

Social acceptance of renewable energy development in southern Spain: Exploring tendencies, locations, criteria and situations

Francisco Javier Rodríguez-Segura^{a,*}, Juan Carlos Osorio-Aravena^{b,c}, Marina Frolova^a, Julio Terrados-Cepeda^c, Emilio Muñoz-Cerón^c

^a Department of Regional and Physical Geography and Institute for Regional Development, University of Granada, 18071, Granada, Spain

^b Innovative Energy Technologies Center, Universidad Austral de Chile, Campus Patagonia s/n, 5950000, Coyhaique, Chile

^c Center for Advanced Studies in Earth Sciences, Energy and Environment. University of Jaén, Campus Las Lagunillas s/n, 23071, Jaén, Spain

ARTICLE INFO

Keywords:

Social acceptability
Social perception
Energy transition
Photovoltaic
Biomass
Wind energy

ABSTRACT

Although, in general, there is a high level of public acceptance of renewable energies (RE) in Spain, at a local scale, protests and campaigns against RE projects are becoming increasingly frequent. In order to identify the factors that most influence the acceptance/rejection of renewable electricity generation technologies (photovoltaic, wind and biomass) at a local level, in this study we conducted a structured survey of the population of the province of Jaén in southern Spain. The analysis of the results of the questionnaire reveals that the social acceptance of RE plants is influenced by their location and size, and identifies the main criteria and situations that people take into consideration when deciding whether to support or reject RE projects. Although the results suggest that all RE technologies are widely accepted, they also highlight a preference for photovoltaic energy and for medium-sized plants in sites with low natural value. This article provides information and recommendations to facilitate the drafting of policies, plans and future studies that will enable social barriers to the implementation of RE technologies to be reduced, so helping accelerate the energy transition that is required in order for agreed climate targets to be met.

1. Introduction

The need to reduce greenhouse gas emissions, so as to avoid irreversible damage to the planet's ecosystems in the coming decades has become a worldwide emergency. This has caused governments to rethink their energy policies in order to speed up the generalized installation of electricity production technologies based on renewable sources (Masson-Delmotte et al., 2021). The use of fossil fuels in the energy sector is responsible for 73.2% of world emissions of greenhouse gases (Ritchie et al., 2020). The weakness of the European energy system has been laid bare on more than one occasion, such as in the oil crises of 1973 and 1978, which highlighted the EU's structural weakness as regards energy supply (Urrea Corres, 2011). This problem remains a source of concern today and its main cause is the strong dependence of Europe on imported oil and gas, especially from Russia (El País, 2022).

In this context, the EU is faced with various different challenges: i) to reduce greenhouse gas emissions, as agreed in international agreements such as the Paris Agreement, ii) to reduce dependence on energy imports

from outside the EU, and iii) to transfer these objectives to a local scale. This means that society in general and local communities in particular must embark on an energy transition towards a system based on renewable energy (RE) sources. Local support or acceptance of RE technologies is crucial for a successful transition to cleaner, more sustainable energy. For this reason, understanding the different factors that influence local acceptance of RE projects is of vital importance when it comes to designing spatial plans setting out the most suitable locations for installing them. These plans can then be integrated into the RE policies of European countries.

Surveys conducted by the European Commission (Eurobarometers) indicate substantial support amongst the EU population for RE in general, as well as increasing, more widespread use of these energy resources (European Commission, 2006; European Commission, 2012; European Commission, 2019). Research also shows that they are widely accepted in Spain and in south-west Europe in general (Barral et al., 2019). However, in spite of this generalized acceptance of RE, we observed that certain specific kinds of renewable technology projects are

* Corresponding author. Universidad de Granada, Facultad de Filosofía y Letras, Campus de la Cartuja, Calle del Prof. Clavera, s/n, 18011, Granada, Spain.
E-mail address: fjsegura@ugr.es (F.J. Rodríguez-Segura).

frequently rejected at a local level (Musall and Kuik, 2011).

In Spain, as in other countries in which RE technologies have undergone huge deployment, social perceptions of them have changed. For example, in the particular case of wind power, as its energy potential has grown dramatically through large-scale projects in many regions, its social acceptance has diminished (Dugstad et al., 2020).

The impacts of these projects on the environment and the landscape, the siting of wind farms, their large size, unfair distribution, lack of economic and social benefits for local residents and the lack of transparency in the spatial planning processes have all become critical issues, which have sparked a large number of demonstrations and protests in Spain against this RE source (Prados et al., 2012).

In the case of solar photovoltaic (PV) technology, there have also been recent demonstrations against the installation of large PV plants, which are displacing the traditional agricultural use of the land towards a new, more profitable form of business i.e. electricity generation (Navarrete, 2021).

A lack of social acceptance is therefore considered one of the most important factors limiting RE development, in that it regularly delays the installation and operation of RE plants (Segreto et al., 2020; Gareiou et al., 2021). We must therefore find out more about the opinions of energy consumers regarding the possible installation of RE plants in their local areas, so as to gain an insight into how best to approach this process so as to ensure social acceptance and successful installation (Ek, 2005).

Numerous researchers have highlighted the importance of attitudes, visual perceptions, perceived environmental damage, perceived energy cost and personal risk as the factors that most influence individual opposition to energy technologies (Ek, 2005; Wüstenhagen et al., 2007; Rosso-Cerón and Kafarov, 2015; Liebe and Dobers, 2019). However, they have tended to focus on the analysis of the acceptance or rejection of RE projects, without exploring in detail the specific factors behind people's perceptions of them (Batel et al., 2016). While most research in recent years has centred on the social acceptance of wind farms (Fast, 2013; Caporale et al., 2020; Dugstad et al., 2020; Legendijk et al., 2021), there are much fewer recent studies on the social acceptance of a range of different RE technologies (Yuan et al., 2011; Soland et al., 2013; Sütterlin and Siegrist, 2017; Prosperi et al., 2019). Furthermore, sub-sub-national scale is not so present in those type of studies (Fast, 2013). These more holistic integrated studies of the different RE technologies that may be installed in a particular territory have largely been overlooked in the literature.

Therefore, based on a lack of understanding of how to reduce social barriers towards RE projects, especially when the specific factors behind people's opinions at the sub-sub-national level are considered together with various technologies—their sizes, and their potential locations—the aim of this work, carried out by an interdisciplinary team, is to analyse the social acceptance or rejection of a range of different RE generation technologies (PV, wind and biomass) within the context of the province of Jaén (Spain). More than 50 solar PV plants are already in operation in this area, together with a windfarm and three biomass power generation plants and for each technology, there is great potential for the technically feasible implementation of new projects in the short term (Osorio-Aravena et al., 2022). In this study, we prepare and applied a structured survey that has three main objectives: (1) assess the levels of acceptance of the local community regarding RE technologies and the possible areas of the province where they might be sited; (2) analyse the effects of location on the degree of acceptance of each technology and; (3) identify the criteria and situations that could act as factors in the acceptance/rejection of RE projects in the study area.

The interdisciplinary methodology applied in this work is a contribution to the existing literature in terms of how to evaluate the factors, criteria and situations which can influence, in either a positive or negative sense, local people's acceptance of RE projects at the sub-sub-national level. In fact, the procedure carried out to apply the survey is also a contribution in terms of how to cover almost the whole territory

under study, despite the COVID-19 pandemic situation, and it is easy to replicate.

The results and findings of this work provide useful information and recommendations to facilitate the drafting—or improving—of policies, plans and future studies to reduce the social barriers towards the installation of RE technologies, so helping accelerate the energy transition that is required in order for agreed climate targets to be met.

The results may also serve as a reference for the siting of RE plants in rural areas of the Mediterranean Basin, in which most of the land is occupied by olive groves, resulting in competition for the land between RE systems and agriculture.

This article is structured as follows. Sections 2 and 3 describe the case study and methodology, while Section 4 presents the results of our analysis. Section 5 sets out the conclusions and recommendations for planners and developers. Finally, the limitations of this work are exposed in Section 6.

2. Case study

2.1. Geographical overview

The Province of Jaén is situated in the North-East of the autonomous region of Andalusia, Spain (see Fig. 1). It is made up of 97 municipalities, which for administrative purposes are grouped together in ten sub-regions. It has a surface area of 13,484 km² or 15.5% of the total area of Andalusia and a population of 627,190 (Instituto Nacional de Estadística, n.d). The province has 304,175 ha of protected natural areas and 550,000 ha of olive groves, a crop on which the local economy is based (Herrador Lindes and Martín Mesa, 2020). In fact, Jaén produces 50% of Spanish olive oil and 20% of all the oil produced worldwide (Esencia de Olivo, 2021).

2.2. Current situation of electricity generation in the province of Jaén

In 2021, the province of Jaén had an installed capacity of 422.96 MW of RE technology, 4.7% of the total for Andalusia as a whole. Gross electricity production was 605.2 GWh (Agencia Andaluza de la Energía, 2021) (Table 1). It had just one windfarm with an installed power capacity of 15.2 MW, 3 power stations driven by biomass (16 MW, 15 MW and 6 MW) and over 50 photovoltaic plants. Most of these had power capacities of less than 10 MW, while the largest had a capacity of 11.8 MW. The renewable electricity produced in the province of Jaén covers just 28.9% of all the electricity consumed in the province (Agencia Andaluza de la Energía, 2021). The province has no electricity generation plants driven by fossil fuels or hydropower (Agencia Andaluza de la Energía, 2021). This means that it is clearly dependent on other areas for its energy needs. The great potential of RE in this area could therefore provide a perfect solution to enable the province to become self-sufficient in electricity as part of the energy transition. In this case, RE would have to compete with agriculture for the limited available land in the region. It is therefore necessary to search for alternatives that enable energy and agricultural production within the same physical space.

