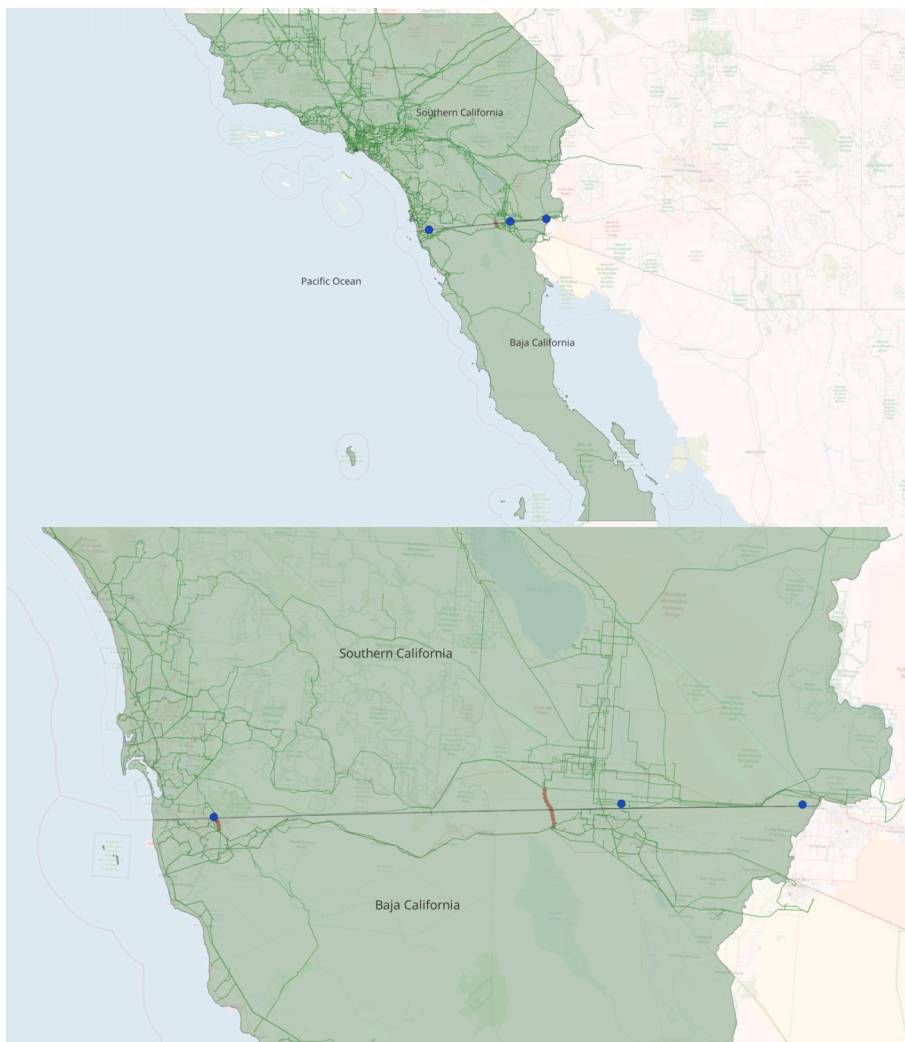


Fig. 2. Transmission lines (in green) of Southern California and Baja California, their interconnecting electricity (in red), and natural gas pipelines (in blue). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

group and 7.0 min for the control group, possibly because of the extra introduction text in the treatment group and because the introduction might have incentivized respondents to think more thoroughly. For the in-person sample, the average time was 15 min (control and treatment

group), which was longer than the online sample because in-person respondents could ask clarifying questions. Dynata, a market research company with coverage in Mexico and the US, collected the online sample by distributing the questionnaire to an online panel in Southern

California and Baja California with the characteristics described in Tables 2, 3, and 4. This online panel consisted of Dynata subscribers who covered a representative sample of the cross-border region. Additionally, an in-person sample was pursued to reach a non-representative sample of vulnerable and HTR groups and, thus, ensure diversity.

3.2.1. Including vulnerable and HTR groups

Diverse vulnerable households and justice attributes can be identified in Southern California and Baja California. The justice attributes of this study are related to the energy vulnerabilities in the region: Lack of affordability of electricity, gas, and transportation despite subsidies and lack of electricity connection in Baja California [58]; water scarcity, water pollution, and wildfires on both sides of the border [59]. The HTR and vulnerable groups that experience those vulnerabilities are diverse. For example, Indigenous communities in several municipalities in Baja California lack electricity connections and public transport [58]. Inhabitants in Mexicali have a high electricity consumption in Summer due to climate conditions and an energy inefficient behavior (e.g., leaving the window open when the air conditioning is running) (First author’s fieldwork notes, 2024).

The in-person survey was pursued to include HTR groups with a targeted snowball sampling because of its effectiveness in reaching hidden populations such as homeless people, sex workers, and drug addicts [60]. This in-person sampling method identified local networks to reach HTR groups through their networks [61]. Thus, the first author contacted reference persons of each vulnerable group, who agreed to have people interviewed. Additionally, some groups, like a feminist group and Indigenous community leaders, were initially contacted via social media like Facebook and WhatsApp, as social media have been proven successful in reaching HTR groups [62,63]. To make the in-person questionnaire accessible to participants, a team of three local survey assistants and the first author assisted participants in reading and explaining the questions. The responses and personal information were anonymized to meet the European General Data Protection Regulation (GDPR) standards. Additionally, in-person participants received monetary compensation to reward their valuable input. The questionnaire was available in Spanish and English. Yet, participants who spoke a different language (Indigenous language) were assisted by a translator from the same social network. This approach is supported by previous survey studies working with HTR groups, which recommend collaborating with participants in the survey design and implementation [62]. Similarly, participants who could not read the questions themselves were assisted so that they could answer verbally. The in-person survey required significantly more effort and similar funding compared to the online survey.

3.3. Discrete choice experiment

The survey consisted of a discrete choice experiment (DCE) that helped explain how the perception of justice impacts the willingness of

Table 2 Comparison of online and in-person sampling methods.

