Energy Policy 208 (2026) 114899

Contents lists available at ScienceDirect

Energy Policy

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

Social perception of renewable energies: barriers and opportunities for an inclusive energy transition

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ARTICLE INFO

Keywords:
Renewable energies
Social perception
Energy sources
Climate change
Social impact

ABSTRACT

The energy transition from an energy mix based on fossil fuel sources to one based on renewable energy is increasingly part of the public agenda in the European Union. The horizon is the fight against climate change and thus a paradigm shift for the progressive electrification and decarbonization of the social, productive and consumption systems. However, the transition to a sustainable development model must be fair and inclusive for present and future generations and accordingly depends on the social perception of this process. This research contributes to addressing the gap in the literature and aims to delve into the social perceptions of the population towards renewable energies in Spain. The results reveal that though renewable energies are largely supported by public opinion, along with environmental protection and health, this concern wanes when it affects the household energy bill. Furthermore, knowledge about technical and economic aspects of these renewable technologies is limited. This research also highlights the public's confidence in universities – thus in science – and the low level of trust in political parties regarding energy-related information. Finally, social acceptance of solar energy and biomass can be observed in rural areas, whereas there is lower approval in larger urban areas. The research has been carried out based on the Survey of Social Perception on Support for Renewable Energies, being the first representative survey at the national level in Spain. These findings contribute to policy design and performance regarding the transition to renewable energy technologies and its close relation to public opinion.

1. Introduction

1.1. Institutional context

There is already institutional architecture for the development of renewable energies in democratic societies. Social acceptance of such development is a key issue that has the capacity to accelerate or slow down their fight against climate change (Jeong and Ha, 2015; Schwirplies, 2018; Tam and McDaniels, 2013). Hence, analysis of the opinions, values, attitudes, and knowledge of the population is an important input for public policies (Bouman et al., 2021; Corner et al., 2014).

The global institutional framework for renewable energy development is fundamentally shaped by the UN 2030 Agenda and its Sustainable Development Goals (SDGs) (United Nations, 2015), which establish a comprehensive blueprint for sustainability and environmental protection (Diaz-Sarachaga et al., 2018; Kostetckaia and Hametner, 2022; Tremblay et al., 2020). Within this context, the European Union's strategy identifies energy production and distribution as crucial elements for achieving an equitable ecological transition (European Commission, 2022).

The imperative to address climate change through energy decarbonization, coupled with increasing energy demand, has prompted governments worldwide to prioritise renewable energy policies in their transition agendas (Meeus et al., 2022). Since 2022, the Russia-Ukraine war has introduced new parameters in renewable energy transition discourse, particularly regarding EU energy security (European Commission, 2022), while simultaneously highlighting societal vulnerability to energy price fluctuations (Belaïd, 2022). In response to these challenges, the degrowth theoretical framework questions prevailing economic growth paradigms, advocating for reduced energy demand as a sustainable alternative to supply-focused renewable expansion (Grubler et al., 2018; Sorrell, 2015).

Renewable energies offer varying resources across diverse geographical contexts (Nations, 2022). From an environmental

This article is part of a special issue entitled: Climate-Tech-Justice published in Energy Policy.

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https://doi.org/10.1016/j.enpol.2025.114899
Received 17 March 2025; Received in revised form 8 September 2025; Accepted 16 September 2025
Available online 16 October 2025

perspective, renewable energy expansion has been instrumental in climate change mitigation through greenhouse gas emission reduction, offering a significantly cleaner alternative to fossil fuels (Creutzig et al., 2017; Jacobson et al., 2018; Sanz-Hernández et al., 2019). The emergence of renewable energy production as a central component of ecological transition policies has garnered substantial support (although with controversy in the case of wind and solar farms) and regulatory framework development within the European context, considering the risks of climate and energy policies driven by short-termism and cost-effectiveness (Ćetković and Buzogány, 2016). This institutional backing reflects growing recognition of the role of renewables in achieving broader sustainability objectives while addressing energy security concerns.

1.2. Renewable energy in Spain

Spain is one of the countries with the greatest development of renewable energies and it continues to grow along these lines. In just a few years, it has managed to become the third country in the world in solar production per capita – only surpassed by Australia and the Netherlands –, as well as holding the sixth position for the highest percentage of this type of renewable source in the electric system – behind Chile, Greece, Hungary, the Netherlands and Australia. In 2020 Spain approved the National Integrated Energy and Climate Plan (PNIEC, 2021–2030), and since 2023 renewable energies have covered over 50 % of the demand (in 2024, almost 57 % of the electricity mix in Spain was from renewables) (Fig. 1).

In relation to seasonal reliability considerations, this perception framework is quite complex when examined against supply reliability concerns, particularly during the during the winters. For example, solar energy is affected by fewer hours of sunlight, lower solar angle, cloud cover, and snow and ice. In December, photovoltaic generation can fall by up to 50 % compared to the summer months. In addition, during the winter, wind energy is affected by stronger and more consistent winds, with the denser air allowing wind turbines to generate more electricity with the same wind speed. There is also less turbulence and more constant airflow for the turbines, while at the same time, snowstorms and ice can damage the turbines. Wind energy can generate between 30 % and 40 % of renewable electricity during this season, consolidating itself as one of the main renewable sources.

Spain pursues the decarbonization and energy security goals set by the EU (Peña-Ramos et al., 2021). The Strategic Framework for Energy and Climate in Spain was established in 2019, which is the key tool to follow the triple line set by Europe: mitigation, adaptation and just transition (Ministerio para la Transición Ecológica y el Reto Demográfico, 2020). The key elements of the Strategy are focused on governmental initiatives such as: i) the Climate Change and Energy Transition Law; ii) the Integrated National Energy and Climate Plan 2021–2030 (PNEC); iii) the National Climate Change Adaptation Plan 2021–2030, and iv) the Just Transition Strategy.

Based on this global and specific institutional framework for Spain, this research analyses the social perception of renewable energies in Spain.

2. Contextual and theoretical framework: social perception of renewable energies

Energy can provide direct economic benefits to local communities by generating employment (Ellis et al., 2023; Irena and Ilo, 2022), while also improving their energy sovereignty (Sanz-Hernández et al., 2019). Renewable energies, such as solar and wind energy, have become increasingly cost-competitive compared to fossil energy sources (Cortes Simon & Arango Londoño Adriana, 2017).

In several European countries, renewable energies are cheaper and create three times more jobs compared to fossil fuels (Agora Energiewende and Ember, 2021; Nations, 2022). At the same time, decentralised solar PV allows households to generate their own electricity, reducing dependence on conventional electricity grids and providing greater energy resilience (Cacciatore et al., 2012). It is aimed at promoting individual and household responsibility, generating empowerment and autonomy, similar to the use of carbon calculators in the UK (De Aguiar et al., 2016).

The transition to renewable energy depends on its medium- and long-term social acceptance and how it is managed with citizens (Dermont et al., 2017; Ellis et al., 2023; Gargallo et al., 2020; Vuichard et al., 2022). This acceptance operates through multiple interconnected dimensions, as Wuestenhagen et al. (2007) identify: (i) socio-political acceptance (broad policy support); (ii) community acceptance (local project acceptance), and (iii) market acceptance (investor and consumer adoption). Despite widespread acceptance of renewable energies (European Commission, 2019), the rapid development of renewable energy (RE) installations in Spain (and other countries), and especially

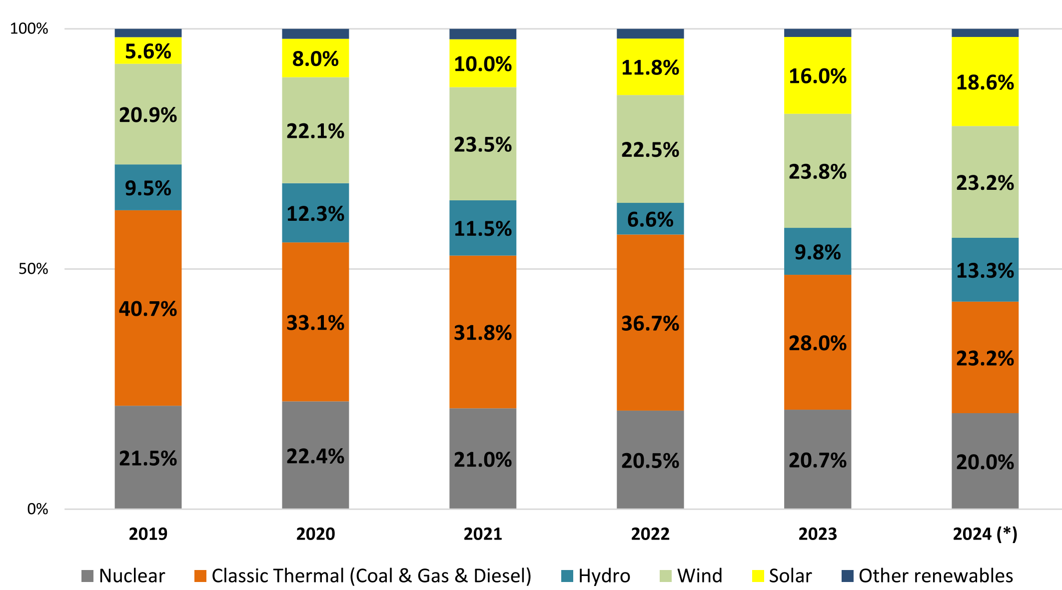


Fig. 1. Structure of energy generation by technologies in Spain (2019–2024) (%).
Source: Own elaboration, Data from REE (2023). (*) Estimated data.

wind and solar energy, have sparked many demonstrations and protests (Bidwell, 2013; Prados, 2010; Rodríguez-Segura et al., 2023).

It can be said that no energy source is completely neutral. On the contrary, all of them have negative externalities, making it necessary to choose the least harmful solution. When RE infrastructures are installed, there are social actors that are 'winners' (who receives monetary benefits or other as a result) and 'losers' (suffers some type of damage or detriments) (Komor and Bazilian, 2005). Their socio-economic and environmental impacts will depend on aspects such as the size of the infrastructures and the socioeconomic characteristics of the location where they are implemented (Rodríguez-Segura et al., 2023; Zárate-Toledo et al., 2019).

Further, the energy transition towards renewable energies is embedded in the fight against climate change, and more specifically in the perceived trade-offs between climate change and energy security (Arndt, 2023; Hazboun and Boudet, 2020). The theoretical perspective of the risk society (Beck, 1992) helps to interpret the social perception of energy and its relationship with the risk of climate change. At the same time, climate change denial is also a framework for analysing social perception (Hess and Renner, 2019).

In addition, impacts of climate change are characterised, among other aspects, by their unequal distribution in geography (Adger et al., 2005; Althor et al., 2016). Conflict and disagreement can take place when populations in rural areas are asked to sacrifice themselves in the name of the general interest of climate change (mostly urban areas) by accepting the installation of renewable energy sources in nearby municipalities (Cordoves-Sánchez and Vallejos-Romero, 2019; Gargallo et al., 2020).

The sociological perspective on the phenomenon 'not-in-my-backyard' (NIMBY) phenomenon (Stein, 1996) is relevant to this analysis. As Kim and Chung (2019) note, while these projects can potentially boost local economies, rural communities often fail to experience substantial improvements in wealth or employment. Renewable Energies (RE) might have a negative effect on the economy or on job creation in the rural areas where they are installed (Clausen and Rudolph, 2020; Costa and Veiga, 2021; Duarte et al., 2022; Jean, 2014). Further, Duarte et al. (2022) emphasize that environmental, acoustic, and visual impacts frequently overshadow the less tangible benefits of climate change mitigation in public perception.

Theoretical frameworks that focus on socioeconomic and demographic factors are also relevant in influencing public awareness about the different forms of renewable energy sources, such as perceptions of environmental (and social) risks and impacts (Balta-Ozkan and Le Gallo, 2018; Karytsas and Theodoropoulou, 2014).

Along these lines, cultural theory proposes four categories to perceive the world, and which are present in public opinion regarding renewable energies: individualistic, hierarchical, egalitarian and fatalistic (Carlisle and Smith, 2005), with values and beliefs representing a core influence as well (Bidwell, 2013).

Finally, the level of trust in political or social institutions is another framework to be considered in the analysis of social perception, particularly for complex issues where the population's knowledge is limited, as in the case of energy (Rayner, 2010).

Knowledge and analysis of social perception i.e., public advocacy and sentiment, on various energy issues profoundly affects our energy future (Li et al., 2019). Research dedicated to the social acceptance of associated production facilities has become a well-established field in recent decades (Sposato and Hampl, 2018). Specifically, in the face of the widespread and rapid intensification of climate change (IPCC, 2021), empirical research on energy preferences has focused on support for renewable forms of energy such as wind, solar or hydroelectric power (Greenberg, 2009; Karlstrøm & Ryghaug, 2014; Visschers and Siegrist, 2014).

The theoretical perspective of environmental justice (McCauley and Heffron, 2018) is also relevant to the understanding of the social perception of these energies. Jenkins et al. (2017) argue that energy justice should be central to the transition, addressing not only cost-benefit distribution but also recognition and procedural issues. This connects with the argument of Steg et al. (2015) who maintain that while knowledge alone cannot change behaviour, it remains an important precursor for energy policy acceptance. Studies show that experiential knowledge (direct exposure to renewable technologies) can be more influential than factual knowledge in shaping acceptance (Knudsen et al., 2015; Rand and Hoen, 2017). Thus, it is necessary to interpret the urban-rural discrepancy not as mere selfishness but rather as an expression of legitimate concerns about local impacts and procedural justice as Wolsink (2018) suggests.

Scholars of environmental politics also point to the need to carry out more research on citizens' opinions, which may be an essential tool in this process (Duarte et al., 2022; Prakash and Bernauer, 2020). However, there are very few studies on public attitudes comparing different energy sources (Arndt, 2023; Hazboun and Boudet, 2020; Rodríguez-Segura et al., 2023).

Surveying a population is a method for consulting citizens on specific initiatives, such as the development of energy infrastructures, even when results are not binding (Arnstein, 1969). Thus, surveys could be a valuable asset in preventing social conflicts by also taking into account the different social responses (Ahmed et al., 2024; Frantál et al., 2023), or palliating socioeconomic inequalities between social groups (Cordoves-Sánchez and Vallejos-Romero, 2019) – but also between territories – for a just and equitable energy transition (Sardaro et al., 2019).

In the case of Spain, there is no precedent for analysing the social perception of renewable energies, this being the first survey of its kind carried out. This research represents several key innovations compared to existing literature on renewable energy social perception in Spain. First, methodologically, it is the first nationally representative survey (n = 1240) conducted across all 17 Autonomous Communities plus two autonomous cities, providing extensive coverage that previous local or regional studies could not achieve. Second, in terms of scope, unlike previous works that examined single renewable technologies or limited geographical areas, our research provides the first comparative analysis of social perception across multiple renewable energy sources (solar, wind, biomass, hydroelectric, geothermal, tidal, and green hydrogen) versus non-renewable sources (nuclear, oil, coal, gas, and fracking) at the national level. Third, empirically, this study addresses a significant gap in Spanish energy policy literature by providing baseline data for future longitudinal studies and policy evaluations. Fourth, the timing coincides with Spain's ambitious renewable energy targets (81 % renewable electricity by 2030) and provides crucial insights for policy implementation that were previously unavailable at the national scale.

While this descriptive study does not test explicit causal relationships, the implicit theoretical model suggests that demographics and geography influence knowledge and awareness, which in turn affect acceptance levels. Similarly, institutional trust mediates information processing and policy support, while proximity to infrastructure creates direct experience that influences NIMBY responses.

Thus, the research design prioritised national coverage and baseline establishment over hypothesis testing, with future research potentially employing structural equation modelling to test specific causal pathways identified through this foundational work.

Its main objective is to deepen our understanding of the social perception of renewable energies in Spain. Specifically, through a survey method we analyse social opinion, knowledge and consensus on different renewable energy technologies, as well as with fossil-fuel energy sources. We also investigate other closely related issues such as the perception of science and technology (and specifically those aimed at producing energy); energy policies, along with the supply and investment in energy research and development; the degree of trust in institutions and in society in the face of the challenge of the energy transition; attitudes towards self-consumption; and the NIMBY phenomenon.

The main hypothesis of this research is that renewable energies have widespread social acceptance in Spain, but there is a lack of knowledge regarding some of these technologies and the socio-political context in which they develop. All of this is of interest for a better understanding of public opinion on renewable energies.