2.3. Potential for renewable electricity generation in the province of Jaén

According to Ruiz-Arias et al. (2012), the RE technologies with the greatest potential and the most feasible implementation in the province of Jaén are solar PV, wind and biomass. According to these authors' calculations, the theoretical potential in this province for electricity generation from solar PV and wind energy came to 1000 TWh and 110 TWh, respectively. These figures are 358 and 39 times higher than the total consumption of electricity in the province in 2019. They also estimated that with the annual residues produced by the pruning of olive trees in the province, a further 820 GWh could be generated each year i.e. 29% of total electricity consumption in 2019.



Fig. 1. Geographical location within Spain of the province of Jaén.

Table 1
Installed capacity and renewable electricity generation in the province of Jaén, 2021

	Biomass	Hydropower	Photovoltaic	Wind	TOTAL
MW installed	37.0	212.2	157.44	15.2	422.96
GWh generated	239.2	178.0	161.7	26.3	605.2

Recently, [Osorio-Aravena et al. \(2022\)](#) estimated that in the province of Jaén, solar PV, wind and biomass energy had a potential annual production of 8.9 TWh, 0.91 TWh and 0.68 TWh, respectively. They asserted that this production capacity was not merely theoretical, but could feasibly be implemented in the short term. They also argued that it would bring substantial socio-economic benefits and would be accepted by local people. Their combined total is equivalent to 3.8 times the total electricity consumption in the province in 2019. These authors also estimated that 1.5% of the total surface area of the province would be required for the installation of the solar PV plants and windfarms needed to produce such a large amount of electricity.

However, in practice, successful installation of this RE production capacity in the short term is far from easy. This will depend on factors such as the size of the power stations, their specific location, and a wide range of other criteria and situations affecting the acceptability and/or rejection of RE projects. Many of these are associated with sociocultural aspects of the local population ([Osorio-Aravena et al., 2022](#)).

3. Methodology

This study was based on a structured survey applied in the province of Jaén, the main objective of which was to analyse the social acceptance by local people of three renewable energy technologies (solar PV, wind and biomass) and their possible locations. We also evaluated the criteria and situations that could influence the degree of acceptance or rejection of RE projects. Our ultimate aim was to provide useful information for decision-makers so that they can devise policies and plans that can break down the social barriers that stand in the way of the successful implementation of RE technologies. We also sought to provide a useful tool for companies wishing to carry out projects of this kind, and in so doing help accelerate the energy transition.

The procedure followed during the course of this work, which can be replicated at other territorial scales (e.g. regional and/or national), was divided into three stages. The first stage involved the preparation of a questionnaire. In the second stage, this questionnaire was used in surveys of local groups and neighbourhood associations in the different municipalities of the province of Jaén. Finally, we analysed the answers and interpreted the results.

In the following subsections, we will now describe each of the three stages that made up this study.

3.1. Preparation of the survey

The preparation of the survey involved two basic steps. The first was to select the renewable electricity production technologies that we were going to evaluate and their possible installation sites. The second stage was to prepare the questionnaire, which was later applied in the form of a survey of the inhabitants of the province of Jaén.

When making our selection of possible RE technologies, two criteria were considered: i) that plants using this technology were already in operation in the province, and; ii) that the technology had significant technical potential and could feasibly be implemented in the short term. Of the four renewable electricity generation technologies currently in operation in Jaén (see section 2.2), we selected solar PV, wind and biomass. This decision, together with the possible locations, was based on studies conducted by [Ruiz-Arias et al. \(2012\)](#) and [Osorio-Aravena et al. \(2022\)](#) into the potential for RE in the province of Jaén and whether it could feasibly be integrated into the electricity network in the short term.

We then began devising the questionnaire, which had three initial objectives: i) assess the levels of acceptance within the local community of RE technologies and the possible sites where they might be located in the province; ii) analyse the effect of location on the degree of acceptance of each technology, and iii) identify the criteria and situations that might influence the acceptance/rejection of RE projects in the study area. For this reason, the survey was divided into three blocks (see [Appendix A](#)):

- In Block 1, interviewees were asked two multiple-choice questions in an initial attempt to uncover any general trends regarding the acceptability of RE projects amongst people from the province of

Jaén. In these questions, interviewees were asked to choose which type of technology (on the basis of project size - small <5 MW, medium 5–50 MW and large >50 MW - *Real Decreto 413/2014*, de 6 de junio) they considered most suitable for installation in their province, and which areas (possible sites) within the province they considered most suitable for installing RE projects (regardless of the type of technology or the size of the plant).

- In Block 2, the interviewees were asked the same set of questions about each technology so as to assess the acceptability of each one in greater detail, in line with the different locations proposed for their installation. Using a Likert scale, the interviewees were asked to select their degree of agreement - from totally disagree (1) to totally agree (5) – with the construction of solar PV plants, windfarms and biomass power stations in different locations. The proposed locations were chosen on the basis of the location of existing PV plants, windfarms and biomass power stations in the province and the locations assessed in previous studies (Ruiz-Arias et al., 2012; Osorio-Aravena et al., 2022).
- In Block 3, the interviewees were asked four multiple-choice questions which sought to identify the factors that influence the acceptance or rejection of RE projects in the study area. In the first question, interviewees were asked to choose the criteria that would improve their perspective regarding the possible implementation of a RE project in the municipality. In the second question, the interviewees were asked to indicate which situations might be conceived as a barrier for the development of RE projects in their municipal areas. In the third question, the interviewees were asked about how much they agreed with a series of statements and questions of varying kinds which have traditionally been associated with RE. Finally, in the fourth question, which referred specifically to biomass-driven power stations, the interviewees were asked to indicate the factors that might lead them to reject the construction of these powerplants (the analysis of this last question is associated with Block 2). In the last part of this Block, the interviewees were asked to provide the following details: age, sex and municipality of residence.

3.2. Application of the questionnaire

Due to the health emergency produced by the Covid-19 pandemic, the survey was drawn up using the Google Forms questionnaire administration software, and distributed online through Facebook groups. In order to guarantee maximum possible coverage of the study area and to try to reduce bias as much as possible in the sample, the online questionnaire was sent out to social/neighbourhood groups on a variety of issues in each town in the province. In this way, the aim was to achieve a heterogeneous sample in which the socio-economic diversity of the province was represented.

For this purpose, the survey was posted directly to all existing public social groups on Facebook and access was requested to those private groups. In the same way, the survey was sent to the institutional profiles that each City Council has on the social network requesting its publication and citizen participation.

Finally, in order to achieve active participation and wider dissemination, a reminder of the survey was placed in each publication every evening for a month.

The fact that the survey was conducted online also made it easier to collect the information for its subsequent analysis, as the answers were registered on a digital database linked to the online questionnaire.

3.3. Analysis of the answers and interpretation of the results

The answers to each block of questions were analysed statistically using the IBM SPSS Statistics computer programme. The answers were subjected to different statistical tests depending on the nature of the questions and the particular focus of analysis of each block.

Table 2

Interpretation of the Cramer's V effect size. Source: [International Business Machines Corporation \(IBM\)](#).

Effect size	Interpretation
≤0.2	The result is weak. Although the result is statistically significant, the fields are only weakly associated.
0.2–0.6	The result is moderate. The fields are moderately associated.
>0.6	The result is strong. The fields are strongly associated.

In Block 1, we began by assessing the whole set of answers for each question individually. In Question 1, the objective was to identify which technology (wind or PV) and project size the local residents considered most suitable for development in the province of Jaén, while in the second question the aim was to observe the general predisposition of the population to hosting renewable technologies in different areas and sites within the province.

Secondly, and given that interviewees can select more than one option when answering each question, we tried to identify general trends in the acceptability of the installation of wind and PV technologies in different areas of the province we were studying. To this end, we combined the multiple answers associated with the “Size of the wind and solar PV installations” with those associated with the “potential areas for the installation of RE projects” using a contingency table, known in the SPSS software as a cross table. This table enabled us to analyse and observe the interaction between the different variables (“size of installations” and “installation site”) in order to identify possible patterns. These in turn would allow us to go beyond the raw data in our interpretation of the results.

The Pearson χ^2 Test was used to analyse the answers for Block 2, which are related with the respondents' degree of agreement regarding the installation of each technology in different locations. In this study, the χ^2 Test was used as a test of independence so as to find out whether there was a significant relationship between the answers to the variables “acceptability of the technology in the province of Jaén” and “locations of the installations”. This would tell us whether the acceptability of the RE projects is influenced by their location. In order to determine whether the variables were related in any way, a significance level (referred to as α or *alfa*) of <0.05 was used for the χ^2 Test (Gómez, 2008).