Data collection method	Citizen groups reached	Number of complete answers	Control sample	Treatment sample
Online Qualtrics questionnaire with online panel Dynata	General representative sample.	N = 651	N = 352	N = 299
Printed and online Qualtrics questionnaire with the in-person snowball sampling method	HTR and vulnerable groups.	N = 118	N = 52	N = 66

Table 3 Sample demographics.

Online questionnaire	Female	Male	Other gender or did not want to say	18 to 44 years	More than 44 years
Online control	181	146	25	189	163
Online treatment	121	118	60	149	150
HTR control	33	19	0	28	24
HTR treatment	39	27	0	41	25

Table 4 Reach of HTR and vulnerable groups in the cross-border region.

HTR groups in the cross-border region	Living on the Mexican side	Living on the US side
Female	Y	Y
Low income	Y	Y
With an education level lower than High School	Y	Y
Indigenous communities	Y	Not reached due to study limitations
Feminist groups	Y	Not reached due to study limitations
Households without an electricity connection	Y	Not identified due to survey design limitations
Immigrants and low-income Families that cross the border regularly for education or employment purposes	Y	Y
Long-distance commuters	Y	Y
Households with extremely low electricity consumption	Y	Not identified due to survey design limitations
Households that struggle to afford their energy bill	Y	Not identified due to survey design limitations

diverse citizens to participate in the energy transition. DCE has become popular in obtaining individuals' preferences in the context of the energy transition [64–66]. In a DCE, participants answer a number of choice tasks in which they select between mutually exclusive alternatives (e.g., different levels of engagement, high/low) characterized by a set of attributes (e.g., impacts related to inclusion/justice). The participants' choices are analyzed using discrete choice models [67], allowing identification of the individuals' preferences for the discrete alternatives and their attributes.

The experimental design of the DCE was done in three stages, inspired by the procedure suggested by Hensher et al. [84]. The first stage involved framing the choice question, as well as the core elements of the DCE, namely the number of alternatives, attributes, and attribute levels. Participants were asked to choose between three forms of energy projects, which were labelled by their participation form. Alternative 1 was always “You do not participate”; alternative 2 was always “You adopt sustainable measures in your house (LED bulb lights, recycling waste, etc.)”; and alternative 3 was always “You become a local leader by helping coordinate a sustainable energy project in your community (5h/week)”. Each alternative was characterized by three attributes: the form of participating in the project (i.e., the “label” attribute); which groups are receiving clean technologies (solar panels) for free; and the actors who decide on what households can receive the clean technologies. It is expected that type of participation has more influence than attributes two (distributional justice) and three (procedural justice). Details of the attributes and levels are provided in Table 5.

The second stage consisted of determining the number of possible treatments and constructing the experimental design. We use a D-efficient design [68] of 60 choice tasks, allocated in 10 blocks. Hence, each respondent faced a subset of six choice tasks or scenarios, each one with three options to choose from. The D-efficient design is a type of

**Table 5**  
List of attributes and their levels.

Attributes	Levels
How you (respondent) participate in the project	You do not participate You adopt sustainable measures in your house (LED bulb lights, recycling waste, etc.) You become a local leader by helping coordinate a sustainable energy project in your community (5 h/week)
Groups receiving clean technologies (solar panels) for free	5% of households that struggle the most to afford their energy bill 30% of households, based on a random selection 30% of households that struggle the most to afford their energy bill All households with no electricity connection
Actors who decide which households can receive the clean technologies	Federal government State and local government Civil organizations Regions: civil organizations and local and state government Local, state, and federal government levels Civil organizations at the local, state, and federal government levels

experimental design in which the possible attribute levels of each choice

task are selected such that the determinant of the asymptotic variance-covariance matrix of a specific choice model (in our case, a Multinomial Logit Model) is minimized, hence maximizing the statistical efficiency of the choice models that will be used once the sample is collected. In the final stage, we allocated the resulting experimental design to the choice tasks that will be shown in the survey by using the “Conjoint analysis” feature of Qualtrics. An example of the survey choice task is shown in Fig. 3.

The survey instrument that embedded the DCE was divided into two groups, namely the “treatment” and “control”. The allocation of control and treatment questionnaires was randomized for both the online and in-person sample. In the first section of the survey, respondents agreed to participate in the survey via an online consent form, which was integrated into the questionnaire. We followed GDPR standards by anonymizing responses and protecting the identity of participants, and participants were aware that they could stop the survey and skip questions at any time. The second section was only administered to the “treatment” group, in which participants read a description of crucial energy concepts to help participants understand the questions. These concepts covered: Sustainable energy projects, renewable energy, and fossil fuel consumption in Mexico and the US, primary energy decision-makers in Mexico and the US, the way citizens could participate in energy projects, and energy affordability benefits from renewable energy projects. Furthermore, we inserted a bias toward energy justice as well as general information on the energy transition in this description (see

English ▼

(1/6) This is where the choice questions begin. Please read the three project options described below and choose that one you find the best.

	Energy project choice 1	Energy project choice 2	Energy project choice 3
How you participate in the project	You do not participate	You adopt sustainable measures in your house (LED bulb lights, recycling waste, etc.),	You become a local leader by helping coordinate a sustainable energy project in your community (5h/week)
Groups receiving clean technologies	30% of households, based on a random selection	30% of households that struggle the most to afford their energy bill	All households with no electricity connection
Actors who decide on what households can receive the clean technologies	Regions: civil organizations, and local and state government	Civil organizations	Federal government
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

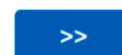


Fig. 3. Example of a choice scenario extracted from Qualtrics.

Appendix A, part 1), describing the status quo and what aspects could make the energy system fairer based on the energy justice framework [26]. This introduction allowed us to assess the impact of previous knowledge and justice framing. The third section contained the DCE choice tasks. The fourth section consisted of nine short questions on demographics, including gender, place of origin, place of residence, income level, age, and education level. In the fifth section, the participants had to answer two open-ended questions to collect people's general opinions on the topic of sustainability: (1) What do you consider to be the most important issues in your locality that should be taken into account when creating an environmentally friendly development plan? and (2) Do you have any final comments or questions about this survey? (optional). Finally, in the sixth section, participants were thanked for their time and effort, and the questionnaire ended.