3. Materials and methods

3.1. Survey design and sampling strategy

The methodology used is quantitative, which allows identification of the values and attitudes (Berinsky, 2017), in this case of the country's population, in relation to the development of renewable energies. The survey process was carried out by the Spanish Foundation for Science and Technology (FECYT), which is part of the Spanish Ministry of Science and Innovation. The study was aimed at people aged 18 and over, who are residents of Spain (FECYT, 2022). The interviews lasted an average of 15 min and were conducted by telephone (landline and mobile phones). The fieldwork was carried out between 15 and September 29, 2022. The design and selection of the sample is representative of the county's population. The sample size was 1240 respondents, representing a sample error of 1.21 % (95 % confidence level). The sample is stratified by Autonomous Community (17 plus two autonomous cities) and habitat size, as well as being adjusted to the sex and age quotas of the population.

The survey's questionnaire is structured by means of closed questions and is organised in six thematic blocks: Block 1. Concerns and priorities [A] (question A1); Block 2. Attitudes towards technologies [B] (questions B1 and B2); Block 3. Attitudes towards renewable energies [E] (questions E1 to E6); Block 4. Trust in institutions and society [D] (questions D1 to D4); Block 5. Energy policies and research [C] (questions C1 to C7); Block 6. Consumption and self-consumption [F] (questions F1 to F3).

We started first with three filter questions to verify that participant nationality was Spanish or, if not, if they had been residing in Spain for five or more years. At the end of the questionnaire, a total of 15 questions were included, aimed at determining the socio-demographic characteristics of the participants (detailed in Appendix A). Thus, the questionnaire contains a total of 41 questions.

3.2. Data analysis

The distribution of the sample is analysed according to the main socioeconomic variables of the population, as well as others related to our object of study. Specifically, these include gender, age, educational level, the size of the habitat in which they reside, family income, employment status, the number of people living in the household, whether they live near an energy production plant and what type it is. Additional variables have been included for a better characterisation of the interviewed population (see Appendix A).

The questions analysed are those included in blocks 2 to 6 above. Two types of analysis were carried out, considering that the chosen questions respond to a Likert-type scale. On the one hand, most of the questions were analysed by calculating the arithmetic mean, as well as the non-parametric Kruskal-Wallis test together with Dunn's grouping to unify the results of the answers according to their statistical significance. Dunn's index aims to define clusters according to the ratio between the minimum inter-cluster distance and the maximum intra-cluster distance (Dunn, 1974). Thus, the Kruskal-Wallis test indicates whether there are significant differences between the groups, while the Dunn test shows the pairs of groups with those differences. This helps to visualise and interpret results by the emergence of conceptual categories comprising the groups' items in each question.

It has been used as criteria that the p-value (<0.0001) must be less than the significance level alpha $= 0.05$ to reject the null hypothesis H0 (samples come from the same population) and accept the alternative hypothesis Ha (samples do not come from the same population).

The Likert scale has values from 1 to 7 - where 1 represents the lowest and 7 the highest score for each question - since most of the items in the questionnaire have this format. To compare the results of these questions, ordinal variables have been transformed into scalars based on this range of values. In addition, the standard deviation in those questions - indicates the degree of consensus or dissent among the participants. On the other hand, for questions C5, C6, C7, E3, F1, F2 and F3, only the frequency results for each answer option were analysed.

Thus, questions designed with a scale of 1–7 are B1 and B2, C2 to C4, questions D2 to D4, and E1 and E2. At the same time, question A1 (Block 1) has been transformed to a scale with values from 1 to 7, with the response options [1] Very little, [2] A little, [3] Some, [4] Quite a lot, [5] A lot; in Block 3, question C1 includes four options [1] Not at all or hardly at all, [2] A little, [3] Quite a lot, [4] A lot. The response options in C5 are only Yes or No; while questions C5, C6 and C7 have not been transformed, and have been analysed based on response frequencies. In Block 4, question D1 has the options [1] Very little trust, [2] Little trust, [3] Neither trust nor distrust, [4] Quite a lot of trust, [5] A lot of trust, thus adapting it to a scale of 1–7. In Block 5, question E3 includes the options [1] More benefits than detriments, [2] The same benefits as detriments, [3] More detriments than benefits, analysed in this case according to the frequencies of each response. In contrast, in question E4, the five options [1] Very negative, [2] Negative, [3] Neither negative nor positive, [4] Positive, [5] Very positive have been transformed into a scale of 1–7. In Block 6, three questions F1 to F3 have been analysed in terms of the frequency of the results. All questions include the options [888] don't know [999] no answer, also analysed in this research. The Kruskal-Wallis test underwent the test of validity (the Chi square Parson correlation and factorial analysis) and reliability (Cronbach and Reliability test - p-value - tests).

The validity of the Kruskal-Wallis test was proved with the Chi square Parson correlation and Cohen's d (Effect Size) (Appendix B) and reliability with both the Cronbach and Reliability test (p-value) (Appendix C).

The sociological phenomenon known as Not in My Backyard (NIMBY) has been finally analysed using the Chi-square test by crossing question E3. "Now I am going to ask you to think about the impact of a series of energy production plants being installed in your city: Would you say that you would perceive more benefits than harms, a balance between benefits and harms, or more harms than benefits, with two questions: "S7. Do you live near a power plant? This question has two response options: [1] Yes, [2] No, [888] Don't know, [999] No answer; and the S5. Habitat size. This question has the following response options: [1] Less than 10,000 inhabitants, [2] 10,001 to 20,000 inhabitants, [3] 20,001 to 50,000 inhabitants, [4] 50,001 to 100,000 inhabitants, [5] 100,001 to 500,000 inhabitants, [6] More than 500,000 inhabitants. Additionally, question E3 was tested with question S4 – the region (Autonomous Community) or residency – and its geographical distribution (question S4).

Chi-square test of independence statistic between question E3 and question S7 were calculated (Appendix D), as well as between question E3 and question S5 (Appendix E).

4. Results

4.1. Sample distribution

The interviews are almost equally divided between women (50.9 %) and men (48.0 %). The most represented age group is the 65+ age group, which accounts for almost one in four respondents (23.2 % of the interviews). The next most represented age groups are 35–44 and 45–54, with just under one in five respondents in both cases (less than 19.0 %). In contrast, the least represented are those in the youngest age group, i. e., those aged 15 to 24 and 25 to 24 (less than 14.0 % in both segments), together with those aged 55 to 64 (just over 15.0 % of the interviews).

Looking at the size of the habitat in which the participants live, almost one in four live in large cities, equivalent to just over 100,000 to 500,000 inhabitants (23.3 %), while the least common in the interviews are those with a population size of over 10,000 to 20,000 inhabitants (10.3 %).

Almost one out of three survey participants answered that they live close to an energy-producing plant (29.3 %), among which the most common is solar energy (13.1 %), or, alternatively, wind or biomass energy (7.4 % and 6.0 % respectively).

Minor differences are registered between the sample distribution and the National Institute of Statistics in some of the core variables such as gender, age and income level (Table 1).

4.2. Socio-political concerns and priorities related to energies

The major socio-political issues of interest proposed can be grouped into three labels according to the degree of interest of the participants (question A1) (Table 2). Politics as a category (Group A) is the least interesting for respondents (average score of 4.0). The second grouping (Group B) includes science and technology, together with economics and business, which are the most highly rated (mean value of 4.6). The third grouping (Group C) includes the three topics of greatest interest: renewable energies, medicine and health, and environment and ecology (values from 4.9 to 5.1, on a scale of 1–7). In this third group there is the greatest consensus (variance of 1.87 and 1.99 for each topic), while politics is the topic with the greatest diversity of opinion among

Table 1
Main features of the sample.

Gender	n	%	National Institute of Statistics (%) - 2022	Difference
[1] Male	595	48.0 %	49.0 %	−1.0 %
[2] Female	631	50.9 %	51.0 %	−0.1 %
[3] Others	14	1.1 %		
D.K.	0	0.0 %		
N.A.	0	0.0 %		
TOTAL	1,240	100.0 %		

Age	n	%	National Institute of Statistics (%) - 2022	Difference
[1] 15–24 years old	122	9.8 %	11.9 %	−2.1 %
[2] 25–34 years old	170	13.7 %	12.9 %	0.8 %
[3] From 35 to 44 years old	233	18.8 %	17.0 %	1.8 %
[4] From 45 to 54 years old	234	18.9 %	18.9 %	0.0 %
[5] From 55 to 64 years old	193	15.6 %	16.1 %	−0.5 %
[6] 65 and over	288	23.2 %	23.2 %	0.0 %
D.K.	0	0.0 %		
N.A.	0	0.0 %		
TOTAL	1,240	100.0 %		
Mean	48.4 years old			

Habitat size	n	%
[1] < 10,000 inhabitants	262	21.1 %
[2] 10,001 to 20,000 inhabitants	128	10.3 %
[3] 20,001 to 50,000 inhabitants	208	16.8 %
[4] 50,001 to 100,000 inhabitants	157	12.7 %
[5] 100,001 to 500,000 inhabitants	289	23.3 %
[6] > 500,000 inhabitants	196	15.8 %
D.K.	0	0.0 %
N.A.	0	0.0 %
TOTAL	1,240	100.0 %
Mean	3.5 habitat size	

Incomes (net family income is around 1100 euros per month)	n	%	National Institute of Statistics - 2022	%
[1] Much higher (more than double)	136	11.0 %	Up to 499 euros	2.1 %
[2] Higher	642	51.8 %	500 to 999 euros	10.7 %
[3] Around that number	409	33.0 %	1000 to 1499 euros	17.4 %
[4] Lower	52	4.2 %	1500 to 1999 euros	15.5 %
[5] Quite lower (less than half)	1	0.1 %	2000 to 2499 euros	15.1 %
D.K.	0	0.0 %	2500 to 2999 euros	15.2 %
N.A.	0	0.0 %	3000 to 4999 euros	19.0 %
TOTAL	1,240	100.0 %	5000 euros or more	5.0 %
Mean	2.3 incomes			

Which of these situations are you currently in?	n	%
[1] Employed	534	43.1 %
[2] Self-employed	91	7.3 %
[3] Retired, pensioner	292	23.5 %
[4] Unemployed who has previously worked	164	13.2 %
[5] Unemployed looking for first job	12	1.0 %
[6] Housewife	67	5.4 %
[7] Student	80	6.5 %
D.K.	0	0.0 %
N.A.	0	0.0 %
TOTAL	**1,240**	**100.0 %**

participants (variance of 2.41).

In general, participants say that they are aware of these major issues on which they have expressed an opinion, given that in no case is the 'don't know' response higher than 0.3 %.

4.3. Social perception of risk and benefits of science and technology applications aimed at energy production

The risk perception of specific science and technology applications (question B1) results in four groupings. On one hand, robotisation of work, wind turbines and the cultivation of genetically modified plants (Group A) are the applications that are perceived to have the lowest risk (mean value of 3.6–3.7) compared to the others. Wind turbines and farming genetically modified plants can also be included in another group of technologies (Group B), with artificial intelligence being perceived as the highest risk (average rating 3.9). Finally, fracking is distinguished from other technologies (Group C), in addition to nuclear energy (Group D). Both are perceived as the uppermost risk (4.5 and 4.8 respectively), with the greatest consensus in their perception as risky technologies (variance of 2.00 and 1.84 respectively) (Table 3).

On the other hand, when the interviewees were asked about the degree of benefit of science and technology applications (question B2), these were ranked in five groups according to the score they received. In this case, fracking and nuclear energy again made a differentiation for each (Group A and Group B respectively), being those considered to bring the least benefit (average of 4.2 and 4.5 respectively). This was followed by genetically modified farming (Group C) (mean value of 4.8), and the duo of robotisation at work and artificial intelligence (Group D) (5.2). This last opinion is the one with the lowest consensus among the participants, compared to the other technologies. Finally, the technology that the participants consider bringing the most benefits is wind turbines alone (Group E) (5.4).

In this case, the technology that is by far the least known in relation to its potential benefits is fracking (17.8 % 'don't know'), together with the cultivation of genetically modified plants (9.0) (Table 4).

4.4. Perceptions of energy and renewable energy issues, energy policies, supply and investment in research and development

4.4.1. Top energy-related issues of concern

The energy issues of greatest concern (question C1) are those related to prevent climate change and rising energy prices (average score of 6.0 in both cases), which is why it forms a thematic space of its own (group D). At the same time, this is a subject for which the participants show a great lack of knowledge ('don't know' response of more than 47.2 %) (Table 5). They are followed, in terms of concern, by those relating to pollution with possible energy shortages (5.7 and 5.8 respectively) as a distinguishable thematic grouping (Group C). In this case, there is a clear lack of knowledge on the issue of pollution (33.6 % answer 'don't know').

The issue of energy dependence on other countries (5.1) is of least concern (Group A), although it is also an unknown issue for most of those interviewed (19.8 % 'do not know'). Next in relevance are all aspects related to the low use of clean energy, overconsumption, storage and energy supply (Group B) (average 5.3 to 5.5).

Except for the issue "concern for the low use of renewable energies", in this section the data indicate a great lack of knowledge of the participants about energy consumption and storage, and, in addition, approximately one in four people say they do not know.

4.4.2. The objectives of public administrations regarding energy policies

The most highly rated priorities for public administrations in terms of energy policies (question C2) are unified above all in a broad area including renewable energies and the environment, energy prices and supply (Group C) (averages of 5.8–6.0). In contrast, issues such as reduction of energy consumption and energy imports, even though they rate as relevant (4.9 and 5.1 respectively), are less so. On the other hand, these two thematic areas are the ones with the greatest diversity of opinions (variances of 1.42 and 1.23 respectively) (Table 6).

In this section, the lack of knowledge about the objectives consulted is very low according to the data (the option 'don't know' is below 3.0 %, with values of less than 1.0 % being the most common).

4.4.3. Assessment of renewable energies

The participants primarily advocate renewable energies (question C3), compared to fossil fuels as a source of energy (Group D), and better

Table 2
Interest level in each topic (Question A1)Kruskal–Wallis test and Dunn groups to compare the impact of land use-land cover (LULC) on ecosystem services. Letters in parentheses represent statistically different groups as identified by the Dunn test. In bold the most remarkable results.
Block 1. Concerns and priorities [A].

Categories	Groups			Mean [1] Very little - [7] A lot	No. of Observations	No. of Missing Values	Variance (n-1)	D.K. (%)	N.A. (%)
Politics	A			4.0	1,240	1	2.41	0.1%	0.0%
Science and Technology		B		4.6	1,240	2	2.2	0.2%	0.0%
Economy and Business		B		4.6	1,240	2	2.15	0.2%	0.0%
Renewable Energies			C	4.9	1,240	1	1.87	0.1%	0.0%
Medicine and Health			C	4.9	1,240	1	2.08	0.1%	0.0%
Environment and ecology			C	5.1	1,240	4	1.99	0.3%	0.0%

K (Observed value)	396.006
p-value (one-sided)	<0,0001
alpha	0.05

Table 3
Risk level perception of Science and Technology applications (Question B1).
Block 2. Attitudes towards technologies [B].
B1. I am going to ask you now to give us your opinion on some specific applications of science and technology. Regardless of their benefits, to what extent do you consider that they have risks … ? Please use a scale from 1 to 7 where 1 means "no risk" and 7 means "many risks".

Categories	Groups				Mean [1] No risk - [7] High Risk	No. of Observations	No. of Missing Values	Variance (n-1)	D.K. (%)	N.A. (%)
Robotization at work	A				**3.6**	1,240	36	2.04	2.9%	0.0%
Wind turbines	A	B			3.7	1,240	34	2.03	2.7%	0.0%
Cultivation of genetically modified plants	A	B			3.7	1,240	107	1.89	8.6%	0.0%
Artificial intelligence		B			3.9	1,240	29	2.26	2.3%	0.0%
Fracking (technique for extracting fossil fuels)			C		4.5	1,240	203	2	0.1%	0.1%
Nuclear energy				D	4.8	1,240	10	1.84	0.8%	0.0%
K (Observed value)	11.07									
p-value (one-sided)	<0,0001									
alpha	0.05									

Table 4
Level of benefit from specific applications of Science and Technology (Question B2).
Block 2. Attitudes towards technologies [B].
B1. I am going to ask you now to give us your opinion on some specific applications of science and technology. Regardless of their benefits, to what extent do you consider that they have risks … ?.