However, the Pearson χ^2 Test does not determine the degree of the dependence or independence relationship; we therefore decided to apply the Cramer's V correlation, so as to measure the effect size of the relations between the two variables (in line with Table 2). This enabled us to establish the strength of the association between them and to infer whether there were factors that influence said association in those cases in which it is not perfect (= 1).

Finally, the results of Block 3 were analysed descriptively according to the number of times that each of the options was marked (in the questions with multiple answers) or according to the number of interviewees who selected each option as a percentage of the total (question about the degree of agreement). The aim was to identify which criteria would improve the respondents' general outlook regarding the installation of a RE project in their municipalities and find out which situations they believe would act as a barrier.

4. Results and discussion

In this section we present and discuss the results and analysis of the survey. Firstly, we describe the characteristics of the sample group. Then we analyse the trends regarding public acceptance of different RE technologies as a function of their size and depending on the proposed sites for installation, so as to later explore in greater depth for each technology how location affects the degree of acceptance. Finally, we analyse the criteria and situations that can influence the acceptance or

rejection of RE projects in the study area.

4.1. Characteristics of the sample group

The sample group consisted of a total of 329 interviewees (n = 329), which, according to the formula applied by Gareiou et al. (2021), implied a margin of error of 5.4% in the extrapolation to the population as a whole. This means that the survey has a confidence level of 94.6%, which is a percentage within the standard representativeness range established in social science studies (Rositas Martínez, 2014). In terms of sex representation, 47% of the respondents were female and 53% were male. The most highly represented age groups were between 51 and 60 years old (26% of the respondents) and from 41 to 50 years old (24%). The age structure of the sample group is representative of the age structure of the inhabitants of the province, according to statistics from the Instituto Nacional de Estadística (INE) (2021).

In spatial terms, we received answers from 60 municipalities out of a total of 97 in the province. These included the largest towns in the 10 subregions that make up the province, which means that the sample offers a general impression of the situation in all the different subregions.

4.2. Trends in the acceptance of RE projects in the province of Jaén

The results set out below are for the answers to the questions in Block 1. In response to the question about which type of technology (on the basis of project size - small <5 MW, medium 5–50 MW and large >50 MW - Real Decreto 413/2014, de 6 de junio) they considered most suitable for installation in the province of Jaén, 65% opted for solar PV plants and 35% for windfarms. In addition, in all three plant sizes, a higher percentage of respondents opted for solar PV plants than for windfarms. This is in line with a trend that has been observed in other studies that analyse the social acceptability where solar energy is widely more accepted than wind energy (Sütterlin and Siegrist, 2017; Marrero et al., 2021). A greater acceptance of solar energy compared to wind energy that authors such as Jeuland et al. (2021) try to explain by a more positive perception of the impacts and usefulness of solar energy.

The answers also shows that the public prefer medium-sized power plants (5–50 MW), with a trend towards small installations (≤5 MW) and that the least popular option was large power plants (>50 MW). These preferences, is in line with the size of the existing PV plants (<12 MW) and windfarms (15.2 MW) in the province.

A preference for solar PV and medium-sized projects differs with the Spanish auction strategy oriented towards large-size projects, predominantly wind farm projects, in order to quickly reach European targets in this area (EuropaPress, 2022). In fact, this strategy has met with strong social opposition, mobilising over 180 Spanish associations against renewable megaprojects (LaSexta.com, 2021). This emerging social barrier can be reduced by implementing energy policies that prioritise the size of projects and the type of RE technology that local people prefer.

This result indicates that despite the high acceptance of solar and wind energy in the province of Jaén, the degree of acceptability is not stable when the size variable is introduced. Therefore, if a comparison of acceptability for different technologies, or even for a single technology, but without considering the size of the infrastructure, trends can be

obtained that do not persist as large-scale implementation is proposed.

As regards possible sites, the “areas of no environmental value” option was the most popular, in that it was ticked by 46% of those interviewed compared to just 4% who selected “protected natural areas”, the location considered least suitable for hosting RE projects. This suggests that the respondents show a certain degree of environmental sensitivity in that they prefer the locations with the least possible environmental impact. This suggests that degraded land such as barren fields, quarries or abandoned industrial areas should be prioritised as possible installation sites for RE projects.

The second least popular option for installing a RE project was “tourist areas”, which was selected by just 8.6% of those interviewed. This suggests that those interviewed consider that installing RE projects in these areas could make them less attractive for tourists by damaging the natural and landscape values of these areas. From this point of view, and in some cases strong conviction, examples of social rejection of RE projects are becoming more and more frequent throughout Spain (Bayona, 2020; Bella, 2021; Mohorte, 2021).

In the contingency table representing the combination of the set of answers that the interviewees gave to the two questions in Block 1 (Fig. 2), a general trend can be observed in which both technologies are associated with areas of no environmental value, with a higher preference for solar PV plants, as reflected in the warmer tones.

It is also clear that even though windfarms are not the preferred option for installation in the different areas, many people would be willing to site medium-sized windfarms in areas of no environmental value. In short, medium-sized RE projects in areas of no environmental value could be considered the most favourable option when trying to guarantee high levels of social acceptability, with a low spatial footprint.

We also noticed a slight trend amongst the respondents when combining medium-sized plants with olive-growing and livestock-farming areas, with a greater willingness to install medium-sized solar PV plants in olive-growing areas (Fig. 2).

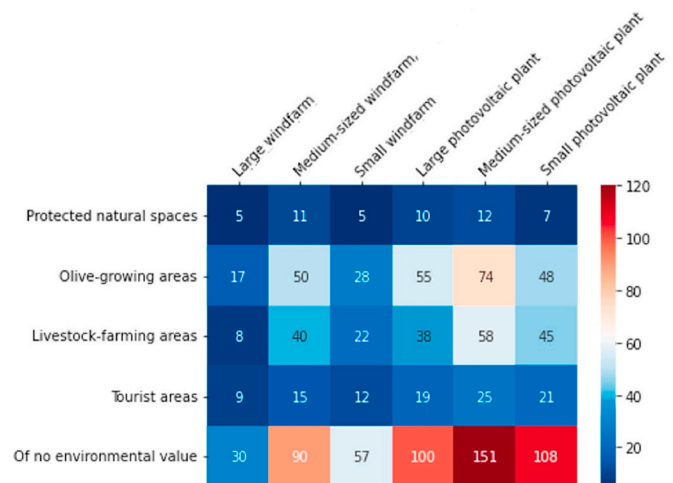


Fig. 2. Contingency table for the preferences regarding “Potential areas for the installation of renewable energy projects” and “size of the photovoltaic plants and windfarms”.

PV energy has expanded rapidly in the province over the last 10 years through solar fields and solar irrigation-pump facilities (Agencia Andaluza de la Energía, 2021). As a result, local residents are becoming more familiar with installations of this kind, which in most cases are located in olive-growing areas. However, the sensitivity towards rural landscapes and the growing conflicts related with the use of the land has led to strong opposition to RE projects in Spain (Frolova, 2010; Martín-Arroyo, 2022). As a result, the preference of the surveyed population is for areas of no environmental value.

However, the prominent development of solar energy in the province of Jaén, as in the rest of Spain, has taken place on agricultural land due to the large extension and availability of this land (Frolova Ignatieva et al., 2014). As a consequence, Andalusia is currently facing growing social opposition to large solar PV plants that threaten future investments in its provinces (Losa, 2022). Therefore, considering the opinion of local communities in tools such as environmental sensitivity maps, and prioritising these preferences in energy policies can be an effective measure to ensure a smooth transition to RE.

Finally, analysing these trends can help policy makers to propose new models of territorial planning that take into account citizens' preferences and thus reconcile interests. Along these lines, and in relation to the above-mentioned results, it would be interesting to propose agrivoltaic systems, where the symbiosis between PV energy production (respondents' preferred technology) and olive crop would allow farmers to obtain new sources of income without losing any of the productivity or the ownership of their land (Toledo and Scognamiglio, 2021). How to make olive-growing compatible with solar electricity production is a line of research that has yet to be explored within the field of agrivoltaics.

4.3. Effects of the location of RE projects on social acceptability

Table 3 (for solar PV plants) and Table 4 (for windfarms) show the results of the Pearson χ^2 Test and the Cramer's V Test, as applied to the association between the answers to the questions in Block 2 about the degree of agreement with the installation of each technology in the province of Jaén (acceptability variable) and the possible sites (location variable).

The tests showed that there was a certain dependence between two variables given that for all the relations in the Pearson χ^2 Test, α was less than 0.05 (Tables 3 and 4). This shows that there is a relationship between the answers given by the respondents in relation to the degree of agreement with the idea of installing PV plants and windfarms in the province and the degree of agreement regarding the different possible locations in which these plants could be installed. The social acceptability of solar PV plants and windfarms in this province therefore depends to some extent on the location of these installations. This reinforces the previous results, and in addition to considering technology and its size, policies and energy planning should take into account the location of projects. In democratic systems, citizens' attitudes of acceptance or rejection of different types of energy largely decide the fate of energy policies and influence their approval and success (Li et al., 2019). As Tables 3–5 reveal, social acceptance of different RE technologies can be influenced by perceptions towards specific locations, and their consideration in energy policies should serve to focus the energy transition towards a model with less social opposition.