### 3.4. Data analysis: discrete choice models

The data analysis is done through discrete choice models based on the Random Utility Maximization (RUM) model. We estimated different choice models to compare their results. For example, we calculated the effect that incorporating an introduction with information on energy topics and justice elements had on people's willingness to participate, in contrast to not including such information. The RUM model is a behavioral and econometric framework based on the notion that individuals seek to maximize the utility obtained from mutually exclusive alternatives and their attributes. In the RUM model, the utility of each alternative is commonly modeled as a linear-in-parameters function that depends on its respective attributes, a set of parameters that account for the preferences for increases of each attribute, and a stochastic error term. Mathematically, for a given individual  $n$  that faces  $J$  alternatives, the utility obtained from alternative  $j$  is given by eq. (1):

$$U_{nj} = V_{nj} + \varepsilon_{nj} = \delta_j + \sum_k^K \beta_k X_{nj,k} + \varepsilon_{nj}, \quad (1)$$

where  $V_{nj}$  is the observed part of the utility function  $U_{nj}$  and  $\varepsilon_{nj}$  is the stochastic error term, which represents an unobserved part of the utility.  $V_{nj}$  depends on  $\delta_j$ , which is an alternative-specific constant parameter, and  $\beta_k$  is a parameter associated with the  $k$ -th attribute  $X_{nj,k}$ .

Under the RUM model, an alternative  $i$  is chosen if  $U_{ni} > U_{nj}$ , for all  $j \neq i$ . However, the utility values are not perfectly observable since they depend on stochastic error terms. Instead, the analyst can derive an expression of the probability of choosing alternative  $i$  by assuming a distribution for the error terms. Given such a probability, the analyst obtains the estimated parameters using maximum likelihood estimation. Following Train (2009), by assuming an i.i.d. Gumbel distribution for  $\varepsilon_{nj}$ , the probability of choosing alternative  $i$  follows a Multinomial Logit (MNL) model, as shown in eq. (2):

$$P_{ni} = \text{Prob}(U_{ni} \geq U_{nj}, \forall j \neq i) = \frac{\exp(V_{ni})}{\sum_j \exp(V_{nj})}. \quad (2)$$

The estimated parameters of the MNL model have a behavioral interpretation. Firstly, the alternative-specific constants  $\delta_j$  inform the individual preferences for choosing alternative  $j$ , compared to other alternatives, and irrespective of the attributes of such alternative. For instance, if  $\delta_j > \delta_l$ , then, on average, alternative  $j$  is preferred over alternative  $l$ , without considering their respective attributes. Secondly, the attribute-specific parameters  $\beta_k$  inform about the individual preferences for the increase of the associated parameter  $k$ . If  $\beta_k > 0$ , then increases of attribute  $k$  are preferred, on average. Conversely, if  $\beta_k < 0$ , then decreases of attribute  $k$  are preferred, on average.

In addition, we estimate a Latent Class (LC) choice model. The LC choice model extends the MNL model to account for the discrete heterogeneity of preferences across individuals. In the LC choice model, it is assumed that the sample is divided into  $C$  classes. The unconditional probability of choosing alternative  $i$  is given by eq. (3)

$$P_{ni}^{LC} = \sum_{c=1}^C \pi_{nc} \cdot P_{ni|c}, \quad (3)$$

$\pi_{nc}$  is the class membership probability, which is the conditional probability of being in class  $c$ . This class is modeled as a linear-in-parameters function that depends on constant and individual-specific characteristics (e.g., gender, education, etc.).  $P_{ni|c}$  is the MNL probability of choosing alternative  $i$ , conditional on being in class  $c$ . Hence, for each class  $c$ , the term  $P_{ni|c}$  is similar to eq. (2), but it depends on an independent set of parameters  $\delta_c$  and  $\beta_c$ . Therefore, eq. (3) is a weighted sum of the probability of being in each class. In turn, in the LC choice model, each class is described by its own set of conditional parameters, both from the class membership function and from the conditional choice probability.

## 4. Results

Table 6 presents the results of the discrete choice model (MNL) for the online and in-person panels in the cross-border region, which encompassed a sample of 768 answers and 4608 observations. All the estimated parameters are statistically significant at a 95% confidence level. The first set of parameters accounts for the preference for participating in the project in two forms, compared with not participating. The second set of parameters reflects respondents' preferences for increasing the coverage of people who can receive clean technologies, compared with a minimum of 5% of households with difficulties paying their electricity bills. The third set of parameters illustrates the preferences for actors involved in the decision-making process, compared with solely involving the federal government.

### 4.1. Preference for citizen participation

Regarding the preferences for participating in the project, all estimates have a positive sign, indicating that respondents prefer to participate in any form rather than not participate. The magnitude of these parameters suggests that respondents are more willing to

**Table 6**  
MNL model estimation results, whole sample.

Attributes	Estimate	Standard error	P-value
<u>How you participate in the project (citizen participation):</u>			
Do not participate (baseline)	0	-	-
Adopt sustainable measures	<b>1.045</b>	<b>0.038</b>	<b>0.000</b>
Become a local leader	<b>0.118</b>	<b>0.045</b>	<b>0.009</b>
<u>Groups receiving clean technologies (distributional justice):</u>			
5% with issues with paying the bill (baseline)	0	-	-
30% randomly assigned	<b>0.102</b>	<b>0.049</b>	<b>0.037</b>
30% with issues to pay the bill	<b>0.383</b>	<b>0.049</b>	<b>0.000</b>
All households without electricity	<b>0.246</b>	<b>0.049</b>	<b>0.000</b>
<u>Deciding actors (procedural justice):</u>			
Federal government (baseline)	0	-	-
Local and federal government	<b>0.148</b>	<b>0.063</b>	<b>0.019</b>
Civil organizations (with citizen participation)	<b>0.226</b>	<b>0.064</b>	<b>0.000</b>
Civil organizations, local and federal government	<b>0.359</b>	<b>0.062</b>	<b>0.000</b>
Local, state, and federal government	<b>0.257</b>	<b>0.063</b>	<b>0.000</b>
Civil organizations, local, and state government	<b>0.212</b>	<b>0.063</b>	<b>0.001</b>
Number of individuals	768		
Number of observations	4608		
Log-likelihood	-4468.63		
Rho-Squared	0.12		
Akaike Information Criterion	8957.25		
Bayesian Information Criterion	9021.61		

**Note:** Statistically significant parameters at a 95% confidence level are in bold.

participate at the household level (e.g., adopting sustainable measures at home, such as changing bulbs to LED and recycling waste) than participating as local leaders. This was expected, as participation at the household level is a measure that is familiar to many families, as explained by some participants (in-person sample). Thus, this level was perceived to require less effort than being a community leader. Becoming a local leader represents another energy citizenship role [27] that requires the most considerable effort among the attribute levels, five hours of work per week.