Categories	Groups					Mean (1-7) [1] Low Benefit - [7] Great Benefit	No. of Observations	No. of Missing Values	Variance (n-1)	D.K. (%)	N.A. (%)
Fracking	A					4.2	1,240	222	1.32	17.8%	0.1%
Nuclear energy		B				4.5	1,240	27	1.48	2.2%	0.0%
Cultivation of genetically modified plants			C			4.8	1,240	112	1.35	9.0%	0.0%
Robotization in the workplace				D		5.0	1,240	25	2.27	2.0%	0.0%
Artificial intelligence				D		5.2	1,240	33	2.07	2.7%	0.0%
Wind turbines					E	5.4	1,240	37	1.37	3.0%	0.0%
K (Observed value)	663.488										
p-value (one-sided)	<0,0001										
alpha	0.05										

for both the environment and health (average scores of 5.6 and 5.7 respectively). However, it is also on these two aspects that there is the greatest dissent among the participants (variance of more than 1.4 points).

In contrast, the least supported idea is that renewable energies are better for the economy than fossil fuels (mean score 5.0). This aspect is also the most unknown question among all respondents (12.6 % of respondents 'don't know') and the most dissenting (1.51).

This is followed by the statement that renewable energies are an existing source in Spain, or that they can provide economic benefits to the country (5.2 and 5.4 respectively), with the economic aspect again being the most unknown among participants (8.4 % 'don't know') (Table 7).

4.4.4. *Renewable energies and energy supply security*

Relating to security in energy supply (question C4), the need of investing in renewable energies (5.8 average value) is the main argument put forward by respondents, compared to the possibility of building more nuclear power plants, which receives a much lower score (3.8), as well as greater unawareness (5.2 % 'don't know').

This is followed by the group of proposals such as supporting energy efficiency in buildings, as well as energy research and innovation (5.4 and 5.5 respectively) (Group B). However, research and innovation also fall within the scope of the importance of the clean energy transition as a proposal, or the development of a well-connected energy grid throughout the country (Group C) (averages of 5.6) (Table 8).

4.4.5. *Assessment of research and development in renewable energies*

In this section, three other issues were also explored. On the one hand, the possible contribution or effects of increasing research and development in renewable energies (question C5). The two results most frequently mentioned by the participants are that it contributes to the

Table 5
Degree of concern about each energy-related issue (Question C1).
Block 3. Perception about energies [C].
C1. For each topic related to energy, could you tell me if you're level of concerned?.

Categories	Groups	Mean [1] Very little - [7] A lot	No. of Observations	No. of Missing Values	Variance (n-1)	D.K. (%)	N.A. (%)
Energy dependence on other countries	A	5.1	1,240	36	1.42	19.8%	0.0%
Low use of renewable energies	B	5.3	1,240	24	1.23	1.8%	0.1%
Very high levels of energy consumption	B	5.4	1,240	12	1.13	25.3%	0.0%
Storage of energy reserves to guarantee winter supply	B	5.5	1,240	55	1.03	26.2%	0.1%
Pollution produced by the energy sources used.	C	5.7	1,240	7	1.19	33.6%	0.0%
Energy shortages	C	5.8	1,240	10	1.08	0.8%	0.0%
Preventing climate change	D	6.0	1,240	6	1.16	47.2%	0.0%
Rising energy prices	D	6.0	1,240	1	1.08	48.2%	0.0%

K (Observed value)	719.233
p-value (one-sided)	<0,0001
alpha	0.05

Table 6
Public administration objectives regarding energy policies (Question C2).
C2. Next I am going to read you a series of objectives related to energy policies, could you tell me to what extent you think each objective should be a priority for public administrations? Use a scale from 1 to 7, where 1 means "Not a priority at all" and 7 means "Absolutely a priority".

Categories	Groups	Mean (1-7) [1] Not priority - [7] Absolutely a priority	No. of Observations	No. of Missing Values	Variance (n-1)	D.K. (%)	N.A. (%)
Reduce energy consumption	A	4.9	1,240	20	1.73	1.6%	0.0%
Reduce energy imports	B	5.1	1,240	36	1.47	2.9%	0.0%
Developing renewable energies	C	5.8	1,240	6	1.21	0.5%	0.0%
Protecting the environment	C	5.9	1,240	0	1.24	0.0%	0.0%
Guaranteeing reasonable energy prices	C	5.9	1,240	1	1.13	0.1%	0.0%
Guaranteeing energy supply	C	6.0	1,240	2	0.96	0.2%	0.0%

K (Observed value)	939.571
p-value (one-sided)	<0,0001
alpha	0.05

protection of the environment (94.7 %) and guarantees the energy supply. (91.9 %). The possibility of reducing energy consumption (65.2 %) or energy imports (70.6 %) are less supported, but still in the majority. The possibility that increased research and development in renewable energies could make renewable energy installations cheaper (83.1 %), or lower energy prices for consumers (79.7 %) are more widely accepted.

On the other hand, regarding opinions on investment in renewable energy research over the last three years (question C6), almost half of the participants (44.6 %) believe that it has increased somewhat or a lot, while almost one in three (22.8 %) indicate that it has not changed at all. Nearly 15.0 % believe that it has decreased somewhat or a lot, while slightly less than one in five 'do not know' (17.9 %).

Finally, almost half of the participants believe that Spain is lagging behind the EU average in terms of research and development of renewable energies (45.6 %); and almost one in four believe that it is at the same level (24.0 %). In contrast, just under 12.0 % believe it is further ahead, and almost one in five 'don't know' (18.3 %) (question C7) (Fig. 2).

Table 7
Degree of agreement with renewable energies and economy and environment (Question C3).
Block 3. Perception about energies [C].
C3. I am going to read you a series of statements, could you please tell me to what extent you agree with each of them using a scale from 1 "Strongly disagree" to 7 "Strongly agree"?.

Categories	Groups				Mean (1-7) [1] Strongly disagree - [7] Strongly agree	No. of Observations	No. of Missing Values	Variance (n-1)	D.K.(%)	N.A. (%)
Better for the economy than fossil fuel energy sources.	A				5.0	1,240	156	1.51	12.6%	0.0%
An existing energy source in Spain.		B			5.2	1,240	68	1.21	5.5%	0.0%
Can provide economic benefits to Spain.			C		5.4	1,240	104	1.26	8.4%	0.0%
Better for the environment than fossil fuel energy sources.				D	5.6	1,240	77	1.41	6.2%	0.0%
Better for human health than fossil fuel energy sources.				D	5.7	1,240	65	1.51	5.2%	0.0%
K (Observed value)	324.826									
p-value (one-sided)	<0,0001									
alpha	0.05									

Table 8
Degree of agreement with the statements. To guarantee energy supply, it is necessary to … (Question C4).
C4. To what extent do you agree or disagree with the following statements? Use a scale from 1 "Strongly disagree" to 7 "Strongly agree".

Categories	Groups				Mean (1-7) [1] Strongly disagree - [7] Strongly agree	No. of Observations	No. of Missing Values	Variance (n-1)	D.K.(%)	N.A. (%)
Build more nuclear power plants	A				3.8	1,240	66	2.09	5.2%	0.1%
Support energy efficiency improvements in buildings.		B			5.4	1,240	31	1.17	2.5%	0.0%
Encourage energy research and innovation		B	C		5.5	1,240	20	1.12	1.6%	0.0%
Facilitate cities and local communities to transition to clean energy			C		5.6	1,240	8	1.07	0.6%	0.0%
Have a well-connected energy grid across the country			C		5.6	1,240	16	1.13	1.3%	0.0%
Encourage investments in renewable energy (e.g. wind, solar, etc.).				D	5.8	1,240	14	1.16	1.1%	0.0%
K (Observed value)	1488.996									
p-value (one-sided)	<0,0001									
alpha	0.05									

4.5. Degree of trust in institutions and society in the face of the energy challenge

Universities are the institutions that, by far, are most trusted (5.8 on average), while political parties are the least trusted (3.8) (question D1). The results also highlight the set formed by the media and the Spanish government as a shared opinion area (group B), which follows the previous ones in degree of support (4.0 and 4.1 respectively); and the government of the autonomous communities together with companies (group C) (4.5 and 5.6); while the European Union and consumer or ecology associations as a joint category (group D) are the second in degree of trust (5.2 and 5.3 respectively) (Table 9).

In turn, regarding the possibility of reducing the effects of climate change in the coming years (question D2), the shift from fossil fuels to renewable energies is the option best valued by respondents (5.0), followed by the possibility of people limiting their energy use (4.2). However, the least credible option among those surveyed is that most people will limit their energy consumption (3.3) (Table 10).

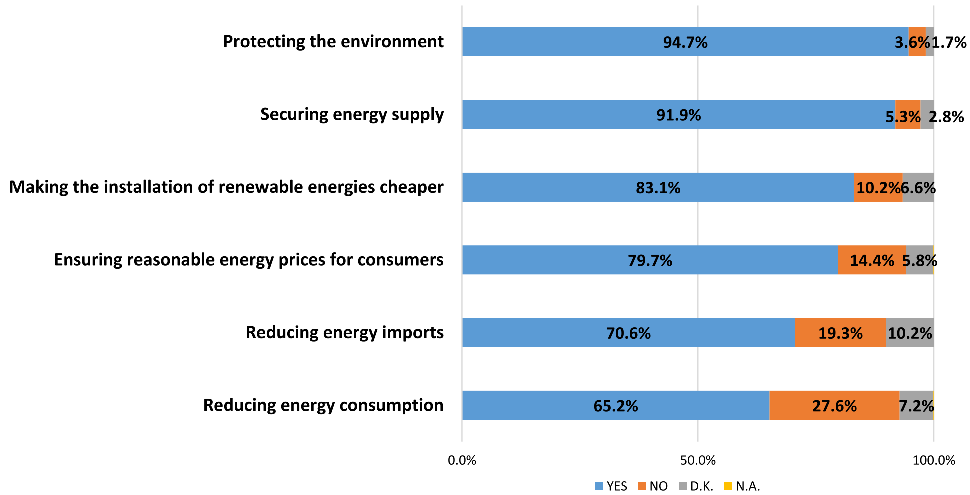
4.6. Attitudes towards renewable energies

There is broad support for the use of renewable energies for the supply of electricity, fuel and heating (average value of 5.9) (question E1) (Table 11).

When asking about the use of specific energies, both renewable and non-renewable (question E2), solar energy receives the most acceptance among respondents (6.2 average value), and as a source differentiated from the rest (Group F), followed by the group formed by hydraulic energy, biomass and wind energy (Group E) (values of 5.8–6.0), as well as green hydrogen as its own category (value of 5.6) (Group D).

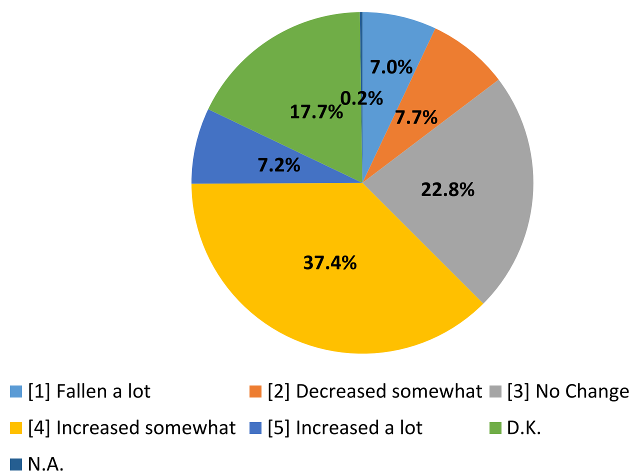
Among renewable energies, equally positively valued, but to a lesser extent than the previous ones, is the group formed by geothermal and tidal energy (Group C) (5.0 and 5.1 respectively); as well as gas as an energy source with a disaggregated assessment from other sources (Group B) (4.3).

On the contrary, those having a more negative perception are the group of non-renewable energy sources, such as nuclear, oil, coal and



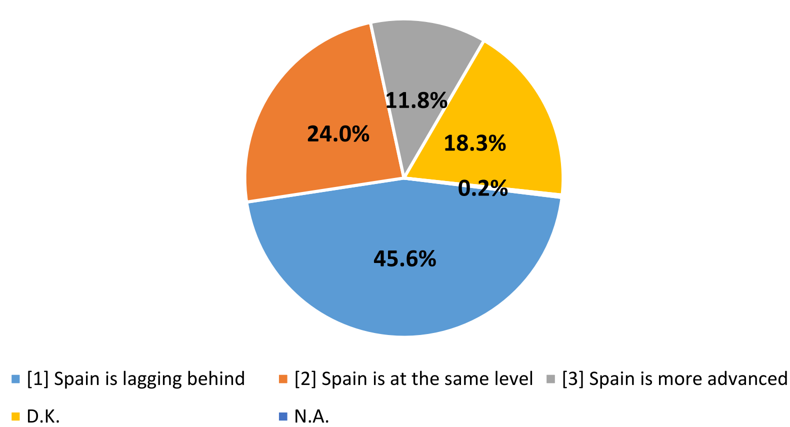
N= 1,240

C6. Do you think that in the last three years the investment in renewable energy research has…



N= 1,240

C7. How do you think Spain compares to the EU average in terms of research and development of renewable energies?



N= 1,240

Fig. 2. Social perception of the public investment in research and development in renewable energies (Questions C5, C6 and C7).

Table 9
Degree of trust, at this moment, in each of the institutions when dealing with energy-related issues (Question D1).

Categories	Groups	Mean (1-7) [1] Very little confidence - [7] A lot of confidence	No. of Observations	No. of Missing Values	Variance (n-1)	D.K. (%)	N.A. (%)
Political parties	A	3.8	1,240	6	1.60	0.4%	0.1%
Media	B	4.0	1,240	12	1.56	0.9%	0.1%
Spanish Government	B	4.1	1,240	11	2.32	0.8%	0.1%
Regional Government	C	4.5	1,240	19	2.06	1.4%	0.1%
Companies	C	4.6	1,240	23	1.91	1.8%	0.1%
European Union	D	5.2	1,240	20	1.74	0.0%	0.1%
NGO's	D	5.3	1,240	15	2.03	1.1%	0.1%
Universities	E	5.8	1,240	12	1.14	0.8%	0.2%

K (Observed value):	2195.626
p-value (one-sided)	<0,0001
alpha	0.05

Table 10
Probability of reducing the effects of climate change if many people limit their energy consumption (Question D2).
D2. How likely do you think it is that the effects of climate change will be reduced if large numbers of people limit their energy consumption? Use a scale from 1 to 7 where 1 is not at all likely and 7 is very likely.

Categories	Mean (1–7) [1] Not at all likely - [7] Very likely	No. of Observations	No. of Missing Values	Variance (n-1)	D.K. (%)	N.A. (%)
To what extent do you think the effects of climate change are likely to be reduced if large numbers of people limit their energy consumption?	3.3	1,240	16	3.64	1.0 %	0.1 %
To what extent do you think people are likely to limit our energy use to reduce climate change in the coming years?	4.2	1,240	106	1.96	8.1 %	0.2 %
To what extent do you think it is likely to reduce the impact of climate change by switching from fossil fuels to renewable energy?	5.0	1,240	83	1.32	6.0 %	0.2 %

Table 11
Degree of support for the use of different types of renewable energies (wind, solar or biomass) to supply us with electricity, fuel and heating (Question E1).
E1.Do you support or oppose the use of different types of renewable energy such as wind, solar or biomass to provide us with electricity, fuel and heating? opposed and 7 being totally supportive.

Categories	Mean (1–7) [1] Totally opposed - [7] Totally supportive	No. of Observations	No. of Missing Values	Variance (n-1)	D.K. (%)	N.A. (%)
Supports or opposes the use of different types of renewable energy (wind, solar, biomass) to provide us with electricity and heating	5.9	1,240	17	1.21	1.4 %	0.0 %

fracking (Group A) (average value of 3.8–3.9), in which in turn the diversity of opinions is more evident (variances almost all higher than 2.00).

These results may be conditioned by the respondents' degree of knowledge of each of these energy sources. In this vein, almost one in three (29.9 %) answer that they do not know geothermal energy, and approximately one in five say they do not know others such as fracking (19.2 %), tidal energy (20.6 %), or green hydrogen (21.9 %) (Table 12).

The survey also asked about the impact that energy production plants could produce if installed in the locality where the interviewees live (question E3). The one with the highest acceptance was the solar energy plant, with more than four out of five interviewees stating that it has more benefits than harms (83.2 %). Wind energy, biomass and hydroelectric power plants also stand out for their positive assessment (72.2 %, 66.6 % and 62.8 % respectively).