In addition, the dependence between the variables is confirmed when the Cramer's V Test is applied on the Pearson χ^2 Test, in that the "locations" variable has a moderate (over 0.3) and in some cases high (over 0.6) strength of association, which reinforces the idea that in general, the people of the province have a very favourable attitude towards RE technologies regardless of their particular location.

The results we obtained indicate that for both solar PV and wind energy technologies, location near a village/town shows the greatest strength of association in the Cramer's V Test (0.615 solar PV/0.655 windfarms) (Tables 3 and 4). This indicates a high degree of social acceptability of the possible installation of solar PV plants and

Table 3

Association between Acceptability of the installation of photovoltaic plants in the province of Jaén and Acceptability of locations.

	Installation of photovoltaic plants in the province of Jaén	
	Pearson χ^2 Test	Cramer's V Test
Near villages/towns	<0.001	0.615
Near industrial estates	<0.001	0.574
Near tracks, roads or railway lines	<0.001	0.423
In agricultural and livestock farming areas	<0.001	0.311
In farming areas, changing the land use, when the RE installation produces greater financial returns	<0.001	0.339
In areas of no environmental value	<0.001	0.494

Table 4

Association between Acceptability of the installation of windfarms in the province of Jaén and Acceptability of locations.

	Installation of windfarms in the province of Jaén	
	Pearson χ^2 Test	Cramer's V Test
Near villages/towns	<0.001	0.655
Near industrial estates	<0.001	0.631
Near tracks, roads or railway lines	<0.001	0.534
In agricultural and livestock farming areas	<0.001	0.403
In farming areas, changing the land use, when the RE installation produces greater financial returns	<0.001	0.423
In areas of no environmental value	<0.001	0.515

Table 5

Association between the variables Acceptability of the installation of a biomass plant in the province of Jaén and Acceptability of locations.

	Installation of biomass plants in the province of Jaén	
	Pearson χ^2 Test	Cramer's V Test
Near a village/town	<0.001	0.564
Near industrial estates/areas	<0.001	0.647

windfarms in the province, and suggests that these projects could be situated near towns and villages. However, other studies that have also considered location as a factor in social acceptability point out that although the acceptability of RE projects being located close to population centres is higher than in the case of fossil fuel power plants, the distance between the RE plants and the respondents' homes is a major factor in acceptability (Sharpton et al., 2020; Pinto et al., 2021). The minimum distance, which another previous study has attempted to approximate and which, based on a review of the literature and the location of existing installations in the province of Jaén, has been estimated at 100 m for solar PV plants and 1.5 km for wind farms (Osorio-Aravena et al., 2022).

The locations with the lowest rating are agricultural and livestock farming areas. Referring to Table 2, the result obtained for these areas is classified as moderate, which is in line with the results shown above, where, although spaces with no environmental or economic impact are prioritised over other proposed spaces, there is a moderate tendency to consider agricultural areas as a potential sites to host RE projects. However, economic and land use factors would seem to be behind the low levels of acceptance of the installation of solar PV and windfarms in these areas. These technologies directly occupy the land (especially in the case of PV plants) and can involve changes in land cover and in the use of agricultural and grazing land, with a knock-on effect on the landscape, natural dynamics and the traditional economy (Prados, 2010).

In line with other studies that analysed the acceptability of RE in

relation to land use and landscape impact (Prados, 2010; Ioannidis and Koutsoyiannis, 2020), in the province of Jaén, people seem to be more doubtful about wind power than about solar PV energy, even though windfarms occupy less land and on occasions even enable joint use, with farmers continuing to farm the land around the turbines. This also seems strange given that at present there is only one windfarm in the whole province and it is sited a long way from any towns or villages. This confirms that resistance to wind energy projects does not seem to spring from cumulative negative experiences of wind turbines *per se*, a finding also highlighted by Ladenburg et al. (2013) and Ladenburg (2015). At the same time, the literature shows that unsuitable planning and development at a supra-local scale can fuel local concerns, so creating negative attitudes towards windfarms, even when there are none situated nearby (Clausen and Rudolph, 2019), as occurs with wind power in this province. Based on this problem, authors such as Giordano et al. (2018) consider that a political opportunity for action arises for local governments, as it has been observed in wind projects that their location is more accepted when the decision, in addition to considering society, comes from the local government.

If the acceptability of installing solar PV plants in the province of Jaén is crossed with the possibility of these facilities being installed in olive groves via a change in land use in those cases in which PV energy production is more profitable than olive-growing, the strength of association between the two variables is very similar to that for installing these RE systems in agricultural and livestock farming areas without receiving any economic benefit. This suggests that, unlike land ownership to which great importance is attached, economic profit is not a limiting factor for solar PV or wind energy development. From this, we can infer that landowners would prefer the plant to be installed on a different site rather than surrendering their ownership of the land (see Fig. 4).

In the study of biomass power production, given that existing biomass power plants in the province are linked to the olive oil sector, the potential locations were restricted to areas surrounding the villages/towns and to industrial estates/areas (where the olive oil factories are normally located). This means that the variable *location* will behave quite differently relative to that of *acceptability of installing biomass plants in the province* than it did relative to solar and wind power, as can be observed in Table 5.

Biomass power plants appear to be widely accepted by the people of the province in that the values are significant in both proposed locations. However, unlike the situation for solar and wind energy, the strength of association for the acceptability of biomass is greater near industrial estates as compared to areas near towns and villages. There could be two reasons for this: firstly, because in Jaén the main bioenergy material used in power stations of this kind comes from waste products of the olive oil industry, which means that its optimum potential location is

near olive mills (Agencia Andaluza de la Energía, 2021), and secondly, because two of these powerplants have already been rejected in this province. The main reasons for complaint were the nearness of these plants to residential areas and the fact that local residents were exposed to bad smells and pollutant gases (Rodríguez Cámara, 2016; López, 2019). This was in line with the results of a survey in which 70% of the respondents declared that the bad smell would be the main reason for rejecting the construction of a biomass plant, while the second main reason for rejection was the fact that the smoke from the factory could be seen from the village (cited by 60%). Therefore, the location of biomass power plants seems to be a more decisive criterion in social acceptance due to the socio-environmental factors that can derive from such location and that can cause citizen rejection, compared to the visibility of wind farms or the large use of land required by solar plants (Upreti, 2004; Upreti and van der Horst, 2004).

Although all these projects are subject to environmental assessment and suitability reports, the negative reactions with which they have sometimes been greeted, such as those displayed against biomass projects in Jaén (Rodríguez Cámara, 2016; López, 2019), reveal the weakness of existing processes for the installation of RE projects and territorial planning in Spain, where public participation is very limited and on occasions is restricted to purely informative processes (Del Valle et al., 2019).

4.4. Criteria and situations that influence the acceptance or rejection of renewable energy projects

The fact that the associations are not exact in the statistical tests we performed shows that the acceptability and the capacity to choose when faced with multiple variables is subject to a wide range of factors that can positively or negatively affect public perceptions of the projects. Social perception should be considered as a primary objective of energy policies Scheer et al. (2017). Furthermore, social perceptions towards different types of energy technologies are a key factor affecting the decisions of developers, consumers and policy-makers on development, consumption and energy policy (Batel et al., 2013).

Fig. 3 illustrates the answers associated with the question: “Which criteria would improve your attitude towards a renewable energy project in your town or village?”. These show that in general terms the population would have a better opinion of RE projects if they provided some kind of benefit for the town. In this figure, we can see that the most attractive potential benefit for local people of a project being located in their municipality would be the economic benefit.

77.4% of the respondents considered that the main criterion with which energy projects should comply would be to provide economic benefits to the population. This was followed by the “meeting local demand” criterion, which was selected by 67.20%. These results

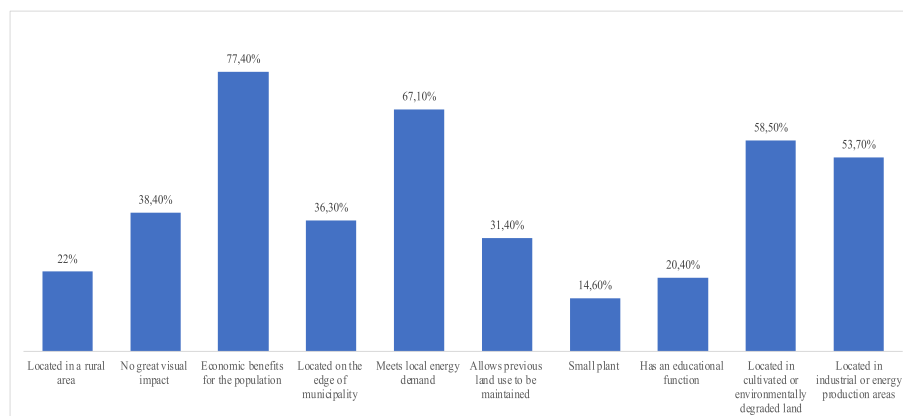


Fig. 3. Criteria that would improve public attitudes towards a renewable energy project in their town or village (based on the number of answers as a percentage of the total number of respondents – respondents could tick as many boxes as they liked).