#### 4.2. Preference for distributional justice

There is a general preference for distributional justice, that is, projects distributing clean technologies to different vulnerable groups. All estimated parameters for distributional justice have a positive sign. This suggests that respondents prefer all proposed increases, compared with the minimum 5% of households with issues paying their energy bills. In terms of the magnitude of the estimated parameters, it is observed that respondents prefer to focus on the provision of technologies to those who have issues paying the bill, followed by all households without electricity, and lastly, a random selection of households. Notably, the level “30% of households with issues paying their energy bill” represents a larger share of inhabitants than the level “all households without electricity connection”. In Mexico, there is 98.95% of electrification [69], but it is well known that some families struggle to afford their energy bills. Conversely, the level “30% of randomly selected households” represents a larger population than “30% of households with issues paying the energy bill”. However, we did not verify if respondents were aware of these facts. Therefore, we can only conclude that participants prefer projects that benefit citizens with energy affordability issues.

#### 4.3. Preference for procedural justice

Regarding the preferences for procedural justice, that is, the involvement of diverse groups in decision-making, the estimated parameters have a positive sign, which suggests that all alternatives over solely involving the federal government are preferred. A potential explanation for this result is that having the federal government as the sole decisionmaker may have been perceived as a top-down approach, with little understanding of the local context. In reality, energy project planning is managed by governmental organizations in federal, state, and private-public partnerships in the US and Mexico. However, in Mexico, the National Secretariat of Energy (SENER) is the central organization in charge. Furthermore, the most preferred involvement strategy was the combination of civil organizations, local (municipal), and federal government, showing that participants prefer that decision-making involves multiple administrative levels and citizens, which is not the case in Mexico and the US. This result shows that citizens prefer projects that include different government levels and citizens, that is, a decentralized and citizen-inclusive decision-making process.

#### 4.4. Differences between the control, treatment, and in-person groups

In this section, we compare how preferences vary across the control (online plus in-person), treatment (online plus in-person), and in-person (control and treatment) groups to evaluate the effect of having a higher knowledge level and a bias toward justice in the treatment group and the differences between the online and in-person samples. Table 7 summarizes these differences in terms of the estimated parameters. The differences between these groups were assessed with a *t*-test to identify statistically significant differences. Significant differences between the control and treatment groups are observed only in procedural justice, which suggests a salience effect rather than a learning effect. The information provided likely increased the prominence of justice considerations in the decision-making process, rather than altering

**Table 7**  
Differences between control, experiment, and in-person sample.

	Control - experiment		Control - in-person		Experiment - in-person	
<u>How you participate in the project:</u>						
Do not participate (baseline)	-	-	-	-	-	-
Adopt sustainable measures	-0.134	0.109	0.049	0.679	0.183	0.133
Become a local leader	-0.011	0.912	-0.451	<b>0.000</b>	-0.440	<b>0.001</b>
<u>Groups receiving clean technologies:</u>						
5%, with issues to pay the bill (baseline)	0.000	-	0.000	-	0.000	-
30% randomly assigned	-0.045	0.675	-0.165	0.267	-0.120	0.431
30% with issues to pay the bill	-0.090	0.401	-0.295	<b>0.044</b>	-0.205	0.174
All households without electricity	-0.028	0.795	-0.600	<b>0.000</b>	-0.571	<b>0.000</b>
<u>Deciding actors:</u>						
Federal government (baseline)	0.000	-	0.000	-	0.000	-
Local and federal government	-0.215	0.120	-0.144	0.446	0.071	0.715
Civil organizations (with citizen participation)	-0.097	0.492	-0.432	<b>0.021</b>	-0.335	0.086
Civil organizations, local and federal govt.	-0.326	<b>0.018</b>	-0.682	<b>0.000</b>	-0.357	0.059
Local, state, and federal government	-0.179	0.198	-0.264	0.166	-0.085	0.667
Civil organizations, local and state government	-0.295	<b>0.034</b>	-0.654	<b>0.000</b>	-0.359	0.061

**Note:** Statistically significant parameters at a 95% confidence level are in bold.

participants' underlying knowledge or attitudes.

The treatment group preferred two decision-making or procedural justice levels (attribute 3): Civil organizations, local and federal government, and civil organizations, local and state government, for which the control group showed a smaller magnitude of the associated parameters. This could be a result of being informed and/or introducing a bias toward more decentralized decision-making in the treatment introduction. Contrary to our expectations, we found that the introduction did not motivate the experimental group to participate more actively. Table 7 shows that there was no difference in people's willingness to participate between the control and treatment groups (*P*-value greater than 0.05); both preferred participating at the household level, as described in Section 4.1.

The analyses revealed differences between the control, in-person, and treatment groups in their willingness to participate, as shown in Table 7. The control group is less willing to participate (-0.451 difference, *P*-value 0.000) as a local leader than the in-person group. The same occurs for the preferences for distributional justice or the groups receiving clean technologies. Specifically, the levels “30% of households with affordability issues” and “households without electricity” are more preferred by the in-person group than the control and experiment groups. Since the in-person group covered only vulnerable groups, these results show that vulnerable groups have a stronger preference toward distributional justice, particularly energy affordability and access, and a stronger willingness to participate than an average citizen.

Interestingly, only two differences are observed between the treatment and in-person groups. The treatment groups show a lesser

preference for becoming a local leader (−0.440 with P-value 0.001) and a lesser preference for the distribution of solar panels to all households without electricity (−0.571 with P-value 0.000). This finding reinforces the interpretation of the results (Section 5.4.2), showing that vulnerable groups have the strongest willingness to participate as local leaders compared to average and informed citizens. This suggests that vulnerable groups have knowledge of energy-related topics and that they value distributional justice the most because of their direct connection with distributional injustices, like a lack of electricity connection. This is also why they are more willing to volunteer as a local leader of energy just projects.