The third segment of energy production types is the one having low acceptance or even rejection; gas-powered plants (32.3 %), and above all oil-powered ones, where almost one in three considers that they would produce more harm than benefits (31.9 %). In this group, the most heterogeneous opinions were expressed (variance of 3.03), as they were for the nuclear power plant – two out of five consider it produces more harm than benefits (37.9 %) (Table 13).

4.7. *Perception of energy consumption and self-consumption*

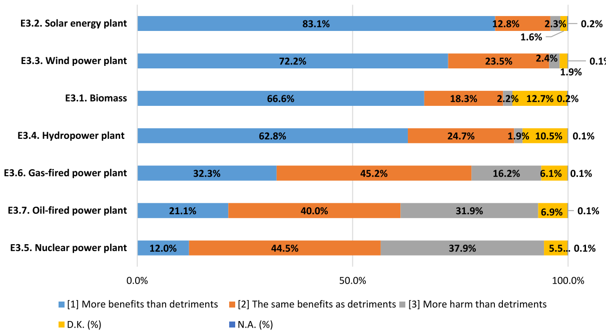
The change to a renewable transition (question F1) would be made by seven out of ten participants only if the amount of the household energy bill was equal to or lower than the one currently contracted (69.3 %). However, one in five (21.0 %) would make this decision even if the cost of the bill increased by up to 10 %; while an almost anecdotal group (2.9 %) would do so if the bill exceeded 10 % of the current one. However, 7.8 % indicate that they do not know what to answer or do not want to answer this question. Approximately the same ratio of participants says they know or do not know about public aid aimed at

Table 12
Degree of support for the use of each of the following energies to supply us with electricity, fuel and heating (Question E2). E2. Next, I would like you to tell me whether you are aware of each of the following energies and to what extent you oppose or support their use to provide us with electricity, fuel and heating. Please answer on a scale of 1–7, with 1 being totally opposed and 7 being totally supportive.

Categories	Groups	Mean (1-7) [1] Totally opposed - [7] Totally Supportive	No. of Observations	No. of Missing Values	Variance (n-1)	Don't Know this energy source (%)	D.K. (%)	N.A. (%)
Nuclear energy	A	3.9	1,240	42	1.57	0.8%	2.3%	0.2%
Oil	A	3.9	1,240	54	2.03	1.5%	2.7%	0.2%
Coal	A	3.9	1,240	85	2.31	3.9%	2.6%	0.4%
Fracking	A	3.8	1,240	295	2.69	19.2%	4.4%	0.2%
Gas	B	4.3	1,240	64	2.37	1.9%	3.0%	0.2%
Geothermal	C	5.0	1,240	426	2.17	29.9%	4.4%	0.1%
Tidal energy (waves and tides)	C	5.1	1,240	312	2.11	20.6%	4.4%	0.1%
Green hydrogen	D	5.6	1,240	296	1.20	21.9%	1.8%	0.2%
Hydraulic energy	E	5.8	1,240	103	1.13	6.5%	1.7%	0.1%
Biomass	E	5.8	1,240	163	1.26	11.5%	1.6%	0.1%
Wind energy	E	6.0	1,240	10	1.18	0.2%	0.5%	0.1%
Solar energy	F	6.2	1,240	6	1.08	0.2%	0.2%	0.1%

K (Observed value)	1488.996
p-value (one-sided)	<0,0001
alpha	0.05

Table 13
Impact that energy production plants would have if installed in your locality (Question E3).



Categories	Mean	No. of observations	No. of Missing Values	Variance (n-1)
E3.1. Biomass	2.9	1,240	160	1.32
E3.2. Solar energy plant	2.7	1,240	22	1.06
E3.3. Wind power plant	3.0	1,240	24	1.39
E3.4. Hydropower plant	3.1	1,240	131	1.42
E3.5. Nuclear power plant	5.3	1,240	69	2.47
E3.6. Gas-fired power plant	4.3	1,240	77	2.66
E3.7. Oil-fired power plant	4.9	1,240	86	3.03

promoting the energy transition of consumers to renewable energy sources (35.0 % and 34.7 % respectively) (question F2), while a somewhat lower ratio (28.5 %) indicates not knowing or not answering this question. Finally, three out of four interviewees (76.1 %) believe that public aid supporting the energy transition of consumers to renewable energy sources should be increased or greatly increased (question F3); while 15.6 % say they would keep them as they are. This represents a much smaller group and, likewise, the option of reducing or greatly reducing this aid is preferred in an almost testimonial way (5.5 %) (Fig. 3).

4.8. Not in My Backyard

All sources of power generation plants are statistically significant associated with living near a production plant, except in the case of a gas-fired power station (p-value). Adjusted residuals indicate that the population living near a power plant think that the biomass power station and photovoltaic power station have more benefits than detriments

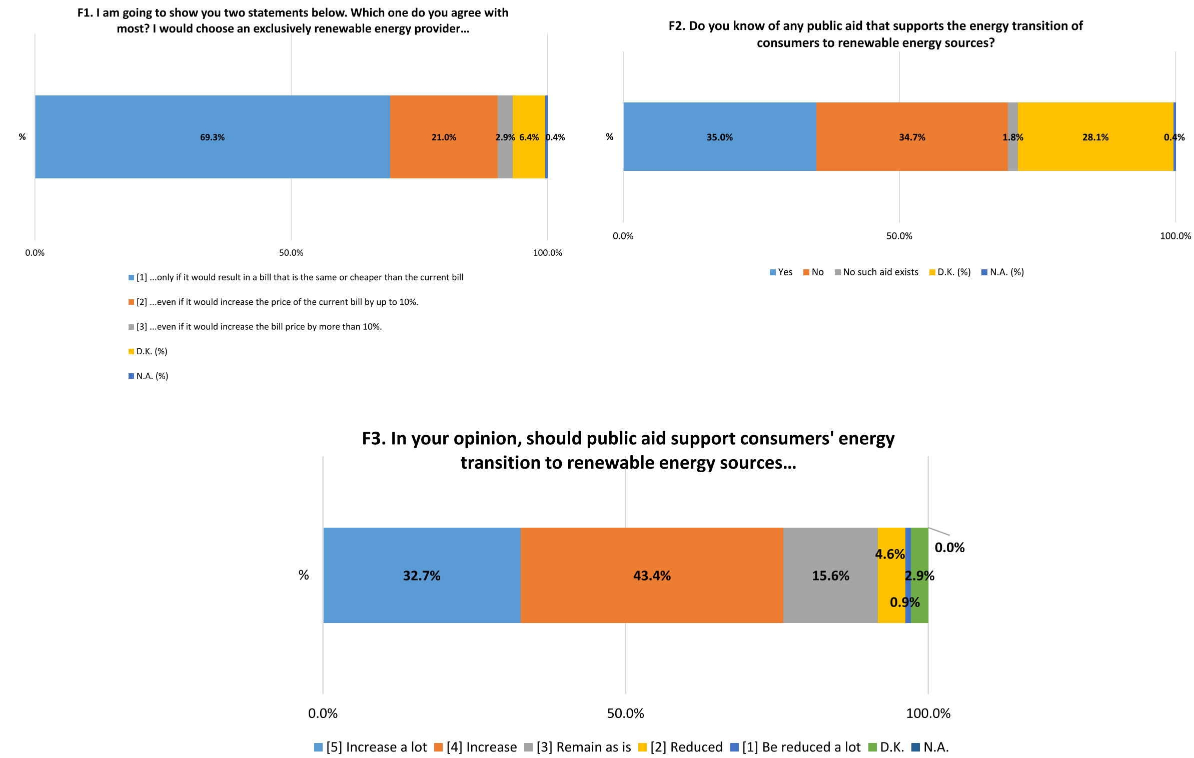


Fig. 3. Perception of public aid to individuals and the transition to renewable energies (Questions F1, F2 and F3) F1 and F2: N = 1240; F3: N = 784 – missing values = 456.

(and not the same benefits as detriments or fewer benefits than detriments); and the wind farm has fewer benefits than detriments.

Conversely, residents with a power plant near their municipality consider the hydropower station, nuclear power plant and oil-fired power plant to have more benefits than detriments (and not the same benefits as detriments or fewer benefits than detriments). In the case of the gas-fired power station, this population believes that it has more detriments than benefits (Table 14).

All renewable energy generation sources show a statistically significant association with the municipality size: biomass power station, photovoltaic power station, hydropower station (p-value) and the wind farm (Spearman's p-value).

Table 14
Association between the perception of the impact of different energy sources when living near an energy production plant (Question E3) and living near an energy production plant (Question S7).
Degree of association between the perceptions of energy impact and living in the surrounding area (p-value)
E3. Ahora le voy a pedir que piense sobre el impacto que tendría que una serie de plantas de producción de energía se instalaran en su localidad. ¿Diría que tendría más beneficios que perjuicios, los mismos beneficios que perjuicios o más perjuicios que beneficios?
E3 X S7.

Power generation plants	p-value	Living near a power plant	[1]Benefit > detriments - Residuals (Adjusted)	[2]Benefit = detriments - Residuals (Adjusted)	[3]Benefit < detriments - Residuals (Adjusted)
E3.1. Biomass power station	0.000	[1] Yes	3.874	−2.957	−2.690
		[2] No	−3.874	2.957	2.690
E3.2. Photovoltaic power station	<0,0001	[1] Yes	4.423	−3.814	−2.043
		[2] No	−4.423	3.814	2.043
E3.3. Wind farm	0.037	[1] Yes	−0.363	1.212	−2.361
		[2] No	0.363	−1.212	2.361
E3.4. Hydropower station	0.002	[1] Yes	−2.374	3.099	−2.047
		[2] No	2.374	−3.099	2.047
E3.5. Nuclear power plant	0.000	[1] Yes	−3.125	−1.469	3.622
		[2] No	3.125	1.469	−3.622
E3.6. Gas-fired power station	0.061	[1] Yes	−0.540	2.055	−1.990
		[2] No	0.540	−2.055	1.990
E3.7. Oil-fired power plant	0.000	[1] Yes	−3.712	3.429	−0.258
		[2] No	3.712	−3.429	0.258

Residuals (Adjusted) (E3.1. Planta de biomasa (pellets, materiales de origen vegetal …)/s7 ¿Vive cerca de alguna planta productora de energía?):
Values displayed in bold are significant at the level alpha = 0,05.
* P- value: values in bold are significant at the alpha = 0.05 level.
* Residuals (Adjusted): The positive sign of the p-value indicates a relationship in the same direction and the negative an inverse relationship.

Specifically, adjusted residuals indicate that the population living in the smaller municipalities (under 100,000 inhabitants) consider that this type of energy sources has more benefits than detriments (in the case of photovoltaic power station, also municipalities with 10,001–20,000 residents); and overall fewer benefits than detriments in the largest municipalities).

By contrast, non-renewable sources analysed (nuclear power plant, gas-fired power station and oil-fired power plant) are not associated with the size of the municipality (Table 15).

The data shows a statistically significant association between the perception of the impact of different energy sources when living near an energy production plant and the region (Autonomous Community) in all

Table 15
Association between the perception of the impact of different energy sources when living near an energy production plant (Question E3) and the habitat size (Question S5).
Degree of association between the perception of energy impact and municipality size (p-value)
E3 X S5.

Power generation plants	p-value	Habitat Size	[1]Benefit > detriments - Residuals (Adjusted)	[2]Benefit = detriments - Residuals (Adjusted)	[3]Benefit < detriments - Residuals (Adjusted)	p-values (Spearman)
E3.1. Biomass power station	0.029	[1] < 10,000	2.369	−2.685	0.569	0.003
		[2] 10,001–20,000	0.734	−0.327	−1.139	
		[3] 20,001–50,000	1.027	−1.369	0.784	
		[4] 50,001–100,000	−0.054	−0.311	0.958	
		[5] 100,001–500,000	−3.052	3.403	−0.588	
		[6] > 500,000	−0.744	1.035	−0.681	
E3.2. Photovoltaic power station	0.009	[1] < 10,000	2.074	−1.574	−1.437	<0,0001
		[2] 10,001–20,000	2.659	−2.584	−0.592	
		[3] 20,001–50,000	1.015	−0.656	−0.955	
		[4] 50,001–100,000	−1.129	0.332	1.942	
		[5] 100,001–500,000	−1.439	1.310	0.517	
		[6] > 500,000	−2.869	2.750	0.723	
E3.3. Wind farm	0.056	[1] < 10,000	2.525	−2.223	−1.060	0.005
		[2] 10,001–20,000	0.373	−0.372	−0.036	
		[3] 20,001–50,000	0.586	−0.591	−0.041	
		[4] 50,001–100,000	−1.211	0.380	2.396	
		[5] 100,001–500,000	−0.844	1.039	−0.460	
		[6] > 500,000	−1.662	1.853	−0.374	
E3.4. Hydropower station	0.013	[1] < 10,000	2.324	−1.894	−1.481	0.000
		[2] 10,001–20,000	0.663	−0.775	0.299	
		[3] 20,001–50,000	0.841	−0.837	−0.073	
		[4] 50,001–100,000	1.385	−1.644	0.697	
		[5] 100,001–500,000	−2.016	1.535	1.618	
		[6] > 500,000	−2.869	3.273	−1.041	
E3.5. Nuclear power plant	0.519	[1] < 10,000	0.412	−0.773	0.606	0.198
		[2] 10,001–20,000	−1.375	0.392	0.349	
		[3] 20,001–50,000	−0.966	0.008	0.535	
		[4] 50,001–100,000	−0.134	1.227	−1.254	
		[5] 100,001–500,000	0.655	−0.184	−0.169	
		[6] > 500,000	0.948	−0.294	−0.215	
E3.6. Gas-fired power station	0.557	[1] < 10,000	1.243	−1.063	0.021	0.199
		[2] 10,001–20,000	1.030	−0.379	−0.821	
		[3] 20,001–50,000	−1.083	0.408	0.849	
		[4] 50,001–100,000	0.325	−0.345	0.118	
		[5] 100,001–500,000	−0.839	0.680	0.049	
		[6] > 500,000	−0.431	0.609	−0.408	
E3.7. Oil-fired power plant	0.430	[1] < 10,000	1.342	−2.601	1.528	0.582
		[2] 10,001–20,000	0.121	1.163	−1.320	
		[3] 20,001–50,000	0.568	−0.489	0.009	
		[4] 50,001–100,000	0.261	0.333	−0.578	
		[5] 100,001–500,000	−1.139	1.100	−0.142	
		[6] > 500,000	−1.081	0.837	0.082	

* P- value: values in bold are significant at the alpha = 0.05 level.
* Residuals (Adjusted): The positive sign of the p-value indicates a relationship in the same direction and the negative an inverse relationship.

Table 16
Degree of association between the perception of the impact of different energy sources when living near an energy production plant (Question E3) and the region (Autonomous Community) or residency (Question S4).

Power generation plants	p-values (Chi square)	N
E3.1. Biomass power station	0.420	1,080
E3.2. Photovoltaic power station	0.055	1,208
E3.3. Wind farm	0.220	1,216
E3.4. Hydropower station	0.002	1,109
E3.5. Nuclear power plant	0.011	1,171
E3.6. Gas-fired power station	<0,0001	1,163
E3.7. Oil-fired power plant	0.000	1,154

non-renewable energy sources, as well as the hydropower station (p-values) (Table 16).

The following describes the geographical distribution in Spain of the social perception of the benefits and detriments of power plants being installed in the participant's locality. Overall, the population living in the insular regions such as Balearic and Canary Islands, along with the Valencian Community believe that there are more detriments than benefits of nuclear power (also Navarra), as well as the gas-fired power stations and oil-fired power plants in the Canary Island, Extremadura and Andalusia residents.

In Madrid and Castilla la Mancha, social rejection is more prominent for photovoltaic power stations (along with the Valencian Community) and for wind farms.

Other technologies such as biomass power station register greater rejection in Navarra and the Valencian Community, along with the hydropower station in La Rioja (Table 17).

4.9. Study limitations

To address the limitations of this study, future research could explore gender dimensions along with inter and intragenerational considerations, and the socio-economic profile of the population in renewable energy perception, an aspect Feenstra et al. (2024) identify as influential in energy decision-making participation and perceived transition benefits.

Also, some questions registered a high number of "don't know" responses (particularly Question C1), which could affect the Kruskal-Wallis test. But this analysis performed well in the validity and reliability tests.