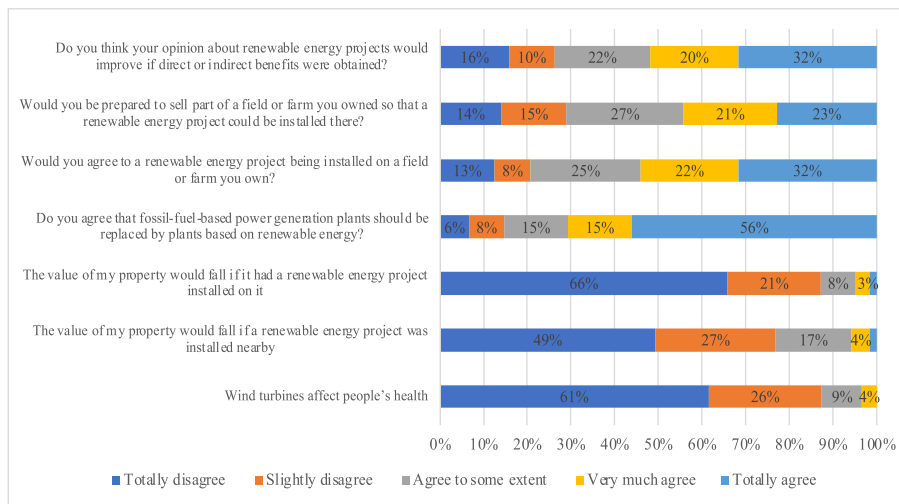


Fig. 4. Degree of agreement of the respondents to different statements and questions about renewable energies (number of respondents who selected each option as a percentage of the total).

reaffirm the idea put forward by Delicado et al. (2016), that Southern European countries show a different pattern than Northern Europe in terms of success factors in energy transition. Contrary to countries such as the UK, Ireland, the Netherlands or Germany, where landscape modification is the most important factor driving local acceptance for most technologies (Bertsch et al., 2016); in Spain, Portugal or Italy, economic attributes and benefit are highly considered factors by the population (Caporale and De Lucia, 2015; Delicado et al., 2016).

The fact that acceptance/rejection was so focused on economic factors meant that the people regard criteria such as the location, the size or the educational function as less important. Even so, over half of those interviewed considered the location of the installations an important criterion in the projects, which would have a positive effect on their acceptability. In fact, 58.5% marked the option “located in non-cultivated or environmentally degraded land” and 53.7% selected “located in industrial areas or areas set aside for energy production”. These results were in line with the rest of the survey, where unused or degraded areas and industrial areas remained the preferred locations for future projects. In these locations, the visual impact was selected by a considerable number of people (38.4%). Although studies such as those by Scherhauffer et al. (2017) found that the location of these installations and their impact on the landscape are important for the social acceptance/rejection of RE, our results were closer to those of Legendijk et al. (2021), who reaffirmed the idea that the positive support from those

concerned is linked above all to economic and community benefits and much less to environmental concerns (Scherhauffer et al., 2017; Legendijk et al., 2021).

In fact, as can be seen in Fig. 4, around 52% of those interviewed were either very much or totally in agreement with the assertion that their attitude towards a RE project would improve if direct or indirect benefits were obtained and 55% with the idea of a project of this kind being installed on land they owned. A high social consideration of benefit, which is latent throughout the responses in this block and which authors such as Kubota (2015) consider should be fairly ensured by local government in order to improve public attitudes towards project acceptance. However, this degree of agreement fell to 44% when asked whether they would be prepared to sell their property or part of it to enable an energy project to be installed. These results seem to confirm a trend in Spain towards a change in land uses linked to an increase in the rental price for the land on which solar PV plants are installed. This has led to more landowners offering their land to the electricity companies due to the fact that they can make more money from the rental than they can from cultivating and working the land (Aparicio, 2020). The Spanish government’s campaign to achieve the energy targets set for 2030 has also led to a series of forced expropriations of land backed by a declaration of “public interest”. This is causing resentment amongst landowners (Martín-Arroyo, 2022), which could explain the reluctance of some to sell even part of their farms.

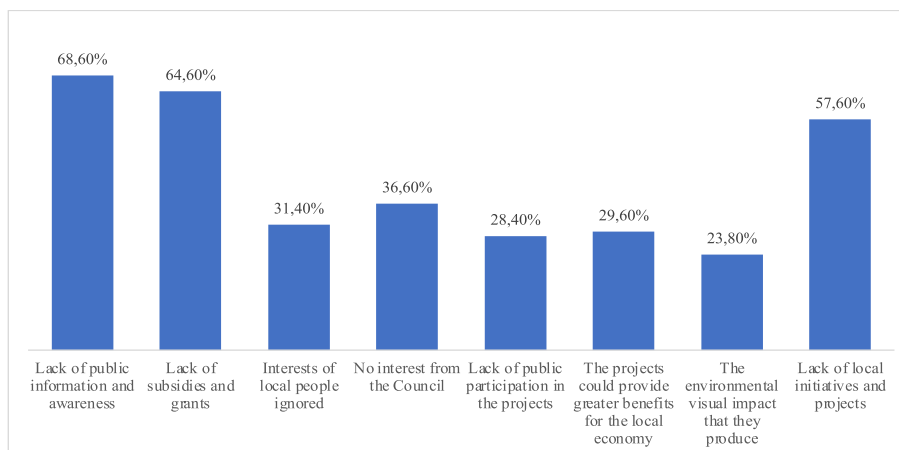


Fig. 5. Situations that would impede the development of renewable energies in the municipality (number of respondents who selected each option as a percentage of the total - respondents could tick as many boxes as they liked).

These results highlight the need to investigate, firstly, the compatibility of olive-growing and renewable electricity production, as proposed by the agrivoltaic systems based on PV panels and on wind power, and secondly the return on a hectare of olive trees as compared to the return on a hectare of solar PV panels or wind turbines. This would enable us to provide more objective information to all the actors involved (politicians, landowners, farmers and renewable energy companies).

In any case, the people of the province of Jaén, as happens in the rest of Spain, are clearly aware of the need to replace fossil fuels with renewable energies. As can be seen in Figs. 4, 71% of those interviewed were either very much or totally in agreement with the idea of replacing powerplants that use fossil fuels with plants based on RE sources, a finding in line with European surveys, which have shown a high level of acceptability of RE within Spanish society (European Commission, 2006, 2012, 2019). This widespread support for renewables is confirmed by the fact that a large proportion of those interviewed strongly reject popular beliefs that wind turbines can have negative effects on human health or on property prices.

In order to gain a clearer picture of public attitudes towards RE projects and their acceptability, respondents were asked “What do you think are the main obstacles to renewable energy development in your municipality?“, so as to find out which situations could cause them to view RE development negatively (see Fig. 5).

The results indicate that a lack of public information and awareness, together with a lack of local initiatives and grants are the main obstacles to RE development in the province of Jaén. In fact, 68.6% of those interviewed said that there was a lack of public information and awareness and that this was the main obstacle for the development of RE projects in their municipality and in the province in general. It is therefore not so much a problem of a lack of direct, active public participation in the projects, but more of a lack of clear accessible information, of dialogue between companies, public authorities and local people that would enable the population to feel that they were in some way part of the project. In this line, it has been observed that the lack of information or knowledge about renewable energy projects is one of the main factors that negatively influence social perception, generating distrust, lack of impartiality and suspicion of investors, which finally translates into rejection of the projects (Rosso-Cerón and Kafarov, 2015). Transparent and publicly available information is necessary, as it allows different stakeholders to carefully inspect scenarios and enables policy makers to deduce which assumptions and contexts drive certain outcomes in the projection of the energy transition (Carvajal et al., 2022). In addition, information from local sources, or well-known intermediaries, is more likely to have a positive impact on public perception (Sauter and Watson, 2007).

The second great obstacle to the development of RE projects was the lack of subsidies and grants. 64.6% of those interviewed said that this would impede RE development in their areas. This situation is very closely linked with the lack of local initiatives and projects, an option which was selected by 57.6% of those interviewed, making it the third greatest obstacle to development. The fact that both situations were marked by a high percentage of respondents indicates that the attitudes of local people would improve and they would show even stronger support for RE projects, if they sprang from local initiatives and if the work were carried out by local companies using local labour. In this way, they believe that the maximum possible benefit would be obtained for the town in which the plant was located. Along similar lines, previous research has demonstrated that locally financed or community projects with high public involvement are better valued and accepted, and ensure more effective use of the potential resources of the local area, so stimulating local socioeconomic development (Ruggiero et al., 2014). In the context of generating social acceptance in local energy communities, policies have proven to be important, both in their ability to make the project cheaper or easier to complete, and in the leadership capacity of politicians and government institutions, which can serve as opinion

leaders on energy-related issues (Azarova et al., 2019).

All these situations act as obstacles to RE development. These obstacles could be overcome by the right energy policies and by plans drawn up together with the local community. Policymakers will therefore play a key role in reducing obstacles and in encouraging and enhancing the factors that would improve social acceptance of the development of RE projects in the province.

5. Conclusions and policy implications

In this study, involving a survey of public opinion in the province of Jaén, we assess social acceptance of the installation of three types of renewable electricity generation technologies (photovoltaic, wind and biomass), their possible locations and sizes, and the criteria and situations that can influence acceptance or rejection of renewable energy (RE) projects in this area. The aim of this research is to provide useful information and recommendations for the preparation of plans and policies that could reduce social obstacles to the implementation of RE technologies and in this way accelerate the energy transition required to enable us to comply with climate targets.