4.5. Latent class choice model

To identify the different groups of citizens regarding preferences, we conducted an LC choice model, which groups individuals into unobserved (latent) classes or groups based on their choices and preferences. The optimal number of classes of the LC choice model is usually determined by estimating different models from two to four latent classes and keeping the model with the lowest Bayesian Information Criterion (BIC). From this procedure, the 4-class LC choice model reported the lowest BIC. Despite the latter, we decided to report the 3-class LC choice model as it is easier to interpret and communicate for the reader, and its BIC differences were not substantial. Appendix C provides details of the BIC per class of the LC choice model.

Table 8 summarizes the estimation results of a 3-class LC choice model, which divides responses into three groups with similar preferences. These classes aggregate the control, treatment, and in-person groups. Based on the class membership parameters of the LC choice model, the class membership probabilities were computed for each class (see Table 9) in terms of the socio-demographic characteristics.

Table 8  
Latent class choice model<sup>a</sup>.

	Class 1			Class 2			Class 3		
Class size:	34.3%			54.0%			11.8%		
	Est.	S.E.	P-val.	Est.	S.E.	P-val.	Est.	S.E.	P-val.
<u>How you participate in the project:</u>									
Do not participate (baseline)	–	–	–	–	–	–	–	–	–
Adopt sustainable measures	<b>2.779</b>	<b>0.211</b>	<b>0.000</b>	<b>0.790</b>	<b>0.074</b>	<b>0.000</b>	<b>−0.951</b>	<b>0.263</b>	<b>0.000</b>
Become a local leader	<b>−0.866</b>	<b>0.319</b>	<b>0.007</b>	<b>0.743</b>	<b>0.082</b>	<b>0.000</b>	<b>−2.864</b>	<b>0.469</b>	<b>0.000</b>
<u>Groups receiving clean technologies</u>									
5% with issues to pay the bill (baseline)	–	–	–	–	–	–	–	–	–
30% randomly assigned	0.021	0.202	0.919	0.011	0.075	0.886	<b>0.918</b>	<b>0.301</b>	<b>0.002</b>
30% with issues to pay the bill	0.398	0.212	0.061	<b>0.435</b>	<b>0.070</b>	<b>0.000</b>	<b>0.780</b>	<b>0.242</b>	<b>0.001</b>
All households without electricity	−0.338	0.236	0.153	<b>0.444</b>	<b>0.072</b>	<b>0.000</b>	−0.027	0.247	0.913
<u>Deciding actors</u>									
Federal government (baseline)	–	–	–	–	–	–	–	–	–
Local and federal government	0.253	0.287	0.378	<b>0.224</b>	<b>0.088</b>	<b>0.011</b>	−0.127	0.246	0.606
Civil organizations (with citizen participation)	0.458	0.286	0.109	<b>0.300</b>	<b>0.092</b>	<b>0.001</b>	0.510	0.300	0.090
Civil organizations, local and federal govt.	<b>0.649</b>	<b>0.270</b>	<b>0.016</b>	<b>0.463</b>	<b>0.091</b>	<b>0.000</b>	0.163	0.266	0.539
Local, state, and federal government	0.425	0.262	0.104	<b>0.311</b>	<b>0.092</b>	<b>0.001</b>	0.162	0.303	0.594
Civil organizations, local and state government	0.256	0.265	0.333	<b>0.301</b>	<b>0.091</b>	<b>0.001</b>	−0.019	0.285	0.946
<u>Class membership parameters:</u>									
Constant	–	–	–	<b>2.155</b>	<b>0.410</b>	<b>0.000</b>	−0.451	0.792	0.569
Is a woman				−0.663	0.204	0.001	−0.386	0.301	0.200
Age 25–34				−0.470	0.371	0.205	0.568	0.756	0.452
Age 35–44				−0.391	0.370	0.290	0.507	0.753	0.501
Age 45–54				<b>−0.969</b>	<b>0.375</b>	<b>0.010</b>	0.757	0.731	0.301
Age 55–64				<b>−1.667</b>	<b>0.400</b>	<b>0.000</b>	0.285	0.741	0.700
Age 65 or more				<b>−2.237</b>	<b>0.416</b>	<b>0.000</b>	−0.689	0.806	0.393
Has a high school education				<b>−0.530</b>	<b>0.269</b>	<b>0.049</b>	−0.435	0.395	0.271
Has a university education				−0.453	0.262	0.083	−0.804	0.421	0.056
Is from Mexico				−0.143	0.229	0.534	<b>−0.853</b>	<b>0.401</b>	<b>0.033</b>
Number of individuals	768								
Number of observations	4608								
Log-likelihood	−3979.14								
Rho-squared vs equal shares	0.214								
AIC	8058.28								
BIC	8380.06								

<sup>a</sup> Results in bold are statistically significant at 95% of confidence level

Table 9  
Class membership probabilities.

Covariate	Class 1 (34.3% = 263)	Class 2 (54% = 415)	Class 3 (11.8% = 91)
Is a woman	63.6%	47.3%	53.5%
Age less than 25	7.2%	16.8%	5.0%
Age 25–34	16.5%	24.7%	18.2%
Age 35–44	15.5%	26.7%	18.3%
Age 45–54	16.5%	15.5%	27.0%
Age 55–64	18.0%	9.0%	20.2%
Age 65 or more	26.4%	7.3%	11.3%
Has less than a high school education	21.7%	28.7%	26.5%
Has at least a high school education	39.6%	33.7%	44.3%
Has a university education	38.7%	37.6%	29.2%
Is from the US	66.9%	59.0%	74.7%
Is from Mexico	30.0%	38.1%	20.9%

4.5.1. Passive citizens

Class 1 consists of participants with an almost equal distribution of age groups, but with more dominance of older adults (26% were older than 65 years old). As shown in Table 9, this class is dominated by women (63%) who went to high school or university (78%) and reside in the US (67%). According to the attribute parameters, Class 1 (34% of the whole sample) shows the highest preference toward a moderate level of participation (i.e., adopting sustainable measures at home). Conversely, respondents of this class are not willing to be local leaders compared to those who do not participate. Regarding the involvement of more actors in the decision-making process, this class prefers having civil organizations and local and federal governments as decision-makers over only

the federal government.