This descriptive study establishes baseline understanding but has limitations in establishing causal relationships. The research design prioritised comprehensive national coverage and baseline establishment over hypothesis testing.

Future research could employ structural equation modelling or experimental designs to test specific causal pathways identified through this foundational work. Additionally, investigation into effective methods for bridging the gap between environmental consciousness and economic behaviour would benefit policy development.

Since the year 2022, when this cross-sectional survey was conducted, the population's social perception of renewable energies may have changed in aspects such as energy security, prices, and geopolitics. A longitudinal approach to this issue is therefore necessary (with periodic surveys) to determine the evolution over time of this issue.

This study contributes to the growing body of literature on social acceptance of renewable energy technologies, specifically in Spain and countries with similar energy structure, while highlighting the need for nuanced, context-sensitive approaches to renewable energy implementation that consider local perspectives, economic incentives, and trusted information channels to achieve widespread public support and participation.

5. Discussion

This study provides significant insights into the social perception of renewable energies in Spain, revealing several key patterns and interconnected themes that merit careful consideration. The findings can be organised into four main thematic areas: 1) social perception and awareness, 2) institutional trust and communication, 3) attitudes towards energy consumption, and 4) socio-spatial dynamics.

Based on the study findings, several policy implications emerge directly from the data. The results show that renewable energies are among the matters that receive the most social interest, forming part of the thematic group alongside environmental protection and ecological concerns. This aligns with recent research indicating growing public support for energy transition (Torma and Aschemann-Witzel, 2024).

A clear preference for renewable energies is observed, particularly solar over nuclear (not supported by citizens as an alternative to fossil fuels), oil, coal and fracking, along with gas as a single energy source from the social perception perspective. This is consistent with broader acceptance trends observed in various European contexts (Brennan and Van Rensburg, 2023; Kanberger and Ziegler, 2023; Khanam and Reiner, 2022; Van Rijnsoever and Farla, 2014).

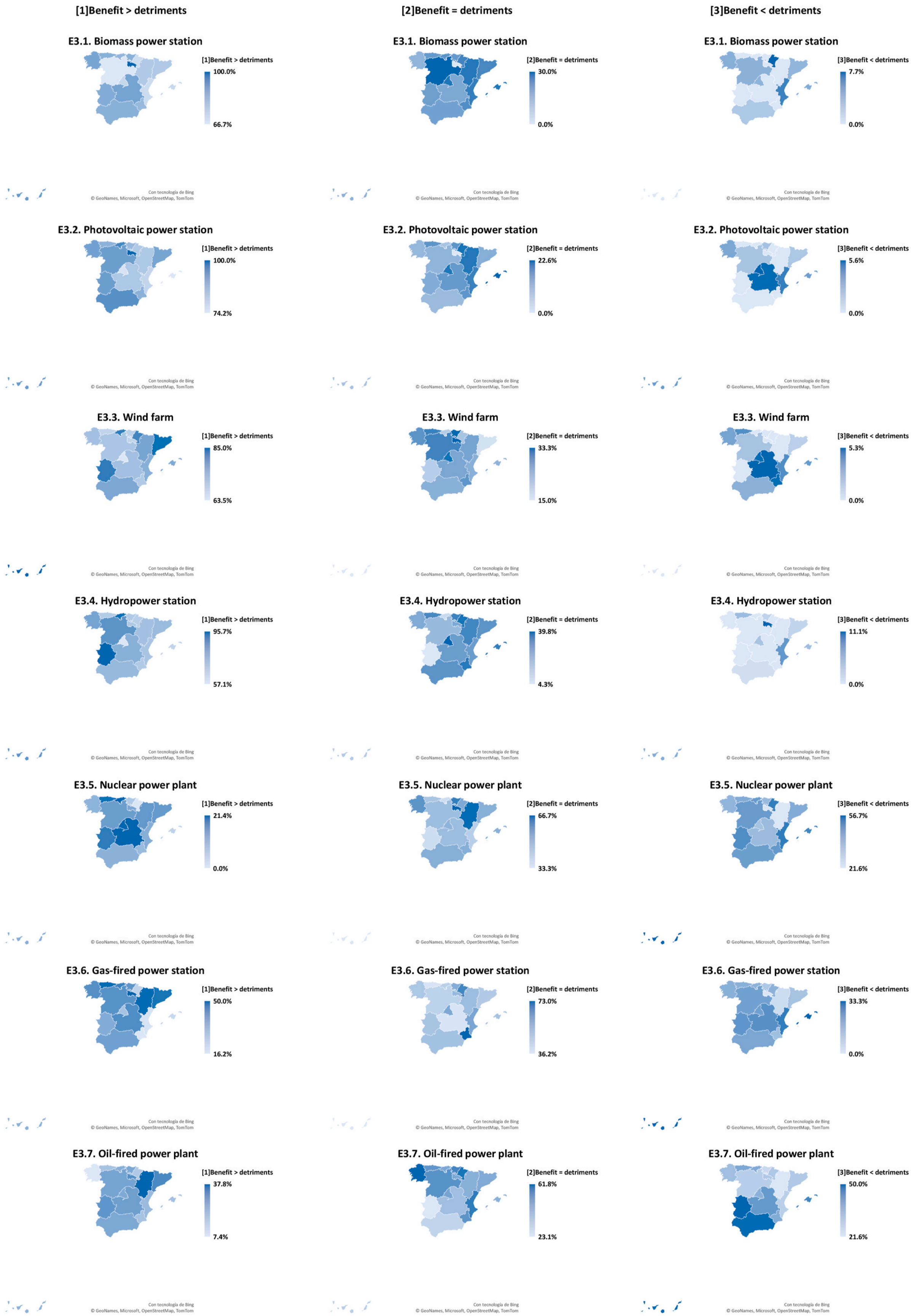
In relation to communication and trust strategies, the institutional trust dimension reveals a significant disparity between the high level of confidence in universities (5.8 average) and low trust in political parties (3.8) regarding energy-related information. This empirically supports the recommendation for science-based communication strategies, with academic institutions serving as credible intermediaries in renewable energy communication. As (Liebe and Dobers, 2019) emphasize, this result underscores the crucial role of scientific communication in shaping public opinions on energy matters. Other studies in the European countries have obtained similar outcomes (Gölz and Wedderhoff, 2018; Kalkbrenner and Roosen, 2016; Sebi and Vernay, 2020).

The performance of governance (in particular aspects such as corruption or the level of bureaucracy), or political stability, have a direct influence on the Green Electricity Transition (Xu et al., 2024; Xu et al., 2024b). The findings suggest that universities could serve as effective intermediaries in renewable energy communication, supporting the argument put forward by Sovacool et al. (2021), that trust influences both specific technology acceptance and perceived legitimacy of the energy transition process.

The population's trust in universities and scientific knowledge rather than in political parties could be due to the former being perceived as relatively independent and aimed at the creation of knowledge and education. Opinion on the latter can be conditioned by cases of corruption, electoral interest (rather than general interest) or populist discourses (Eurofound, 2018; Marcos-Marne and Sendra, 2024).

Institutional quality shapes renewable energy transitions through multiple pathways, as weak governance institutions create policy uncertainty, reduce investor confidence, and limit public participation in energy planning (Schmidt and Sewerin, 2019; Schmidt and Sewerin, 2019). Comparative European research shows that countries with higher government effectiveness scores and lower corruption indices achieve

Table 17
Geographical distribution of the perception of the impact of different energy sources when living near a power plant (Question E3) in the region (Autonomous Community) or residency (Question S4).



faster renewable energy deployment rates (Enevoldsen et al., 2019).

Considering financial incentive programs, the finding that 76.1 % of participants believe public aid for renewable energy transition should be increased provides strong empirical support for enhanced financial incentive programs. However, the economic dimension reveals that most participants show a preference for renewables only if their energy bill improves or at least does not increase, while being sceptical about general economic benefits. This aligns with Azarova et al. (2019) findings that willingness to pay for renewable energy is influenced by both socioeconomic factors and environmental values.

Thus, while there is widespread social support for renewable energy, including solar, the population is generally reluctant to pay more on their electricity bill for renewable energies. A possible explanatory hypothesis is the social perception of higher initial costs and concerns about the intermittency of some renewable sources (S. M. López and Gómez, 2023), or the difficulties in keeping the household at the right temperature, the household's low incomes or understanding the energy bill (López et al., 2025).

In relation to place-based implementation strategies, the NIMBY analysis showing differential acceptance by municipality size (with smaller municipalities demonstrating greater receptivity to renewable installations) directly informs recommendations for place-based implementation strategies that account for local contexts. The study reveals lower acceptance of certain renewable technologies in larger urban areas (biomass-based energy and solar), consistent with recent research on how proximity and local impact perception influence renewable project acceptance (Brennan and Van Rensburg, 2023).

Other studies question these results and delve into the interaction between rural and urban areas when renewable energies' infrastructures are developed (Haikola et al., 2024; Niskanen et al., 2024). Space limitations, higher energy demand, and concerns about aesthetics and property values might explain why the urban population is less receptive to renewable energies. Also, the development of these large infrastructures mostly in rural areas, or the perceived impact on the community, can influence the acceptance of new energy technologies (Haque et al., 2021). This urban-rural divide reflects deeper issues of energy justice, where rural communities often bear the (McCauley and Heffron, 2018).

The research reveals the limited knowledge about technical and economic aspects of renewable technologies, their impact on climate change and energy prices, pollution, energy storage, energy consumption, or energy dependence on other countries (Kariuki, 2018; Nguyen et al., 2023; Persoon et al., 2022). This finding directly supports the need for comprehensive educational initiatives that focus on expanding public understanding of renewable technologies, particularly emphasising their reliability and economic implications.

6. Conclusions

This study contributes to the growing body of literature on social acceptance of renewable energy developments, specifically in Spain and countries with a similar energy structure, while highlighting the need for nuanced, context-sensitive approaches to renewable energy implementation.

The findings indicate a clear hierarchy in public perception of different energy sources, receiving broad support of the use of renewable energies for the supply of electricity, fuel and heating. Also, there is a marked dichotomy between general support for renewable technologies and specific implementation challenges due to considerable variations based on geographical proximity to energy installations and municipality size. Economic incentives focused on smaller municipalities could serve as an effective tool for fostering local acceptance of renewable energy projects.

A significant finding emerges regarding the trust hierarchy in energy-related matters, which represents a remarkable opportunity for knowledge dissemination and public engagement particularly through established academic channels. Thus, successful renewable energy transition requires careful consideration of local perspectives, economic incentives, and trusted information channels to achieve widespread public support and participation. It is also necessary because social perception indicates that Spain lags behind the EU average in research and development of renewable energies.

Finaly, the research reveals a notable disconnect between environmental consciousness or support for renewable energy development and economic willingness to participate in the renewable transition. This scepticism about behavioural change presents an additional challenge for energy transition policies.

Spain aims for 81 % of electricity to come from renewable sources by 2030. However, almost one in three of the 17 Autonomous Communities supports restrictive regulations on the implementation of wind energy. Photovoltaic mega-plants are also rejected in the south of the country, for reasons, for example, of replacing the landscape of olive groves, a traditional crop and determinant of the regional economy.

While this study did not directly assess public attitudes toward equity-sharing mechanisms, the documented preference for local economic benefits and concerns about proximity impacts suggest that policy measures such as the government's consideration of requiring renewable energy companies to cede 20 % of their facilities to residents and municipalities may warrant further empirical investigation to assess their social acceptance and effectiveness.

CRediT authorship contribution statement

Iván López: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Formal analysis, Data curation. **Victoria Sanagustín-Fons:** Writing – review & editing, Writing – original draft, Conceptualization. **José A. Moseñe Fierro:** Writing – review & editing, Visualization, Supervision, Resources, Data curation.

Declaration of competing interest

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

Appendix A. Additional sample features

Autonomous community	n	%
Andalucía	182	14.7%
Aragón	37	3.0%
Principado de Asturias	28	2.3%
Illes Balears	31	2.5%
Canarias	65	5.2%
Cantabria	183	14.8%
Castilla y León	138	11.1%
Castilla-La Mancha	60	4.8%
Cataluña	16	1.3%
Comunitat Valenciana	210	16.9%
Extremadura	2	0.2%
Galicia	57	4.6%
Comunidad de Madrid	29	2.3%
Región de Murcia	72	5.8%
Comunidad Foral de Navarra	9	0.7%
País Vasco	2	0.2%
La Rioja	41	3.3%
Ciudad Autónoma de Ceuta	17	1.4%
Ciudad Autónoma de Melilla	61	4.9%
D.K.	0	0.0%
N.A.	0	0.0%
TOTAL	**1,240**	**100.0%**

On a scale of 1 to 7, where 1 means 'far left' and 7 means 'far right', where would you place yourself?	n	%
[1] Far left	18	1.5%
2	251	20.2%
3	302	24.4%
4	195	15.7%
5	259	20.9%
6	101	8.1%
[7] Far right	33	2.7%
D.K.	50	4.0%
N.A.	31	2.5%
TOTAL	**1,240**	**100.0%**
Mean	**2.3**	

In the last general elections, held in November 2019, you…	n	%
[1] He went to vote and voted	1,074	86.6%
[2] He went to vote but couldn't vote	45	3.6%
[3] He didn't go to vote	98	7.9%
[4] He wasn't old enough/couldn't vote	23	1.9%
D.K.	0	0.0%
N.A.	0	0.0%
TOTAL	**1,240**	**100.0%**

Which party or coalition you voted for.	n	%
[1] PSOE/PSC/PSPV/PSG/PSE	347	28.0%
[2] PP	271	21.9%
[3] Unidas Podemos/En Comú Podem/En Común-Unidas Podemos	105	8.5%
[4] ERC	56	4.5%
[5] Ciudadanos	52	4.2%
[6] Junts per Cat	25	2.0%
[7] EAJ-PNV	29	2.3%
[8] EH Bildu	14	1.1%
[9] Más País/Más Madrid	20	1.6%
[10] CUP	15	1.2%
[11] CCa-NC	12	1.0%
[12] Na+	2	0.2%
[13] Més Compromís	9	0.7%
[14] BNG	11	0.9%
[15] PRC	4	0.3%
[16] Teruel Existe	1	0.1%
[17] PACMA	8	0.6%
[18] VOX	78	6.3%
Others	181	20.9%
TOTAL	**1,240**	**100.0%**

Appendix B. Validity of the Kruskal-Wallis test - Questions A1, B1, B2, C1, C2, C3, C4, D1, E2

Interest level in each topic (Question A1)

Kruskal-Wallis test / Two-tailed test:	
K (Observed value)	396.006
K (Critical value)	11.070
DF	5
p-value (one-tailed)	**< 0,0001**
alpha	0.05

Ha: The samples do not come from the same population.

Effect Size (W²) – Cohen (1988): 0.056

Risk level perception of Science and Technology applications (Question B1)

Kruskal-Wallis test / Two-tailed test:	
K (Observed value)	646.718
K (Critical value)	11.070
DF	5
p-value (one-tailed)	**< 0,0001**
alpha	0.05

Ha: The samples do not come from the same population.

Effect Size (W²) – Cohen (1988): 0.093

Level of benefit from specific applications of Science and Technology (Question B2)

Kruskal-Wallis test / Two-tailed test:	
K (Observed value)	663.488
K (Critical value)	11.070
DF	5
p-value (one-tailed)	**< 0,0001**
alpha	0.05

H0: The samples come from the same population.

Effect Size (W²) – Cohen (1988): 0.085

Degree of concern on each energy-related issue (Question C1)

Kruskal-Wallis test / Two-tailed test:	
K (Observed value)	719.233
K (Critical value)	14.067
DF	7
p-value (one-tailed)	**< 0,0001**
alpha	0.05

Ha: The samples do not come from the same population.

Effect Size (W²) – Cohen (1988): 0.073

Public administration objectives regarding energy policies (Question C2)

Kruskal-Wallis test / Two-tailed test:	
K (Observed value)	939.571
K (Critical value)	11.070
DF	5
p-value (one-tailed)	**< 0,0001**
alpha	0.05

H0: The samples come from the same population.

Effect Size (W²) – Cohen (1988): 0.134

Degree of agreement with renewable energies... (Question C3)

Kruskal-Wallis test / Two-tailed test:	
K (Observed value)	324.826
K (Critical value)	9.488
DF	4
p-value (one-tailed)	**< 0,0001**
alpha	0.05

H0: The samples come from the same population.