In general terms, we came to the conclusion that the population of the province of Jaén were highly in favour of replacing fossil fuel-based powerplants with others based on RE technologies. However, the degree of acceptance varies considerably from one RE technology to the next and can also be affected by criteria and situations such as: the location of the plants and their size, the economic benefits it provides for the local population and the levels of public participation at the different stages of the projects. However, this study has not taken into account how social and economic variables (age, sex, income level or education) may influence social acceptability. Limitations, which are identified and developed in the next section. Therefore, it is considered to continue the present work with a more detailed study that will go deeper into citizen acceptability on the basis of the overview provided in this paper.

In technological terms, the public in this area seem more prepared to accept photovoltaic plants than windfarms or biomass-driven power stations. However, and regardless of the type of RE technology, the general preference is for small and medium-sized installations, providing that they are not installed in protected natural areas or areas popular with tourists. There is also a general willingness to accept photovoltaic and wind energy near towns, in industrial areas and in agricultural and livestock farming land, although the priority of those interviewed was for plants to be installed in areas on which they would have little or no environmental impact. Nonetheless, a finding worth noting but which requires greater analysis is that around 50% of those interviewed are either very much or totally in agreement with the idea of installing RE projects in their olive groves. In fact, given that olive-growing and land ownership have both proved to be important aspects for the people of this area, we suggest that more research be conducted into the compatibility of these crops with photovoltaic systems (within a new field of research known as agrivoltaics) and wind turbines; and into the annual return from a hectare of olive trees compared to that from a hectare of solar panels. Compatibility between the two, in addition to improving public perceptions and acceptability, would reduce Spain's dependence on imported energy, while maintaining agricultural use of the land.

These specific aspects and circumstances could change if a RE project could provide economic benefits for the local population and/or satisfy local energy demand, the criteria that respondents regarded as most important for improving their acceptance of RE. Acceptance of RE projects can also be improved by working on the negative aspects, i.e. the lack of information, of awareness, of local grants, initiatives and projects, the features highlighted by the respondents as the main factors that could trigger rejection of the installation of renewable technologies.

On the basis of the results of this study, the following recommendations could be made to decision-makers, politicians and planners:

- Preferences to technologies, sizes and locations, as well as the criteria and situations identified in the results, need to be prioritised in energy policy and planning because of their link to the acceptability/opposition to RE projects.
- Promote the installation of photovoltaic plants of a similar size to existing plants in the area, i.e. with an installed capacity of up to 12 MW.
- Draw up maps of possible locations for the installation of RE projects in the province on the basis of public consultations.
- Implement lines of finance and business models that enable olive growers to install photovoltaic and wind-power plants on their land, so as to ensure that they receive economic benefits from these projects (either by renting the land to the power company or by selling the electricity they produce).
- Try to find solutions to those situations that can impair public perceptions of the development of RE projects at municipal level. Greater involvement of local governments in areas such as such as a lack of information, grants and local initiatives, can strengthen a positive attitude towards RE projects.
- Considering the history of rejection of energy projects in Jaén and the rest of the country, decision-makers should understand public perceptions and address them through information campaigns.
- Draw up energy plans based on dialogue, training and participation of the local population, given that informed citizens who participate in energy plans and projects can guarantee their success due to higher levels of social acceptance.
- Promote the development of energy communities, to reinforce the weaknesses identified by the population. Politicians and local government institutions can serve as opinion leaders due to the administrative complexity that characterises the energy transition in Spain.

Finally, the results of this research could be used as basic information for improving social acceptance of the RE projects currently being processed. Knowledge of citizens' perceptions and attitudes regarding the aspects considered in this work can be used by policy makers and experts as a strategy for designing campaigns to promote RE projects. Carrying out the recommendations made here would also help accelerate the energy transition in a more participative, fairer way which ensures that the public feel that they are participating in all the different stages of energy production and consumption. This would provide benefits for local communities in rural areas with a Mediterranean climate, areas which, like the one analysed in this study, are characterized by an agricultural economy dominated by olive farming. This means that planned energy development that is aware of and respectful of the available resources in the area would help reduce the tensions between the two sectors (energy and olive oil), due to their high demand for land.

6. Limitations

Some socio-economic parameters such as income, profession or education of respondents were not asked about, which could lead to bias in the sample and responses, as only part of the population might be responding. However, efforts were made to achieve a wide territorial coverage in the issuing of the survey and to reach diverse social groups; as it was described in section 3.1.

Although age and sex were asked in the survey, no analysis of how these parameters may influence social perceptions was undertaken. Nevertheless, the proportion of respondents of both sexes is quite similar. Regarding the age groups, a similarity was observed between the representation of the different age groups and the population structure of the province of Jaén. However, these parameters, together with the above mentioned, need to be studied in depth to see if their consideration influences the responses shown in this work.

Finally, the survey was only issued online due to the restrictions imposed by the Covid-19 context, however, 62% of all municipalities in the province and its ten sub-regions were reached. Although we used

probability sampling design and technically the findings can be generalized for the province of Jaén, yet the findings will be more representative and robust if large sample is selected.

Funding

This research was conducted within the framework of a project entitled: "Adaptation to sustainable energy transition in Europe: Environmental, socio-economic and cultural aspects (ADAPTAS)" (Ministry of Economy, Industry and Competitiveness and State Research Agency of Spain, and European Regional Development Fund, CSO2017-86975-R).

CRedit authorship contribution statement

Francisco Javier Rodríguez-Segura: Conceptualization, Methodology, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. **Juan Carlos Osorio-Aravena:** Methodology, Data curation, Writing – original draft, Writing – review & editing. **Marina Frolova:** Formal analysis, Project administration, Writing – review & editing. **Julio Terrados-Cepeda:** Formal analysis, Writing – review & editing. **Emilio Muñoz-Cerón:** Supervision, Formal analysis, Writing – review & editing.

Declaration of competing interest

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

Data availability

Data will be made available on request.

Acknowledgement

This work is part of a PhD thesis conducted within the Doctoral Programme in City, Territory and Sustainable Planning at the University of Granada, Spain. The first author thanks the Spanish Ministry of Education and Vocational Training for the scholarship: FPU18/01549.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.enpol.2022.113356>.

References

- Agencia Andaluza de la Energía, 2021. Informe de Infraestructuras energéticas. Provincia Jaén. AAE. Junta de Andalucía [Online]. https://www.agenciaandaluzadelaenergia.es/sites/default/files/Documentos/Infraestructuras/20211231_informe_prov_ja_mie_a_0.pdf. (Accessed 2 June 2022).
- Aparicio, L., 2020. Los agricultores se frotran las manos 'plantando' paneles solares. El País [Online]. <https://elpais.com/economia/2020-10-30/los-agricultores-se-frotran-las-manos-plantando-paneles-solares.html>. (Accessed 5 May 2022).
- 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 Pol.* 132, 1176–1183. <https://doi.org/10.1016/j.enpol.2019.06.067>.
- Barral, M.Á., Iglesias-Pascual, R., Carmona, R.G., Prados, M.J., 2019. Planificación, participación e innovación social en los paisajes de las energías renovables. *Estud. Geográficos* 80 (286), 10. <https://estudiosgeograficos.revistas.csic.es/index.php/estudiosgeograficos/article/view/748/833>.
- Batel, S., Devine-Wright, P., Tangeland, T., 2013. Social acceptance of low carbon energy and associated infrastructures: a critical discussion. *Energy Pol.* 58, 1–5. <https://doi.org/10.1016/j.enpol.2013.03.018>.
- Batel, S., Castro, P., Devine-Wright, P., Howarth, C., 2016. Developing a critical agenda to understand pro-environmental actions: contributions from Social Representations and Social Practices Theories. *Wiley Interdiscip. Rev.: Clim. Change* 7 (5), 727–745. <https://doi.org/10.1002/wcc.417>.