#### 4.5.2. Optimistic citizens

Class 2 comprises 47% women, 68% young respondents (younger than 45 years old), 71% highly educated (attended high school or university), and the most extensive presence of residents of Mexico among the three classes, with 38% (see Table 9). This class (54% of the whole sample) prefers to participate at the household level and as a local leader over not participating. This group represents the so-called 'optimistic citizens' who are the most sensitive to justice aspects, as this class showed a preference for projects with apparently more distributional and procedural justice.

#### 4.5.3. Skeptical citizens

As described in Table 9, class 3 is composed of 53% of women, almost equally distributed ages, more dominance of high school attendance (44%), and the lowest among the three with university studies (21%), and the biggest dominance of US residents (75%). Class 3 (11.8% of the sample) shows the largest preference for not participating. Furthermore, this class is the only one that shows a preference toward a random selection of 30% of households to receive solar panels and the only one that is not influenced by the procedural justice attribute (involvement of more actors in the decision-making process). Hence, this group can be considered skeptical because it does not want to participate in projects. As this group is composed mostly of U.S. residents, it can be argued that these respondents may be less sensitive to energy justice issues, as they are likely more distant from energy vulnerabilities and energy-vulnerable groups than residents in Mexico.

### 5. Discussion: to what extent do projects that include justice dimensions (participatory and distributional) motivate citizens to participate, or not?

This study aimed to answer the research question, "To what extent do projects that include justice dimensions (participatory and distributional) motivate citizens to participate, or not?" The surveyed regions were Baja California, Mexico, and Southern California, US, which are part of the Mexico-US cross-border regions. Because this study uses stated-preference data from a hypothetical DCE, findings reflect associations between experimental attributes and choices, not observed participation or causal behavioral mechanisms.

We expected that projects that considered justice aspects would motivate citizens to volunteer because of theoretical assumptions. According to a social acceptance framework, perceiving justice in energy projects in distributional and procedural justice can lead to community acceptance and cooperative behavior of citizens [20,24]. Additionally, justice sensitivity theory states that citizens' preference for justice can be triggered by showing the impacts on affected people [70]. The experiment tested the effects of projects considering aspects related to distributional and procedural justice (see attributes levels 2 and 3 in Table 5) compared to projects that did not consider justice aspects. The results are consistent with theoretical expectations, as most citizens (89%) indicated greater willingness to participate in projects benefiting affected people (vulnerable groups) in terms of distributional (sharing of solar energy technology) and procedural justice (a more horizontal structure of decision-making).

However, the study did not deepen into the actual perception of participants. This study cannot confirm that participants perceived some projects more just than others. We could only see the effect of framing energy projects with what we consider being more distributional just and procedural just. It is possible that participants had other reasons for choosing a project that benefits vulnerable people. Perhaps they considered some projects were more relatable than others, especially for vulnerable groups. Notwithstanding, it is interesting to know that considering justice in energy projects had an overall positive effect on citizens' willingness to participate.

### 5.1. Participation, distributional and procedural justice

As expected, the type of participation was the most influential attribute, followed by distributional justice (distribution of benefits among vulnerable groups) and procedural justice (involvement of diverse actors in decision-making). This is consistent with previous research showing that citizens evaluate energy transition policies not only based on outcomes but also based on their own role and level of involvement [20,27]. These differences reflect the varying degrees of agency described in energy citizenship frameworks, where engagement ranges from individual behavior to active involvement in collective initiatives [10,27].

Between the two justice dimensions, distributional justice had a stronger influence than procedural justice, aligning with evidence showing that perceived distributional fairness is a key determinant of public acceptance, particularly when policies address energy poverty and access to technologies [25,34,35]. Participants may therefore have prioritized distributional outcomes because they are directly linked to material benefits and energy access [26,33,36].

Although procedural justice had a smaller effect, qualitative comments suggest that decision-making processes remain important. One participant noted that when decisions are made only by government authorities, citizens may disagree with implementation details but still have limited influence over the outcome (Notes from the in-person survey, 2024). This reflects findings from environmental governance research showing that perceived procedural fairness affects trust in institutions and acceptance of decisions, even when outcomes are favorable [37,38]. Perceptions of fairness depend on whether stakeholders feel represented and whether decision-making processes are transparent and inclusive [39]. As emphasized in the energy justice and energy democracy literature, insufficient participation can reduce the legitimacy and effectiveness of energy projects, as solutions that do not consider local preferences may not be fully adopted [5,6,10].

In decolonial contexts, procedural justice also requires recognizing forms of authority and knowledge that are not always acknowledged within formal governance structures [9]. Energy justice and energy democracy frameworks highlight that fair decision-making depends on the inclusion of diverse actors, especially where historical inequalities have limited participation [5,10]. For example, the Kumiai, Paipai, and Cucapah Indigenous communities in Baja California, Mexico, maintain traditional systems of authority that are not fully recognized by state institutions, as formal procedures determine who is granted Indigenous status and rights. In such contexts, procedural justice in the energy transition requires that Indigenous communities are able to influence decisions and shape local transition pathways, rather than only being consulted after decisions are made [9].

### 5.2. Level of knowledge

No significant differences in the preferred type of participation were observed between the treatment (i.e., people who were informed about energy, sustainability, and justice topics) and control groups. This may suggest that informing citizens on energy and justice-related topics does not influence citizens' willingness to participate. A possible explanation is that most participants already had some prior understanding of energy and justice issues, enabling them to perceive differences among project options without additional prompting [20,25,26].

This is partly explained by the relatively high education level of the online sample: 13% of participants who reached an education level of middle school or less, 7% who did not want to disclose their educational level, and the rest 80% with middle school education or higher. This is consistent with the average population in California [71], although considerably higher than in Baja California, where the population with a high school degree corresponds to 26% [72]. This aligns with prior research showing that energy literacy and factual knowledge can enhance perceived benefits of renewable energy and increase

acceptance when combined with fair and transparent decision-making and opportunities for meaningful participation [23,47–49]. Therefore, even in relatively knowledgeable populations, it remains important to provide clear information or assess citizens' knowledge levels to ensure informed engagement with energy projects.