Effect Size (W²) – Cohen (1988): 0.051

Degree of agreement with the statements. In order to guarantee energy supply, it is necessary to... (C 4)

Kruskal-Wallis test / Two-tailed test:	
K (Observed value)	1488.996
K (Critical value)	11.070
DF	5
p-value (one-tailed)	**< 0,0001**
alpha	0.05

H0: The samples come from the same population.

Effect Size (W²) – Cohen (1988): 0.263

Degree of trust, at this moment, in each of the institutions when dealing with energy-related issues (Question D1)

Kruskal-Wallis test / Two-tailed test:	
K (Observed value)	2195.626
K (Critical value)	14.067
DF	7
p-value (one-tailed)	**< 0,0001**
alpha	0.05

H0: The samples come from the same population.

Effect Size (W²) – Cohen (1988): 0.203

Degree of support for the use of each of the following energies to supply us with electricity, fuel and heating (Question E2)

Kruskal-Wallis test / Two-tailed test:	
K (Observed value)	2738.358
K (Critical value)	12.592
DF	6
p-value (one-tailed)	**< 0,0001**
alpha	0.05

H0: The samples come from the same population.

Effect Size (W²) – Cohen (1988): 0.325

Appendix C. Reliability of the results of the questions analyzed using the Kruskal-Wallis test - Questions A1, B1, B2, C1, C2, C3, C4, D1, E2

Interest level in each topic (Question A1)

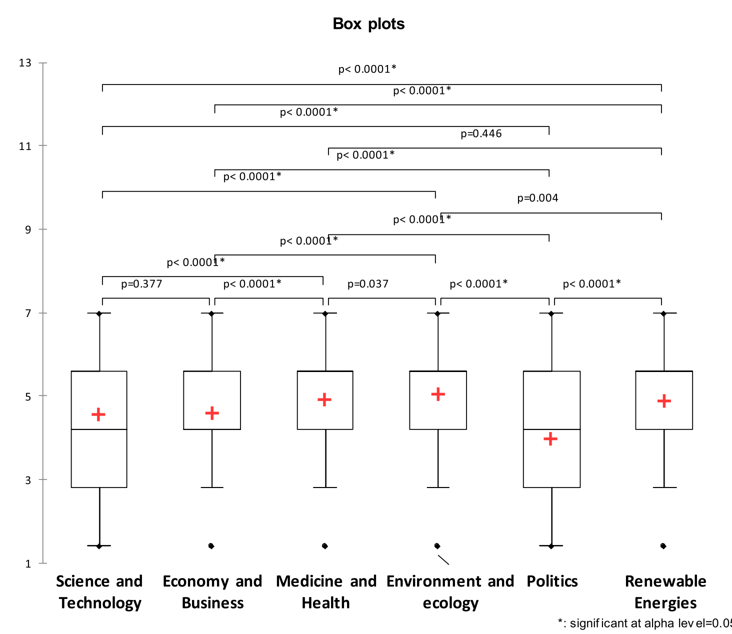
Reliability test (p-value)

Categories	Science and Technology	Economy and Business	Medicine and Health	Environment and ecology	Politics	Renewable Energies
Science and Technology	1	0.377	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
Economy and Business	0.377	1	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
Medicine and Health	**< 0.0001**	**< 0.0001**	1	0.037	**< 0.0001**	0.446
Environment and ecology	**< 0.0001**	**< 0.0001**	0.037	1	**< 0.0001**	0.004
Politics	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	1	**< 0.0001**
Renewable Energies	**< 0.0001**	**< 0.0001**	0.446	0.004	**< 0.0001**	1

Significance level of the Bonferroni correction: 0.0033

Reliability (Cronbach's α)

Cronbach's α	Standardized Cronbach's α
0.850	0.852



Risk level perception of Science and Technology applications (Question B1)

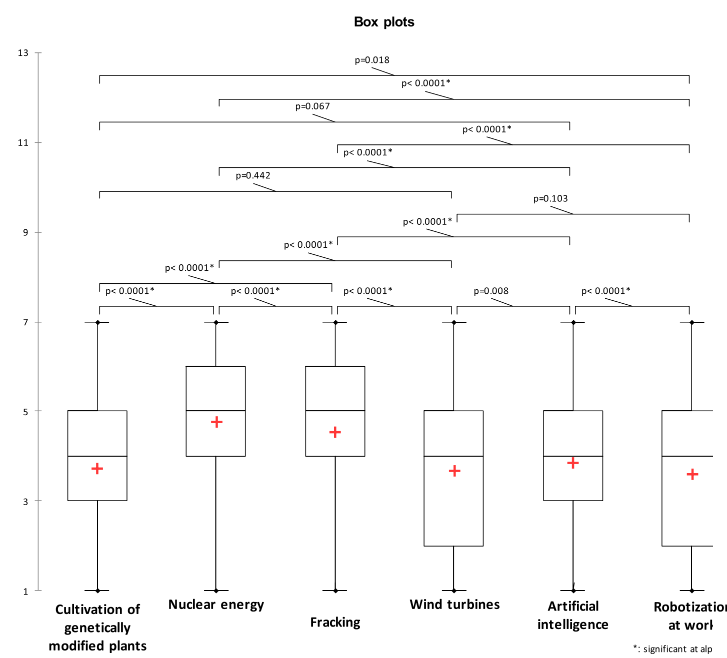
Reliability test (p-value)

Categories	Cultivation of genetically modified plants	Nuclear energy	Fracking (technique for extracting fossil fuels)	Wind turbines	Artificial intelligence	Robotization at work
Cultivation of genetically modified plants	1	< 0.0001	< 0.0001	0.442	0.067	0.018
Nuclear energy	< 0.0001	1	0.001	< 0.0001	< 0.0001	< 0.0001
Fracking	< 0.0001	0.001	1	< 0.0001	< 0.0001	< 0.0001
Wind turbines	0.442	< 0.0001	< 0.0001	1	0.008	0.103
Artificial intelligence	0.067	< 0.0001	< 0.0001	0.008	1	< 0.0001
Robotization at work	0.018	< 0.0001	< 0.0001	0.103	< 0.0001	1

Significance level of the Bonferroni correction: 0.0033

Reliability (Cronbach's α)

Cronbach's α	Standardized Cronbach's α
0.665	0.663



. (*continued*).

Level of benefit from specific applications of Science and Technology (Question B2)

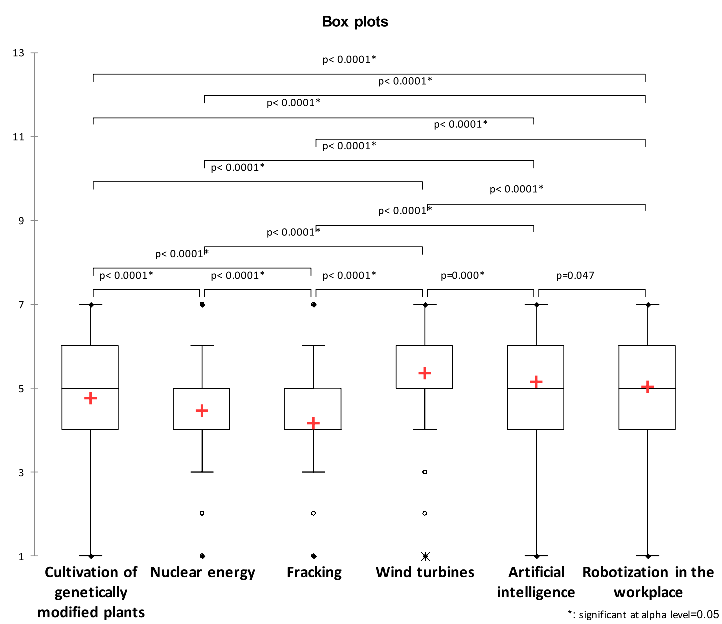
Reliability test (p-value)

Categories	Cultivation of genetically modified plants	Nuclear energy	Fracking	Wind turbines	Artificial intelligence	Robotization in the workplace
Cultivation of genetically modified plants	1	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
Nuclear energy	**< 0.0001**	1	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
Fracking	**< 0.0001**	**< 0.0001**	1	**< 0.0001**	**< 0.0001**	**< 0.0001**
Wind turbines	**< 0.0001**	**< 0.0001**	**< 0.0001**	1	**0.000**	**< 0.0001**
Artificial intelligence	**< 0.0001**	**< 0.0001**	**< 0.0001**	**0.000**	1	0.047
Robotization in the workplace	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	0.047	1

Significance level of the Bonferroni correction: 0.0033

Reliability (Cronbach's α)

Cronbach's α	Standardized Cronbach's α
0.799	0.794



. (*continued*).

Degree of concern on each energy-related issue (Question C1)

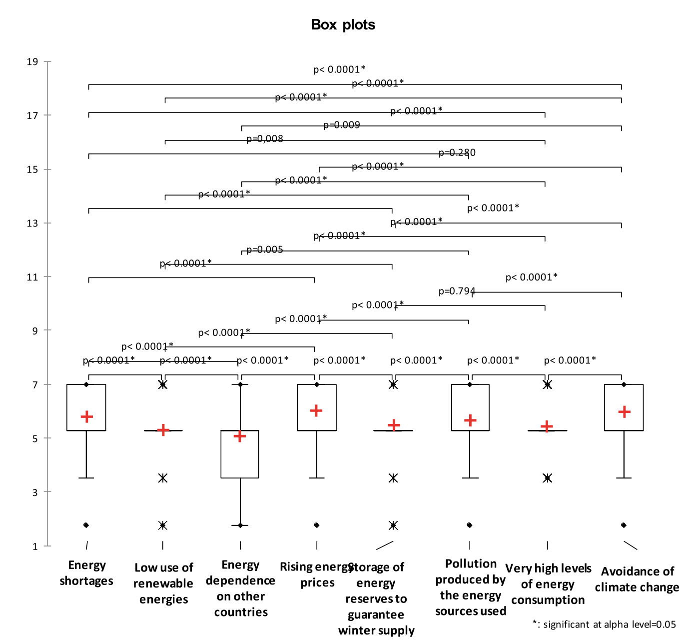
Reliability test (p-value)

Categories	Energy shortages	Low use of renewable energies	Energy dependence on other countries	Rising energy prices	Storage of energy reserves to guarantee winter supply	Pollution produced by the energy sources used.	Very high levels of energy consumption	Avoidance of climate change
Energy shortages	1	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.008	< 0.0001	< 0.0001
Low use of renewable energies	< 0.0001	1	< 0.0001	< 0.0001	0.005	< 0.0001	0.009	< 0.0001
Energy dependence on other countries	< 0.0001	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Rising energy prices	< 0.0001	< 0.0001	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001	0.280
Storage of energy reserves to guarantee winter supply	< 0.0001	0.005	< 0.0001	< 0.0001	1	< 0.0001	0.794	< 0.0001
Pollution produced by the energy sources used.	0.008	< 0.0001	< 0.0001	< 0.0001	< 0.0001	1	< 0.0001	< 0.0001
Very high levels of energy consumption	< 0.0001	0.009	< 0.0001	< 0.0001	0.794	< 0.0001	1	< 0.0001
Avoidance of climate change	< 0.0001	< 0.0001	< 0.0001	0.280	< 0.0001	< 0.0001	< 0.0001	1

Significance level of the Bonferroni correction: 0.0018

Reliability (Cronbach's α)

Cronbach's α	Standardized Cronbach's α
0.768	0.768



. (*continued*).

Public administration objectives regarding energy policies (Question C2)

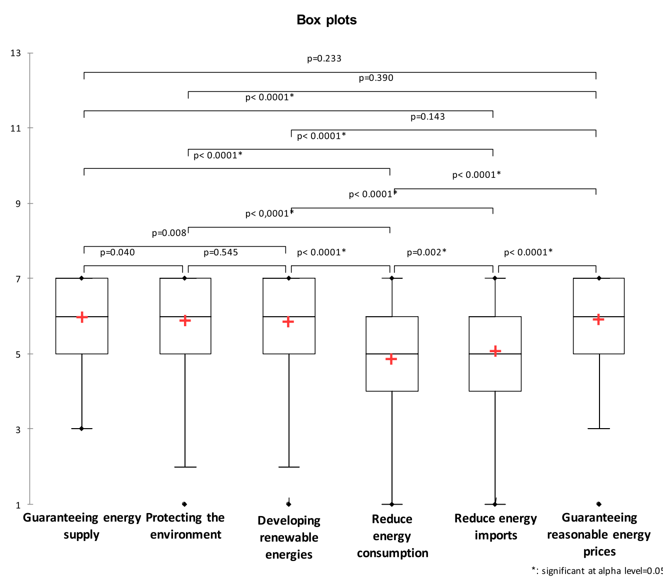
Reliability test (p-value)

Categories	Guaranteeing energy supply	Protecting the environment	Developing renewable energies	Reduce energy consumption	Reduce energy imports	Guaranteeing reasonable energy prices
Guaranteeing energy supply	1	0.040	0.008	**< 0.0001**	**< 0.0001**	0.233
Protecting the environment	0.040	1	0.545	**< 0.0001**	**< 0.0001**	0.390
Developing renewable energies	0.008	0.545	1	**< 0.0001**	**< 0.0001**	0.143
Reduce energy consumption	**< 0.0001**	**< 0.0001**	**< 0.0001**	1	**0.002**	**< 0.0001**
Reduce energy imports	**< 0.0001**	**< 0.0001**	**< 0.0001**	**0.002**	1	**< 0.0001**
Guaranteeing reasonable energy prices	0.233	0.390	0.143	**< 0.0001**	**< 0.0001**	1

Significance level of the Bonferroni correction: 0.0033

Reliability (Cronbach's α)

Cronbach's α	Standardized Cronbach's α
0.782	0.793



. (*continued*).

Degree of agreement with renewable energies... (Question C3)

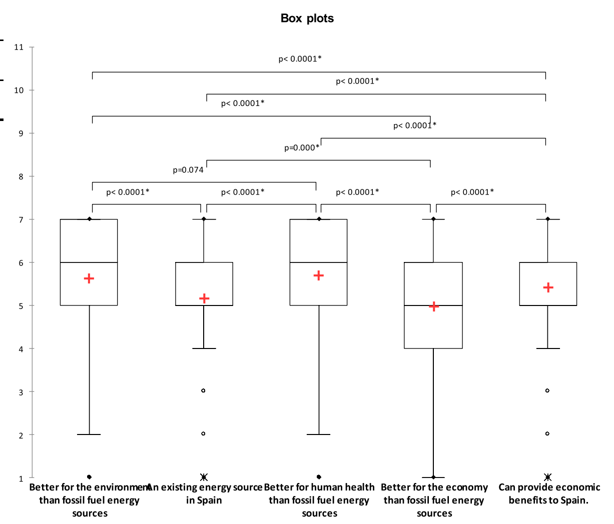
Reliability test (p-value)

Categories	Better for the environment than fossil fuel energy sources	An existing energy source in Spain	Better for human health than fossil fuel energy sources	Better for the economy than fossil fuel energy sources	Can provide economic benefits to Spain
Better for the environment than fossil fuel energy sources	1	< 0.0001	0.074	< 0.0001	< 0.0001
An existing energy source in Spain	< 0.0001	1	< 0.0001	0.000	< 0.0001
Better for human health than fossil fuel energy sources	0.074	< 0.0001	1	< 0.0001	< 0.0001
Better for the economy than fossil fuel energy sources	< 0.0001	0.000	< 0.0001	1	< 0.0001
Can provide economic benefits to Spain	< 0.0001	< 0.0001	< 0.0001	< 0.0001	1

Significance level of the Bonferroni correction: 0.005

Reliability (Cronbach's α)

Cronbach's α	Standardized Cronbach's α
0.829	0.830



. (*continued*).