- Bayona, E., 2020. El rechazo a la 'nueva industria' florece en la España vacía: renovables, macrogránjas y ecología productiva disparan los recelos. Público [Online]. <https://www.publico.es/sociedad/negocios-espana-vaciada-rechazo-nueva-industria-florece-espana-vacia-renovables-macrogranjias-ecologia-productiva-disparan-recelos.html>. (Accessed 5 May 2022).
- Bella, B., 2021. Energías renovables, ¿amenaza u oportunidad para el turismo? ViaEmpresa [Online]. https://www.viaempresa.cat/es/territorio/camaras-territorio_2149686_102.html. (Accessed 4 May 2022).
- Bertsch, V., Hall, M., Weinhardt, C., Fichtner, W., 2016. Public acceptance and preferences related to renewable energy and grid expansion policy: empirical insights for Germany. *Energy* 114, 465–477. <https://doi.org/10.1016/j.energy.2016.08.022>.
- Caporale, D., De Lucia, C., 2015. Social acceptance of on-shore wind energy in Apulia region (southern Italy). *Renew. Sustain. Energy Rev.* 52, 1378–1390. <https://doi.org/10.1016/j.rser.2015.07.183>.
- Caporale, D., Sangiorgio, V., Amodio, A., De Lucia, C., 2020. Multi-criteria and focus group analysis for social acceptance of wind energy. *Energy Pol.* 140, 111387. <https://doi.org/10.1016/j.enpol.2020.111387>.
- Carvajal, P.E., Miketa, A., Goussou, N., Fulcheri, P., 2022. Best practice in government use and development of long-term energy transition scenarios. *Energies* 15 (6), 2180. <https://doi.org/10.3390/en15062180>.
- Clausen, L.T., Rudolph, D., 2019. Disembedding the wind-on people-climate reconciliation in Danish wind power planning. *J. Transdiscipl. Environ. Stud.* 17 (1). https://www.researchgate.net/profile/Laura-Tolnov-Clausen/publication/317741403_Disembedding_the_wind_-_on_people-climate_reconciliation_in_Danish_wind_power_planning/links/5cfa3764585153c3da5d197/Disembedding-the-wind-on-people-climate-reconciliation-in-Danish-wind-power-planning.pdf.
- Delicado, A., Figueiredo, E., Silva, L., 2016. Community perceptions of renewable energies in Portugal: impacts on environment, landscape and local development. *Energy Res. Social Sci.* 13, 84–93. <https://doi.org/10.1016/j.erss.2015.12.007>.
- Del Valle, C., Prados, M.J., Delicado, A., García, R., 2019. La participación pública en los procesos de implantación de las energías renovables en España y Portugal. In: Crisis y espacios de oportunidad: XXVI Congreso de la Asociación Española de Geografía. Libro de Actas, pp. 1339–1353. Asociación de Geografía Española y Universitat de Valencia. https://repositorio.ul.pt/bitstream/10451/41276/1/ICS_Adelicado_Participacion.pdf.
- Dugstad, A., Grimsrud, K., Kipperberg, G., Lindhjem, H., Navrud, S., 2020. Acceptance of wind power development and exposure—Not-in-anybody's-backyard. *Energy Pol.* 147, 111780. <https://doi.org/10.1016/j.enpol.2020.111780>.
- El País, 2022. Crisis Energética Y Europa. *El País*, 9 de marzo, 2022. [Online]. <https://elpais.com/opinion/2022-03-09/crisis-energetica-y-europa.html>. (Accessed 17 May 2022).
- Ek, K., 2005. Public and private attitudes towards “green” electricity: the case of Swedish wind power. *Energy Pol.* 33 (13), 1677–1689. <https://doi.org/10.1016/j.enpol.2004.02.005>.
- Esencia de Olivo (n.d). Aceite de oliva de Jaén. Esencia de Olivo - Aceite de Oliva [Online]. Available: <http://www.esenciadeolivo.es/aceite-de-oliva/aceite-de-jaen/>. (Accessed 12 June 2022).
- EuropaPress, 2022. La cuarta subasta de renovables, con 3.300 MW para eólica y fotovoltaica, se celebrará el 22 de noviembre. EuropaPress [Online]. <https://www.europapress.es/economia/energia-00341/noticia-cuarta-subasta-renovables-3300-mw-eolica-fotovoltaica-celebrara-22-noviembre-20220801223856.html>. (Accessed 13 October 2022).
- European Commission, 2006. Attitudes towards energy [Online]. <https://europa.eu/eurobarometer/surveys/detail/1500>. (Accessed 23 May 2022).
- European Commission, 2012. Energy for all: EU support for developing countries [Online]. <https://europa.eu/eurobarometer/surveys/detail/1032>. (Accessed 23 May 2022).
- European Commission, 2019. Europeans' attitudes on EU energy policy [Online]. <https://europa.eu/eurobarometer/surveys/detail/2238>. (Accessed 23 May 2022).
- Fast, S., 2013. Social acceptance of renewable energy: trends, concepts, and geographies. *Geogr. Compass* 7 (12), 853–866. <https://doi.org/10.1111/gec3.12086>.
- Frolova, M., 2010. Los paisajes de la energía eólica: su percepción social y gestión en España. *Nimbus* 25–26, 93–100, 2010, N°. <http://hdl.handle.net/10835/1459>.
- Frolova Ignatieva, M., Espejo Marín, C., Baraja Rodríguez, E., Prados Velasco, M.J., 2014. Paisajes emergentes de las energías renovables en España, vol. 66. Boletín De La Asociación De Geógrafos Españoles. <https://doi.org/10.21138/bage.1788>.
- Gareiou, Z., Drimili, E., Zervas, E., 2021. Public acceptance of renewable energy sources. In: *Low Carbon Energy Technologies in Sustainable Energy Systems*. Academic Press, pp. 309–327. <https://doi.org/10.1016/B978-0-12-822897-5.00012-2>.
- Giordano, L.S., Boudet, H.S., Karmazina, A., Taylor, C.L., Steel, B.S., 2018. Opposition “overblown”? Community response to wind energy siting in the Western United States. *Energy Res. Social Sci.* 43, 119–131. <https://doi.org/10.1016/j.erss.2018.05.016>.
- Gómez, O.T., 2008. Una aplicación de la prueba chi cuadrado con SPSS. *Ind. Data* 11 (1), 73–77 [Online]. <https://www.redalyc.org/articulo.oa?id=81611211011>. (Accessed 23 May 2022).
- Herrador Linder, I., Martín Mesa, A., 2020. Actualización del II Plan Estratégico de la provincia de Jaén. Fundación "Estrategias para el desarrollo económico y social de la provincia de Jaén" [Online]. https://www.planestrajajaen.org/galerias/galeriaDescargas/plan-estrategico/libros/Actualizacion_II_Plan_Estrategico_provincia_Jaen_2020.pdf. (Accessed 26 May 2022).
- International Business Machines Corporation, 2021. V de Cramer. IBM [Online]. <https://www.ibm.com/docs/es/cognos-analytics/11.1.0?topic=terms-cramrs-v>. (Accessed 16 May 2022).
- Ioannidis, R., Koutsoyiannis, D., 2020. A review of land use, visibility and public perception of renewable energy in the context of landscape impact. *Appl. Energy* 276, 115367. <https://doi.org/10.1016/j.apenergy.2020.115367>.
- Instituto Nacional de Estadística (n.d). Cifras oficiales de población resultantes de la revisión del Padrón municipal a 1 de enero [Online]. Available: <https://www.ine.es/jaxiT3/Datos.htm?t=2876>. (Accessed 10 June 2022).
- Instituto Nacional de Estadística, 2021. Pirámide de la población empadronada en España, Provincias, Jaén. INE, España [Online]. <https://www.ine.es/covid/piramides.htm#lprovTab>. (Accessed 13 June 2022).
- Jeuland, M., Fetter, T.R., Li, Y., Pattanayak, S.K., Usmani, F., Bluffstone, R.A., et al., 2021. Is energy the golden thread? A systematic review of the impacts of modern and traditional energy use in low-and middle-income countries. *Renew. Sustain. Energy Rev.* 135, 110406. <https://doi.org/10.1016/j.rser.2020.110406>.
- Kubota, H., 2015. Social acceptance of geothermal power generation in Japan. In: *Proc. World Geotherm. Congr.*, pp. 19–25. <http://www.geothermal-energy.org/pdf/1GAstandard/WGC/2015/02055.pdf>.
- Ladenburg, J., Termansen, M., Hasler, B., 2013. Assessing acceptability of two onshore wind power development schemes: a test of viewshed effects and the cumulative effects of wind turbines. *Energy* 54, 45–54. <https://doi.org/10.1016/j.energy.2013.02.021>.
- Ladenburg, J., 2015. Does more wind energy influence the choice of location for wind power development? Assessing the cumulative effects of daily wind turbine encounters in Denmark. *Energy Res. Social Sci.* 10, 26–30. <https://doi.org/10.1016/j.erss.2015.06.005>.
- Legendijk, A., Kooij, H.J., Veenman, S., Oteman, M., 2021. Noisy monsters or beacons of transition: the framing and social (un) acceptance of Dutch community renewable energy initiatives. *Energy Pol.* 159, 112580. <https://doi.org/10.1016/j.enpol.2021.112580>.
- LaSexta.com, 2021. Cientos de personas se manifiestan en Madrid en contra de los megaproyectos de renovables en las zonas rurales [Online]. https://www.lasexta.com/noticias/sociedad/cientos-personas-manifiestan-madrid-megaproyectos-renovables-zonas-rurales_20211016616b18e057ce480001bed55f.html. (Accessed 1 June 2022).
- 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. *Energy Res. Social Sci.* 56, 101217. <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 Res. Social Sci.* 47, 247–260. <https://doi.org/10.1016/j.erss.2018.09.004>.
- López, J., 2019. Protesta de centenares de personas de Villanueva del Arzobispo contra la contaminación ambiental. *ABCandalucía* [Online]. <https://sevillla.abc.es/andalucia/jaen/sevi-protesta-centenares-personas-villanueva-arzobispo-contra-contaminacion-ambiental-201911161953-noticia.html>. (Accessed 1 June 2022).
- Losa, J.L., 2022. La Junta pide ayuda a las fotovoltaicas para evitar el rechazo a su “revolución verde”. *ElConfidencial* [Online]. https://www.elconfidencial.com/espana/andalucia/2022-03-19/junta-pide-ayuda-fotovoltaicas-evitar-rechazo-revolucion-verde_3394259/. (Accessed 13 October 2022).
- Marrero, R.J., Hernández-Cabrera, J.A., Fumero, A., Hernández, B., 2021. Social acceptance of gas, wind, and solar energies in the Canary Islands. *Int. J. Environ. Res. Publ. Health* 18 (18), 9672. <https://doi.org/10.3390/ijerph18189672>.
- Martin-Arroyo, J., 2022. Atrapados en la lluvia de megaproyectos renovables. *El País* [Online]. <https://elpais.com/economia/2022-01-07/atrapados-en-la-lluvia-de-mega-parques-renovables.html>. (Accessed 19 May 2022).
- Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J. B.R., Maycock, T.K., Waterfield, T., Yelekçi, O., Yu, R., Zhou, B., 2021. Climate change 2021: the physical science basis. In: *Contribution Of Working Group I to the Sixth Assessment Report Of The Intergovernmental Panel On Climate Change* [Online]. https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FinalDraft_FullReport.pdf. (Accessed 13 May 2022).
- Mohorte, 2021. ¿Energía limpia o pesadilla paisajística? El creciente rechazo del mundo rural a los parques eólicos. *Magnet* [Online]. <https://magnet.xataka.com/en-diez-minutos/energia-limpia-pesadilla-paisajistica-creciente-rechazo-mundo-rural-a-parques-eolicos>. (Accessed 13 May 2021).
- Musall, F.D., Kuik, O., 2011. Local acceptance of renewable energy—a case study from southeast Germany. *Energy Pol.* 39 (6), 3252–3260. <https://doi.org/10.1016/j.enpol.2011.03.017>.
- Navarrete, M., 2021. Baza y Caniles libran la batalla de las fotovoltaicas. *Ideal.es* [Online]. <https://www.ideal.es/granada/provincia-granada/baza-caniles-libran-20210523172932-nt.html>. (Accessed 1 June 2022).
- Osorio-Aravena, J.C., Rodríguez-Segura, F.J., Frolova, M., Terrados, J., Muñoz-Cerón, E., 2022. How much solar PV, wind and biomass energy could be implemented in short and medium term? A multi-criteria GIS-based approach applied to the province of Jaén, Spain. *J. Clean. Prod.* 366, 132920. <https://doi.org/10.1016/j.jclepro.2022.132920>.
- Pinto, L.M.C., Sousa, S., Valente, M., 2021. Explaining the social acceptance of renewables through location-related factors: an application to the Portuguese case. *Int. J. Environ. Res. Publ. Health* 18 (2), 806. <https://doi.org/10.3390/ijerph18020806>.
- Prados, M.J., 2010. Renewable energy policy and landscape management in Andalucía, Spain: the facts. *Energy Pol.* 38 (11), 6900–6909. <https://doi.org/10.1016/j.enpol.2010.07.005>.
- Prados, M.J., Baraja Rodríguez, E., Frolova Ignatieva, M., Espejo Marín, C., 2012. Integración paisajística y territorial de las energías renovables. *Ciudad Territ. - Estud. Territ.* 171, 127–143. <http://hdl.handle.net/11441/26591>.