### 5.3. Citizens willing to volunteer at the household level

We identified three groups of respondents: passive, skeptical, and optimistic. The passive group (class 1) represented citizens who wanted to participate at the household level but did not want to make the biggest effort. This class, dominated by older, educated women from the US, preferred participating from home and was inclined to projects where civil organizations, locals, and the federal government made the decisions. Although this group does not show radical behavior, its preferences for citizen involvement in the transition are more ambitious than the status quo in the US-Mexico cross-border region.

In Mexico and the US, citizen engagement at the household level has been focused on energy efficiency and the ownership of renewables like solar energy and adoption, but the reach of these approaches is limited. The State of California has a community solar program that has offered subsidies to disadvantaged and low-income residents since 2007 [73]. In Baja California and Mexico in general, the National Energy Secretariat started a program in 2024 that subsidizes 25% of all solar panel costs, and 75% can be covered by a 5-year trust fund for households with above-average energy consumption [53]. This subsidy in Mexico is likely not reaching vulnerable households because of the consumption threshold that overlooks average households and households with low consumption. Also, the governmental trust fund conditions may not be appealing to some citizens. Currently, Mexico and the US have policy instruments to incentivize households to acquire more energy-efficient appliances, although the reach of these efforts is not clear [74,75]. In terms of waste recycling, the State of California has several programs that encourage the recycling of bottles, organic waste, and e-waste, and the 2010 ban on plastic bags was unsuccessful [76]. However, in Baja California, recycling is limited to tires and PET bottles, and the latter is not available everywhere in the state [77].

Solar subsidy programs in Baja California should prioritize energy-vulnerable citizens, including those who currently lack access to electricity, rather than focusing only on top consumers. Implementing waste recycling programs in the state, a concern frequently raised by participants, provides a tangible way for citizens to engage at the household level. Therefore, renewable energy programs that address the needs of vulnerable groups and establish a structured waste recycling system in the region could be pivotal for fostering widespread citizen engagement.

### 5.4. Citizens willing to volunteer as local leaders

Among the three classes, optimistic citizens (class 2), comprising mostly young respondents and vulnerable groups, showed the strongest willingness to take local leadership roles. Below, we discuss the implications of this finding for each of these groups separately.

#### 5.4.1. The role of youth

Optimistic citizens (class 2), who represent the majority of the sample (54%), showed the strongest willingness to become local leaders. This finding is consistent with prior studies showing young people's capacity to self-organize to address environmental issues [78], and evidence that youth should be engaged in energy transitions [79], while older people have shown to exhibit more support for climate justice policies [13].

Yet, youth have been widely underrepresented in sustainability policies and decision-making in general, as policies and policy-makers have failed to include youth's interests in the political agenda [80–82]. This is also the case in Mexico and the US, where there is no formal platform for citizens to be represented in decision-making other

than public consultations on existing projects. Opening formal decision-making spaces for youth and other underrepresented groups is necessary for the support, continuity, and maturity of their initiatives. Supporting youth's involvement in local decision-making spaces can be enabled by ICT tools like e-participatory games in co-creation spaces [83].

#### 5.4.2. The role of vulnerable groups

Justice sensitivity studies suggest that observers of injustice are more prone to cooperate, whereas victims of injustice are expected to behave more egoistically [24,31]. Based on this, one might expect advantaged citizen groups (observers) to be the most willing to take on local leadership roles. However, our results show that vulnerable groups are more willing to be local leaders. This pattern is consistent with greater sensitivity to justice-related attributes among vulnerable groups, though the study did not directly measure justice sensitivity, perceived injustice, or underlying motivations. Contrary to theoretical expectations, vulnerable groups' preferences were consistent with a stronger orientation toward collective and justice-oriented project features rather than self-interested choices. However, as this study captures preferences in a hypothetical scenario, actual participation behavior and its motivations require validation through observational or participatory methods.

This finding contributes to the literature by showing that vulnerability does not necessarily translate into lower engagement or self-interested behavior in energy transitions. Vulnerable citizens may volunteer because they experience energy-related challenges directly and recognize the benefits of participation for themselves and others. Many of the surveyed vulnerable groups have lived with energy poverty for extended periods, which may partly explain stronger stated preferences for both distributional and procedural justice attributes [19]. These citizens have previously tried to improve their situation by organizing neighborhoods to acquire solar panels or by petitioning government and electricity companies for connections and affordable tariffs. They also show a preference for procedural justice, valuing the involvement of more actors—especially fellow citizens—in decision-making. Their knowledge of bureaucratic procedures and lived experiences with rigid governance underscores the importance they place on access to energy decision-making spaces.

Open-ended responses further illustrate vulnerable groups' awareness and engagement. For example, one respondent emphasized collective action and basic energy needs:

*“All the people in this neighborhood should join together and pick up the trash from the streets so as not to pollute the environment. Where I live, there is no electricity. It would be nice if they put up light poles. There are students, and they don't have light (illumination) to study. They use small [solar] panels that only charge when there is sun. They only serve for [to turn on] a light bulb.”* (First author's translation, In-person questionnaire respondent, 2024).

Another highlighted the need for self-sufficiency and locally relevant solutions:

*“Implementing the protection of animals, plants, and the territory. [There have been] invasions [of our territory]. The government should give us more work projects and training for self-generation here in the community so that we become self-sufficient. The leaders that the government selects do not advocate for the problems of the rural community. When the government comes up with projects, their conditions do not match our needs.”* (First author's translation, In-person questionnaire respondent, 2024).

These findings suggest that policies aiming to foster local leadership and collective action should explicitly consider and empower vulnerable groups, who may be highly motivated, informed, and justice-sensitive actors capable of shaping equitable energy transitions.

### 5.5. Generalization of findings

The findings of this study raise hypotheses that may be relevant to other cross-border or Global South contexts, though direct generalization is limited by the case-specific design and sampling approach. The

first finding shows that the general population prefers projects with distributional and procedural justice, but it also prefers effortless participation at the household level. This pattern can be expected in most contexts where there is some degree of social awareness of energy poverty. Places where renewable energy projects have caused disturbances might show different results, as acceptance of renewables might be lower.