Degree of agreement with the statements. In order to guarantee energy supply, it is necessary to... (Question 4)

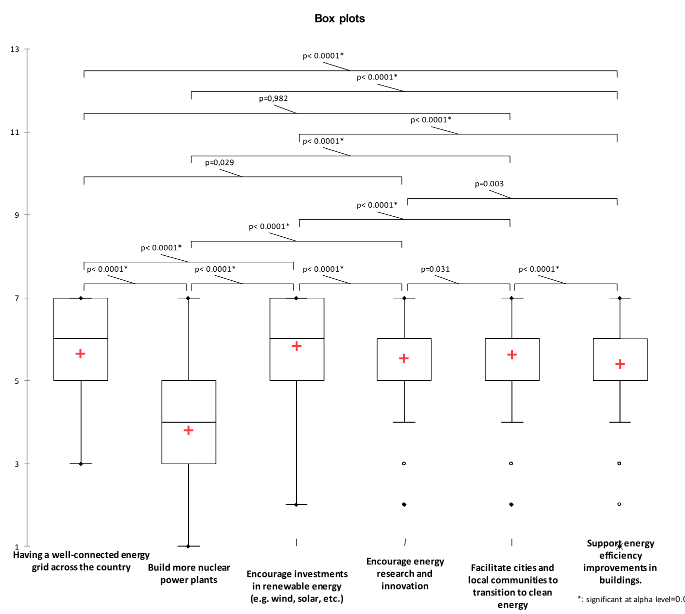
Reliability test (p-value)

Categories	Having a well-connected energy grid across the country	Build more nuclear power plants	Encourage investments in renewable energy (e.g. wind, solar, etc.)	Encouraging energy research and innovation	Facilitating cities and local communities to transition to clean energy	Support energy efficiency improvements in buildings
Having a well-connected energy grid across the country	1	< 0.0001	< 0.0001	0.029	0.982	< 0.0001
Build more nuclear power plants	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Encourage investments in renewable energy (e.g. wind, solar, etc.)	< 0.0001	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001
Encouraging energy research and innovation	0.029	< 0.0001	< 0.0001	1	0.031	0.003
Facilitating cities and local communities to transition to clean energy	0.982	< 0.0001	< 0.0001	0.031	1	< 0.0001
Support energy efficiency improvements in buildings	< 0.0001	< 0.0001	< 0.0001	0.003	< 0.0001	1

Significance level of the Bonferroni correction: 0.0033

Reliability (Cronbach's α)

Cronbach's α	Standardized Cronbach's α
0.721	0.750



. (*continued*).

Degree of trust, at this moment, in each of the institutions when dealing with energy-related issues (Question D1)

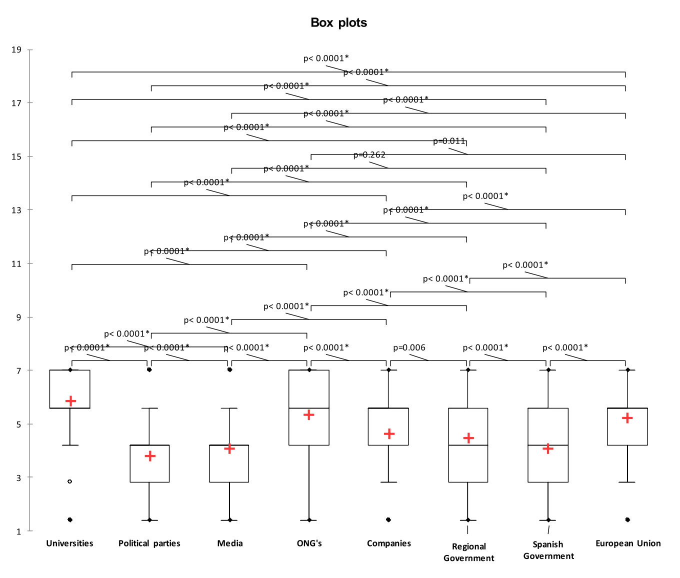
Reliability test (p-value)

Categories	Universities	Political parties	Media	ONG's	Companies	Regional Government	Spanish Government	European Union
Universities	1	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Political parties	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Media	< 0.0001	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001	0.262	< 0.0001
ONG's	< 0.0001	< 0.0001	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001	0.011
Companies	< 0.0001	< 0.0001	< 0.0001	< 0.0001	1	0.006	< 0.0001	< 0.0001
Regional Government	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.006	1	< 0.0001	< 0.0001
Spanish Government	< 0.0001	< 0.0001	0.262	< 0.0001	< 0.0001	< 0.0001	1	< 0.0001
European Union	< 0.0001	< 0.0001	< 0.0001	0.011	< 0.0001	< 0.0001	< 0.0001	1

Significance level of the Bonferroni correction: 0.0018

Reliability (Cronbach's α)

Cronbach's α	Standardized Cronbach's α
0.798	0.800



. (*continued*).

Degree of support for the use of each of the following energies to supply us with electricity, fuel and heating (Question E2)

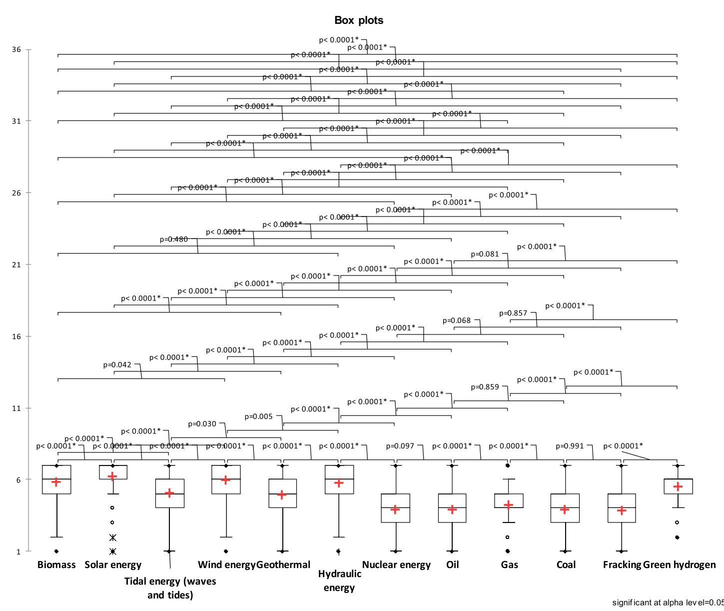
Reliability test (p-value)

Categories	Biomass	Solar energy	Tidal energy (waves and tides)	Wind energy	Geothermal	Hydraulic energy	Nuclear energy	Oil	Gas	Coal	Fracking	Green hydrogen
Biomass	1	< 0.0001	< 0.0001	0.042	< 0.0001	0.480	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Solar energy	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Tidal energy (waves and tides)	< 0.0001	< 0.0001	1	< 0.0001	0.030	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Wind energy	0.042	< 0.0001	< 0.0001	1	< 0.0001	0.005	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Geothermal	< 0.0001	< 0.0001	0.030	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Hydraulic energy	0.480	< 0.0001	< 0.0001	0.005	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nuclear energy	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	1	0.097	< 0.0001	0.068	0.081	< 0.0001
Oil	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.097	1	< 0.0001	0.859	0.857	< 0.0001
Gas	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	1	< 0.0001	< 0.0001	< 0.0001
Coal	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.068	0.859	< 0.0001	1	0.991	< 0.0001
Fracking	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.081	0.857	< 0.0001	0.991	1	< 0.0001
Green hydrogen	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	1

Significance level of the Bonferroni correction: 0.0008

Reliability (Cronbach's α)

Cronbach's α	Standardized Cronbach's α
0.802	0.808



. (*continued*).

Appendix D. Chi-square test of independence: perception of the impact of different energy sources and living near an energy production plant (Question E3) and living near an energy production plant (Question S7)

E3.1. Biomass power station

Test of independence	
Chi-square (Observed value)	17.440
Chi-square (Critical value)	5.991
DF	2
p-value	0.000
alpha	0.05

Ha: There is a link between the rows and the columns of the table.

E3.2. Photovoltaic power station

Test of independence	
Chi-square (Observed value)	19.781
Chi-square (Critical value)	5.991
DF	2
p-value	**< 0,0001**
alpha	0.05

Ha: There is a link between the rows and the columns of the table.

E3.3. Wind farm

Test of independence	
Chi-square (Observed value)	6.592
Chi-square (Critical value)	5.991
DF	2
p-value	**0.037**
alpha	0.05

Ha: There is a link between the rows and the columns of the table.

E3.4. Hydropower station

Test of independence	
Chi-square (Observed value)	12.737
Chi-square (Critical value)	5.991
DF	2
p-value	**0.002**
alpha	0.05

Ha: There is a link between the rows and the columns of the table.

E3.5. Nuclear power plant

Test of independence	
Chi-square (Observed value)	17.397
Chi-square (Critical value)	5.991
DF	2
p-value	**0.000**
alpha	0.05

Ha: There is a link between the rows and the columns of the table.

E3.6. Gas-fired power station

Test of independence	
Chi-square (Observed value)	5.592
Chi-square (Critical value)	5.991
DF	2
p-value	0.061
alpha	0.05

H0: The rows and the columns of the table are independent.

E3.7. Oil-fired power plant

Test of independence	
Chi-square (Observed value)	17.412
Chi-square (Critical value)	5.991
DF	2
p-value	**0.000**
alpha	0.05

Ha: There is a link between the rows and the columns of the table.

Appendix E. Chi-square test of independence: perception of the impact of different energy sources and living near an energy production plant (Question E3) and the habitat size (Question S5)

E3.1. Biomass power station

Test of independence	
Chi-square (Observed value)	20.032
Chi-square (Critical value)	18.307
DF	10
p-value	**0.029**
alpha	0.05

Ha: There is a link between the rows and the columns of the table.

E3.2. Photovoltaic power station

Test of independence	
Chi-square (Observed value)	23.592
Chi-square (Critical value)	18.307
DF	10
p-value	**0.009**
alpha	0.05

Ha: There is a link between the rows and the columns of the table.

E3.3. Wind farm

Test of independence	
Chi-square (Observed value)	14.780
Chi-square (Critical value)	18.307
DF	10
p-value	0.140
alpha	0.05

H0: The rows and the columns of the table are independent.

E3.4. Hydropower station

Test of independence	
Chi-square (Observed value)	22.520
Chi-square (Critical value)	18.307
DF	10
p-value	**0.013**
alpha	0.05

Ha: There is a link between the rows and the columns of the table.

E3.5. Nuclear power plant

Test of independence	
Chi-square (Observed value)	9.140
Chi-square (Critical value)	18.307
DF	10
p-value	0.519
alpha	0.05

H0: The rows and the columns of the table are independent.

E3.6. Gas-fired power station

Test of independence	
Chi-square (Observed value)	8.744
Chi-square (Critical value)	18.307
DF	10
p-value	0.557
alpha	0.05

H0: The rows and the columns of the table are independent.

E3.7. Oil-fired power plant

Test of independence	
Chi-square (Observed value)	10.121
Chi-square (Critical value)	18.307
DF	10
p-value	0.430
alpha	0.05

H0: The rows and the columns of the table are independent.

Data availability

Data will be made available on request.

References

Adger, W.N., Arnell, N.W., Tompkins, E.L., 2005. Successful adaptation to climate change across scales. Glob. Environ. Change 15 (2). https://doi.org/10.1016/j.gloenvcha.2004.12.005.

Agora Energiewende, Ember, 2021. The European Power Sector in 2020: Up-to-Date Analysis on the Electricity Transition. https://www.agora-energiewende.org/fileadmin/Projekte/2021/2020_01_EU-Annual-Review_2020/A-EW_202_Report_European-Power-Sector-2020.pdf.

Ahmed, S., Ali, A., D'Angola, A., 2024. A review of renewable energy communities: concepts, scope, progress, challenges, and recommendations. In *sustainability (Switzerland)* (vol. 16, issue 5). https://doi.org/10.3390/su16051749.

Althor, G., Watson, J.E.M., Fuller, R.A., 2016. Global mismatch between greenhouse gas emissions and the burden of climate change. Sci. Rep. 6. https://doi.org/10.1038/srep20281.

Arndt, C., 2023. Climate change vs energy security? The conditional support for energy sources among Western Europeans. Energy Policy 174. https://doi.org/10.1016/j.enpol.2023.113471.

Arnstein, S.R., 1969. A ladder of citizen participation. J. Am. Plann. Assoc. 35 (4). https://doi.org/10.1080/01944366908977225.

Azarova, V., Cohen, J., Friedl, C., Reichl, J., 2019. Designing local renewable energy communities to increase social acceptance: evidence from a choice experiment in Austria, Germany, Italy, and Switzerland. Energy Policy 132. https://doi.org/10.1016/j.enpol.2019.06.067.

Balta-Ozkan, N., Le Gallo, J., 2018. Spatial variation in energy attitudes and perceptions: evidence from Europe. In: Renewable and Sustainable Energy Reviews, vol. 81. https://doi.org/10.1016/j.rser.2017.06.027.

Beck, U., 1992. Risk Society: towards a New Modernity, vol. 66. Sage, London. Radical Philosophy.

Belaïd, F., 2022. Implications of poorly designed climate policy on energy poverty: global reflections on the current surge in energy prices. Energy Res. Social Sci. 92, 102790. https://doi.org/10.1016/j.erss.2022.102790.

Berinsky, A.J., 2017. Measuring public opinion with surveys. In: Annual Review of Political Science, vol. 20. https://doi.org/10.1146/annurev-polisci-101513-113724.

Bidwell, D., 2013. The role of values in public beliefs and attitudes towards commercial wind energy. Energy Policy 58. https://doi.org/10.1016/j.enpol.2013.03.010.

Bouman, T., Steg, L., Perlaviciute, G., 2021. From values to climate action. Curr. Opin. Psychol. 42, 102–107. https://doi.org/10.1016/J.COPSYC.2021.04.010.

Brennan, N., Van Rensburg, T.M., 2023. Does intermittency management improve public acceptance of wind energy? A discrete choice experiment in Ireland. Energy Res. Social Sci. 95, 102917. https://doi.org/10.1016/j.erss.2022.102917.

Cacciatore, M.A., Scheufele, D.A., Shaw, B.R., 2012. Labeling renewable energies: how the language surrounding biofuels can influence its public acceptance. Energy Policy 51. https://doi.org/10.1016/j.enpol.2012.09.005.

Carlisle, J., Smith, E.R.A.N., 2005. Postmaterialism vs. egalitarianism as predictors of energy-related attitudes. Environ. Polit. 14 (4). https://doi.org/10.1080/09644010500215324.

Ćetković, S., Buzogány, A., 2016. Varieties of capitalism and clean energy transitions in the European Union: when renewable energy hits different economic logics. *Climate Policy, 16*(5). https://doi.org/10.1080/14693062.2015.1135778.

Clausen, L.T., Rudolph, D., 2020. Renewable energy for sustainable rural development: Synergies and mismatches. Energy Policy 138. https://doi.org/10.1016/j.enpol.2020.111289.

Cordoves-Sánchez, M., Vallejos-Romero, A., 2019. Social construction of risk in non-conventional renewable energy: risk perception as a function of ecosystem services in La Araucanía, Chile. Ecol. Econ. 159, 261–270. https://doi.org/10.1016/J.ECOLECON.2019.01.031.

Corner, A., Markowitz, E., Pidgeon, N., 2014. Public engagement with climate change: the role of human values. Wiley Interdiscipl. Rev.: Clim. Change 5 (3). https://doi.org/10.1002/wcc.269.

Cortes Simon, & Arango Londoño Adriana, 2017. Renewable energy in Colombia: an approach from the economy. Revista Ciencias Estrategicas 25 (38).

Costa, H., Veiga, L., 2021. Local labor impact of wind energy investment: an analysis of Portuguese municipalities. Energy Econ. 94. https://doi.org/10.1016/j.eneco.2020.105055.

Creutzig, F., Agoston, P., Goldschmidt, J.C., Luderer, G., Nemet, G., Pietzcker, R.C., 2017. The underestimated potential of solar energy to mitigate climate change. In *Nature Energy* (Vol. 2, Issue 9). https://doi.org/10.1038/nenergy.2017.140.

De Aguiar, T.R.S., Fearfull, A., Sanagustín Fons, M.V., 2016. Calculating the carbon footprint: implications for governing emissions and gender relations. Account. Forum 40 (2). https://doi.org/10.1016/j.accfor.2016.04.001.