- Prosperi, M., Lombardi, M., Spada, A., 2019. Ex ante assessment of social acceptance of small-scale agro-energy system: a case study in southern Italy. *Energy Pol.* 124, 346–354. <https://doi.org/10.1016/j.enpol.2018.10.015>.
- Real Decreto 413/2014, 2014. de 6 de junio, por el que se regula la actividad de producción de energía eléctrica a partir de fuentes de energía renovables, cogeneración y residuos. de 10 de junio de Boletín Oficial del Estado, núm 140, 43876–43978 [Online]. https://www.boe.es/diario_boe/txt.php?id=BOE-A-2014-6123. (Accessed 11 May 2022).
- Ritchie, H., Roser, M., Rosado, P., 2020. Emissions by sector - our world in data 2020 [Online]. <https://ourworldindata.org/emissions-by-sector>. (Accessed 6 June 2022).
- Rodríguez Cámara, J., 2016. Firmas de 650 tosirianos para exigir que la planta de biomasa sea limpia. *DiarioJaén* [Online]. <https://www.diariojaen.es/provincia/firmas-de-650-tosirianos-para-exigir-que-la-planta-de-biomasa-sea-limpia-YY1643067>. (Accessed 7 June 2022).
- Rositas Martínez, J., 2014. Los tamaños de las muestras en encuestas de las ciencias sociales y su repercusión en la generación del conocimiento (Sample sizes for social science surveys and impact on knowledge generation). *Innovaciones de negocios* 11 (22), 235–268. <http://eprints.uanl.mx/12605/>.
- Rosso-Cerón, A.M., Kafarov, V., 2015. Barriers to social acceptance of renewable energy systems in Colombia. *Curr. Opin. Chem. Eng.* 10, 103–110. <https://doi.org/10.1016/j.coche.2015.08.003>.
- Ruggiero, S., Onkila, T., Kuittinen, V., 2014. Realizing the social acceptance of community renewable energy: a process-outcome analysis of stakeholder influence. *Energy Res. Social Sci.* 4, 53–63. <https://doi.org/10.1016/j.erss.2014.09.001>.
- Ruiz-Arias, J.A., Terrados, J., Pérez-Higuera, P., Pozo-Vázquez, D., Almonacid, G., 2012. Assessment of the renewable energies potential for intensive electricity production in the province of Jaén, southern Spain. *Renew. Sustain. Energy Rev.* 16 (5), 2994–3001. <https://doi.org/10.1016/j.rser.2012.02.006>.
- Sauter, R., Watson, J., 2007. Strategies for the deployment of micro-generation: implications for social acceptance. *Energy Pol.* 35 (5), 2770–2779. <https://doi.org/10.1016/j.enpol.2006.12.006>.
- Scheer, D., Konrad, W., Wassermann, S., 2017. The good, the bad, and the ambivalent: a qualitative study of public perceptions towards energy technologies and portfolios in Germany. *Energy Pol.* 100, 89–100. <https://doi.org/10.1016/j.enpol.2016.09.061>.
- Scherhauer, P., Höltinger, S., Salak, B., Schuppenlehner, T., Schmidt, J., 2017. Patterns of acceptance and non-acceptance within energy landscapes: a case study on wind energy expansion in Austria. *Energy Pol.* 109, 863–870. <https://doi.org/10.1016/j.enpol.2017.05.057>.
- Segreto, M., Principe, L., Desormeaux, A., Torre, M., Tomassetti, L., Tratzi, P., et al., 2020. Trends in social acceptance of renewable energy across Europe—a literature review. *Int. J. Environ. Res. Publ. Health* 17 (24), 9161. <https://doi.org/10.3390/ijerph17249161>.
- Sharpton, T., Lawrence, T., Hall, M., 2020. Drivers and barriers to public acceptance of future energy sources and grid expansion in the United States. *Renew. Sustain. Energy Rev.* 126, 109826 <https://doi.org/10.1016/j.rser.2020.109826>.
- Soland, M., Steimer, N., Walter, G., 2013. Local acceptance of existing biogas plants in Switzerland. *Energy Pol.* 61, 802–810. <https://doi.org/10.1016/j.enpol.2013.06.111>.
- Sütterlin, B., Siegrist, M., 2017. Public acceptance of renewable energy technologies from an abstract versus concrete perspective and the positive imagery of solar power. *Energy Pol.* 106, 356–366. <https://doi.org/10.1016/j.enpol.2017.03.061>.
- Toledo, C., Scognamiglio, A., 2021. Agrivoltaic systems design and assessment: a critical review, and a descriptive model towards a sustainable landscape vision (three-dimensional agrivoltaic patterns). *Sustainability* 13 (12), 6871. <https://doi.org/10.3390/su13126871>.
- Upreti, B.R., 2004. Conflict over biomass energy development in the United Kingdom: some observations and lessons from England and Wales. *Energy Pol.* 32 (6), 785–800. [https://doi.org/10.1016/S0301-4215\(02\)00342-7](https://doi.org/10.1016/S0301-4215(02)00342-7).
- Upreti, B.R., van der Horst, D., 2004. National renewable energy policy and local opposition in the UK: the failed development of a biomass electricity plant. *Biomass Bioenergy* 26 (1), 61–69. [https://doi.org/10.1016/S0961-9534\(03\)00099-0](https://doi.org/10.1016/S0961-9534(03)00099-0).
- Urrea Corres, M., 2011. La política energética de la Unión Europea a la luz del Tratado de Lisboa. En *Seguridad, modelo energético y cambio climático*. Madrid: Ministerio de Defensa, Subdirección General de Publicaciones, pp. 115–144. http://repositori.uji.es/xmlui/bitstream/handle/10234/118405/politica+energetica_urrea+corres_2_011.pdf?sequence=1.
- Wüstenhagen, R., Wolsink, M., Bürer, M.J., 2007. Social acceptance of renewable energy innovation: an introduction to the concept. *Energy Pol.* 35 (5), 2683–2691. <https://doi.org/10.1016/j.enpol.2006.12.001>.
- Yuan, X., Zuo, J., Ma, C., 2011. Social acceptance of solar energy technologies in China—end users' perspective. *Energy Pol.* 39 (3), 1031–1036. <https://doi.org/10.1016/j.enpol.2011.01.003>.