The second finding suggests that the pattern of youth and vulnerable groups showing stronger willingness to take local leadership roles may be present in other Global South contexts, where vulnerable groups already make a considerable effort in trying to solve their energy service problems, like a lack of electricity access. Youth have widely been reported as more invested in sustainability initiatives [78,81,83], which suggests that youth might be more willing to lead local energy projects elsewhere.

Yet, opportunities for citizens to participate in decision-making in Mexico and the United States remain limited to consultation processes as part of Environmental Impact Assessments and Statements, with little scope for shared governance or community leadership. This institutional setting contrasts with recent energy citizenship approaches, which emphasize that a just and effective energy transition requires enabling citizens to take multiple roles, including collective actors and contributors to governance, rather than only individual consumers [44–46]. This study suggests that policies enabling youth and vulnerable groups to take community leadership roles may support broader uptake of local energy transition projects, a hypothesis that warrants testing in real-world participatory settings. For example, decision-makers could engage with youth via digital platforms and offer training to help address energy issues in their communities. Additionally, identifying, acknowledging, and connecting with existing local organizations and traditional authorities of vulnerable groups is needed to enable participation in decision-making.

### 5.6. Methodological limitations and future research

The DCE method was effective in evaluating the influence of justice perception on people's behavior, so we recommend it for future studies testing energy justice aspects. However, socio-demographic and open-ended questions on respondents' priorities to tackle in a sustainable development plan helped confirm the relevance of the research and identify further issues not covered by the study. Nonetheless, we cannot ensure that all groups interested in participating will actually do it in a real-world setting. Thus, future studies can validate citizens' willingness to participate using participatory methods like game-based scenarios or in a real project, where participants' behavior is observed to evaluate their actual level of engagement.

The DCE design also has inherent limitations that should be acknowledged. First, only three attributes were included (participation type, distributive justice, and procedural justice); other potentially relevant attributes such as economic costs, environmental impacts, and trust in institutions were omitted, which may have inflated the relative importance of the included attributes. Second, the treatment group introduction explicitly framed energy projects in terms of justice, which likely primed respondents to prioritize justice-related attributes, which is a framing effect that should be considered when interpreting the results. Third, the attribute levels were chosen to represent a range of justice configurations but do not capture the full complexity of real project designs. Additionally, this study does not operationalize recognition justice, which concerns the respect for diverse identities, cultures, and knowledges in energy governance. Future research could assess this dimension, particularly in contexts involving Indigenous and marginal communities.

It is important to note that the differences between vulnerable groups and other groups can be influenced by the data collection method. Surveying vulnerable groups was not possible with the online panel from Qualtrics, but could only be reached with a targeted sampling method

and in-person data collection. This is clearly a limitation of the method that can be overcome if the general population is also surveyed in person. However, when addressing justice issues with vulnerable groups, one needs to establish a two-way communication channel. The survey results suggest that vulnerable groups are interested in getting involved in energy projects with justice components, and this could be a means for decision-makers to start addressing energy justice issues.

It is essential to acknowledge the challenges of reaching HTR and vulnerable groups in surveys, especially when the decision scenarios are highly complex. About the same funding was used for the online sample of 651 answers, recruited by a market research company, and the in-person sample of 118 answers with a group of five local assistants (led by the first author). Additionally, conducting the in-person survey required more previous work to identify the target groups and make connections with them through key stakeholders. Sometimes, these groups are located in remote areas or are available early in the morning on their way to work, requiring more effort from the assistants. It is worth mentioning the strong interest these groups had in participating in the survey, as many of them did not want to accept the monetary compensation. Yet, we consider this compensation necessary as a form of gratitude for the time they spent answering the questionnaire. Sometimes, they would respond during working hours. These challenges should be accounted for in future studies aiming to include HTR groups.

The description of distributional and procedural justice in terms of attributes and levels is limited and case-study specific. The distributional justice levels combined targeting qualitative groups (off-grid, random) with quantitative coverage (5%, 30% energy poor). The results overlook whether participants prioritized certain groups or coverage. A follow-up interview could help clarify this point.

## 6. Conclusion

We answered the research question: To what extent do projects that include justice dimensions (participatory and distributional) motivate citizens to participate, or not?. This study provides evidence consistent with the view that procedural and distributional justice attributes are associated with greater citizen preference and stated willingness to participate in local energy projects [20]. This preference is also present when citizens do not receive additional information on justice, energy, and sustainability topics. In contrast, the preference for procedural justice increased when further information was provided.

Remarkably, most citizens (88% of 768 respondents) stated willingness to participate in local energy projects by taking sustainable measures at home, especially when the projects are perceived as distributionally and procedurally just. We recommend local policy makers to prioritize vulnerable groups in solar panel subsidy programs and to implement a structured waste recycling program in Baja California. These two measures could be key to fostering widespread household-level engagement in the energy transition.

Our empirical findings challenge current conceptions of roles in energy citizenship. Vulnerable groups and youth value energy-just projects the most and are the most willing to have a leading energy citizenship role. Despite their energy struggles in meeting basic energy needs [19] and far from being conflicted with other priorities, as has been previously reported [30], HTR groups like energy-poor, off-grid, immigrants, long-commuters, and female groups showed a strong interest in actively addressing local sustainability issues. These groups have non-institutionalized modes of organization, which should be identified, acknowledged by, and connected with formal institutions to enable vulnerable groups' formal participation in decision-making.

Surprisingly, the largest demographic group, with 54% of the sample, the youth (mostly younger than 44 years), also showed more willingness to be local leaders. This finding shows great potential for widespread local sustainable energy projects. This finding urges the creation of platforms supported by formal institutions where diverse youth can participate or be represented in local energy decision-making

in the US-Mexico cross-border region.

### CRedit authorship contribution statement

**Amanda Martínez-Reyes:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **José Ignacio Hernández:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Gerdien de Vries:** Writing – review & editing, Supervision.

### Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Martínez-Reyes Amanda declares that this paper was partially funded by the Energy Transition Lab of the Faculty of Technology, Policy and Management at Delft University of Technology, under the call “Open exploration of the energy transition 2021; short risky projects”.

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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.2026.104770>.

### Data availability

Data will be made available on request.

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