Dermont, C., Ingold, K., Kammermann, L., Stadelmann-Steffen, I., 2017. Bringing the policy making perspective in: a political science approach to social acceptance. Energy Policy 108. https://doi.org/10.1016/j.enpol.2017.05.062.
Diaz-Sarachaga, J.M., Jato-Espino, D., Castro-Fresno, D., 2018. Is the sustainable development goals (SDG) index an adequate framework to measure the progress of the 2030 agenda? *Sustainable development, 26*(6). https://doi.org/10.1002/sd.1735.
Duarte, R., García-Riazuelo, Á., Sáez, L.A., Sarasa, C., 2022. Analysing citizens' perceptions of renewable energies in rural areas: a case study on wind farms in Spain. Energy Rep. 8, 12822–12831. https://doi.org/10.1016/J.EGYR.2022.09.173.
Dunn, J.C., 1974. Well-separated clusters and optimal fuzzy partitions. J. Cybern. 4 (1). https://doi.org/10.1080/01969727408546059.
Ellis, G., Schneider, N., Wüstenhagen, R., 2023. Dynamics of social acceptance of renewable energy: an introduction to the concept. Energy Policy 181. https://doi.org/10.1016/j.enpol.2023.113706.
Enevoldsen, P., Permien, F.H., Bakhtaoui, I., Krauland, A. K. von, Jacobson, M.Z., Xydis, G., Sovacool, B.K., Valentine, S.V., Luecht, D., Oxley, G., 2019. How much wind power potential does europe have? Examining european wind power potential with an enhanced socio-technical atlas. Energy Policy 132. https://doi.org/10.1016/j.enpol.2019.06.064.
Eurofound, 2018. Societal change and trust in institutions. Publications Office of the European Union Luxembourg.
European Commission, 2019. Special Eurobarometer 490: Climate Change. European Commission, Directorate-General for Climate Action.
European Commission, 2022. REPowerEU: Affordable, Secure and Sustainable Energy for Europe. In European Commission - European Commission.
FECYT, 2022. Encuestas de percepción social de la ciencia y la tecnología en España. https://www.fecyt.es/lo-que-hacemos/cultura-cientifica/estudios-percepcion-social-de-la-ciencia.
Feenstra, M., Laryea, C., Stojilovska, A., 2024. *Gender aspects of the rising cost of living and the impact of the energy crisis*. EU: European Union. http://www.europarl.europa.eu/supporting-analyses.
Frantál, B., Frolova, M., Liñán-Chacón, J., 2023. Conceptualizing the patterns of land use conflicts in wind energy development: towards a typology and implications for practice. Energy Res. Social Sci. 95, 102907. https://doi.org/10.1016/J.ERSS.2022.102907.
Gargallo, P., García-Casarejos, N., Salvador, M., 2020. Perceptions of local population on the impacts of substitution of fossil energies by renewables: a case study applied to a Spanish rural area. Energy Rep. 6. https://doi.org/10.1016/j.egyr.2019.08.085.
Gölz, S., Wedderhoff, O., 2018. Explaining regional acceptance of the German energy transition by including trust in stakeholders and perception of fairness as socio-institutional factors. Energy Res. Social Sci. 43, 96–108. https://doi.org/10.1016/J.ERSS.2018.05.026.
Greenberg, M., 2009. Energy sources, public policy, and public preferences: analysis of US national and site-specific data. Energy Policy 37 (8). https://doi.org/10.1016/j.enpol.2009.04.020.
Grubler, A., Wilson, C., Bento, N., Boza-Kiss, B., Krey, V., McCollum, D.L., Rao, N.D., Riahi, K., Rogelj, J., De Stercke, S., Cullen, J., Frank, S., Fricko, O., Guo, F., Gidden, M., Havlík, P., Huppmann, D., Kiesewetter, G., Rafaj, P., Valin, H., 2018. A low energy demand scenario for meeting the 1.5 °c target and sustainable development goals without negative emission technologies. Nat. Energy 3 (6). https://doi.org/10.1038/s41560-018-0172-6.
Haikola, S., Anshelm, J., Niskanen, J., 2024. Beyond the backyard: scaling up of resistance to wind power in Sweden. Environ. Chall. 16, 100987. https://doi.org/10.1016/J.ENVC.2024.100987.
Haque, A.N., Lemanski, C., De Groot, J., 2021. Why do low-income urban dwellers reject energy technologies? Exploring the socio-cultural acceptance of solar adoption in Mumbai and Cape Town. Energy Res. Social Sci. 74, 101954.
Hazboun, S.O., Boudet, H.S., 2020. Public preferences in a shifting energy future: comparing public views of eight energy sources in North America's Pacific Northwest. Energies 13 (8). https://doi.org/10.3390/en13081940.
Hess, D.J., Renner, M., 2019. Conservative political parties and energy transitions in Europe: opposition to climate mitigation policies. Renew. Sustain. Energy Rev. 104, 419–428. https://doi.org/10.1016/J.RSER.2019.01.019.
IPCC, 2021. IPCC: summary for policymakers. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.
Irena, Ilo, I., 2022. Renewable Energy and Jobs: Annual Review 2023. /pressreleases/2022/Sep/Renewable-Energy-Jobs-Hit … (Issue May).
Jacobson, M.Z., Delucchi, M.A., Cameron, M.A., Mathiesen, B.V., 2018. Matching demand with supply at low cost in 139 countries among 20 world regions with 100% intermittent wind, water, and sunlight (WWS) for all purposes. Renew. Energy 123. https://doi.org/10.1016/j.renene.2018.02.009.
Jean, B., 2014. Innovation and modernising the rural economy. Organ. Econ. Co.
Jenkins, K., McCauley, D., Forman, A., 2017. Energy justice: a policy approach. Energy Policy 105. https://doi.org/10.1016/j.enpol.2017.01.052.
Jeong, Y., Ha, J., 2015. The comparative study of perception of the public and stakeholder to climate change adaptation. J. Climate Change Res. 6 (2), 159–166.
Kalkbrenner, B.J., Roosen, J., 2016. Citizens' willingness to participate in local renewable energy projects: the role of community and trust in Germany. Energy Res. Social Sci. 13, 60–70. https://doi.org/10.1016/J.ERSS.2015.12.006.
Kanberger, E.D., Ziegler, A., 2023. On the preferences for an environmentally friendly and fair energy transition: a stated choice experiment for Germany. Energy Policy 182, 113730. https://doi.org/10.1016/J.ENPOL.2023.113730.
Kariuki, D., 2018. Barriers to renewable energy technologies development. Energy Today 2018. February 2018.
Karlstrøm, H., Ryghaug, M., 2014. Public attitudes towards renewable energy technologies in Norway. The role of party preferences. Energy Policy 67. https://doi.org/10.1016/j.enpol.2013.11.049.
Karytsas, S., Theodoropoulou, H., 2014. Socioeconomic and demographic factors that influence publics' awareness on the different forms of renewable energy sources. Renew. Energy 71, 480–485. https://doi.org/10.1016/J.RENENE.2014.05.059.
Khanam, T., Reiner, D.M., 2022. Evaluating gaps in knowledge, willingness and heating performance in individual preferences on household energy and climate policy: evidence from the UK. Renew. Sustain. Energy Rev. 160, 112229. https://doi.org/10.1016/J.RSER.2022.112229.
Kim, E.S., Chung, J.B., 2019. The memory of place disruption, senses, and local opposition to Korean wind farms. Energy Policy 131, 43–52. https://doi.org/10.1016/J.ENPOL.2019.04.011.
Knudsen, J.K., Wold, L.C., Aas, Ø., Kielland Haug, J.J., Batel, S., Devine-Wright, P., Qvenild, M., Jacobsen, G.B., 2015. Local perceptions of opportunities for engagement and procedural justice in electricity transmission grid projects in Norway and the UK. Land Use Policy 48. https://doi.org/10.1016/j.landusepol.2015.04.031.
Komor, P., Bazilian, M., 2005. Renewable energy policy goals, programs, and technologies. *Energy Policy, 33*(14). https://doi.org/10.1016/j.enpol.2004.03.003.
Kostetckaia, M., Hametner, M., 2022. How sustainable development goals interlinkages influence European union countries' progress towards the 2030 agenda. *Sustainable development, 30*(5). https://doi.org/10.1002/sd.2290.
Li, R., Crowe, J., Leifer, D., Zou, L., Schoof, J., 2019. Beyond big data: social media challenges and opportunities for understanding social perception of energy. In: Energy Research and Social Science, vol. 56. https://doi.org/10.1016/j.erss.2019.101217.
Liebe, U., Dobers, G.M., 2019. Decomposing public support for energy policy: what drives acceptance of and intentions to protest against renewable energy expansion in Germany? Energy Research and Social Science, 47. https://doi.org/10.1016/j.erss.2018.09.004.
López, S.M., Gómez, J.F., 2023. Aceptación social de proyectos de energía renovable locales. Cuadernos Orkestra.
López, I., García-Valdecasas, J.I., Lasierra, C.M., 2025. Household strategies for coping with energy poverty: technological and socio-familial dilemmas. Energy Build. 329, 115117.
Marcos-Marne, H., Sendra, M., 2024. Everything for the people, but trust? Exploring the link between populist attitudes and social trust in Italy, Portugal, and Spain. Swiss Polit. Sci. Rev. 30 (3), 263–279.
McCauley, D., Heffron, R., 2018. Just transition: integrating climate, energy and environmental justice. Energy Policy 119. https://doi.org/10.1016/j.enpol.2018.04.014.
Meeus, L., Batlle, C., Glachant, J.-M., Hancher, L., Pototschnig, A., Ranci, P., Schittekatte, T., 2022. The 5th EU electricity market reform: a renewable jackpot for all Europeans package? *European University Institute, 2022/59, 59*(RSC Policy Briefs). https://cadmus.eui.eu/handle/1814/75089.
Ministerio para la Transición Ecológica y el Reto Demográfico, 2020. INTEGRATED NATIONAL ENERGY AND CLIMATE PLAN 2021-2030. https://www.miteco.gob.es/es/ministerio/marco-estrategico-energia-clima.html.
Nations, United, 2022. What is renewable energy? Climate action. https://www.un.org/en/climatechange/what-renewable-energy.
Nguyen, T.T.H., Phan, G.Q., Tran, T.K., Bui, H.M., 2023. The role of renewable energy technologies in enhancing human development: empirical evidence from selected countries. Case Stud. Chem. Environ. Eng. 8. https://doi.org/10.1016/j.cscee.2023.100496.
Niskanen, J., Anshelm, J., Haikola, S., 2024. A multi-level discourse analysis of Swedish wind power resistance, 2009–2022. Polit. Geogr. 108, 103017. https://doi.org/10.1016/J.POLGEO.2023.103017.
Peña-Ramos, J.A., Del Pino-García, M., Sánchez-Bayón, A., 2021. The Spanish energy transition into the eu green deal: alignments and paradoxes. Energies 14 (9). https://doi.org/10.3390/en14092535.
Persoon, P.G.J., Bekkers, R.N.A., Alkemade, F., 2022. The knowledge mobility of renewable energy technology. Energy Policy 161. https://doi.org/10.1016/j.enpol.2021.112670.
Prados, M.J., 2010. Renewable energy policy and landscape management in Andalusia, Spain: the facts. *Energy Policy, 38*(11). https://doi.org/10.1016/j.enpol.2010.07.005.
Prakash, A., Bernauer, T., 2020. Survey research in environmental politics: why it is important and what the challenges are. In *Environmental Politics* (Vol. 29, Issue 7). https://doi.org/10.1080/09644016.2020.1789337.
Rand, J., Hoen, B., 2017. Thirty years of North American wind energy acceptance research: what have we learned?. In: Energy Research and Social Science, vol. 29. https://doi.org/10.1016/j.erss.2017.05.019.
Rayner, S., 2010. Trust and the transformation of energy systems. Energy Policy 38 (6), 2617–2623. https://doi.org/10.1016/J.ENPOL.2009.05.035.
Rodríguez-Segura, F.J., Osorio-Aravena, J.C., Frolova, M., Terrados-Cepeda, J., Muñoz-Cerón, E., 2023. Social acceptance of renewable energy development in southern Spain: exploring tendencies, locations, criteria and situations. Energy Policy 173. https://doi.org/10.1016/j.enpol.2022.113356.
Sanz-Hernández, A., Esteban, E., Garrido, P., 2019. Transition to a bioeconomy: perspectives from social sciences. J. Clean. Prod. 224, 107–119. https://doi.org/10.1016/J.JCLEPRO.2019.03.168.
Sardaro, R., Faccilongo, N., Roselli, L., 2019. Wind farms, farmland occupation and compensation: evidences from landowners' preferences through a stated choice survey in Italy. Energy Policy 133. https://doi.org/10.1016/j.enpol.2019.110885.

Schmidt, T.S., Sewerin, S., 2019. Measuring the temporal dynamics of policy mixes – an empirical analysis of renewable energy policy mixes' balance and design features in nine countries. *Research Policy, 48*(10). https://doi.org/10.1016/j.respol.2018.03.012.

Schwirplies, C., 2018. Citizens' acceptance of climate change adaptation and mitigation: a survey in China, Germany, and the US. Ecol. Econ. 145, 308–322.

Sebi, C., Vernay, A.L., 2020. Community renewable energy in France: the state of development and the way forward. Energy Policy 147, 111874. https://doi.org/10.1016/J.ENPOL.2020.111874.

Sorrell, S., 2015. Reducing energy demand: a review of issues, challenges and approaches. In: Renewable and Sustainable Energy Reviews, vol. 47. https://doi.org/10.1016/j.rser.2015.03.002.

Sovacool, B.K., Hess, D.J., Cantoni, R., 2021. Energy transitions from the cradle to the grave: a meta-theoretical framework integrating responsible innovation, social practices, and energy justice. Energy Res. Social Sci. 75. https://doi.org/10.1016/j.erss.2021.102027.

Sposato, R.G., Hampl, N., 2018. Worldviews as predictors of wind and solar energy support in Austria: bridging social acceptance and risk perception research. Energy Res. Social Sci. 42. https://doi.org/10.1016/j.erss.2018.03.012.

Steg, L., Perlaviciute, G., van der Werff, E., 2015. Understanding the human dimensions of a sustainable energy transition. In: Frontiers in Psychology, vol. 6. https://doi.org/10.3389/fpsyg.2015.00805.

Stein, D., 1996. Not in my back yard: the handbook. American planning association. J. Am. Plann. Assoc. 62 (4), 545.

Tam, J., McDaniels, T.L., 2013. Understanding individual risk perceptions and preferences for climate change adaptations in biological conservation. Environ. Sci. Pol. 27, 114–123.

Torma, G., Aschemann-Witzel, J., 2024. Sparking stakeholder support: creating personas for renewable energy innovation adoption based on qualitative data analysis. Energy Res. Social Sci. 109. https://doi.org/10.1016/j.erss.2023.103407.

Tremblay, D., Fortier, F., Boucher, J.F., Riffon, O., Villeneuve, C., 2020. Sustainable development goal interactions: an analysis based on the five pillars of the 2030 agenda. *Sustainable Development, 28*(6). https://doi.org/10.1002/sd.2107.

United Nations, 2015. Transforming Our World: the 2030 Agenda for Sustainable Development United Nations United Nations Transforming Our World: the 2030 Agenda for Sustainable Development. United Nations.

Van Rijnsoever, F.J., Farla, J.C.M., 2014. Identifying and explaining public preferences for the attributes of energy technologies. Renew. Sustain. Energy Rev. 31, 71–82. https://doi.org/10.1016/J.RSER.2013.11.048.

Visschers, V.H.M., Siegrist, M., 2014. Find the differences and the similarities: relating perceived benefits, perceived costs and protected values to acceptance of five energy technologies. J. Environ. Psychol. 40. https://doi.org/10.1016/j.jenvp.2014.05.007.

Vuichard, P., Broughel, A., Wüstenhagen, R., Tabi, A., Knauf, J., 2022. Keep it local and bird-friendly: exploring the social acceptance of wind energy in Switzerland, Estonia, and Ukraine. Energy Res. Social Sci. 88. https://doi.org/10.1016/j.erss.2022.102508.

Wolsink, M., 2018. Social acceptance revisited: gaps, questionable trends, and an auspicious perspective. In: Energy Research and Social Science, vol. 46. https://doi.org/10.1016/j.erss.2018.07.034.

Wuestenhagen, R., Wolsink, M., Buerer, M.J., 2007. Social acceptance of renewable energy innovation: an introduction to the concept. Energy Policy 35 (5), 2683–2691. https://doi.org/10.1016/j.enpol.2006.12.001.

Xu, R., Murshed, M., Li, W., 2024a. Does political (de) stabilization drive clean energy transition. Polit. Ekon. 72 (2), 357–374.

Xu, R., Pata, U.K., Dai, J., 2024b. Sustainable growth through green electricity transition and environmental regulations: do risks associated with corruption and bureaucracy matter. Polit. Ekon. 72 (2), 228–254.

Zárate-Toledo, E., Patiño, R., Fraga, J., 2019. Justice, social exclusion and indigenous opposition. Energy Research and Social Science, 54. A case study of wind energy development on the Isthmus of Tehuantepec, Mexico. https://doi.org/10.1016/j.erss.2019.03.004.